UCONN
UNIVERSITY OF CONNECTICUT

Office of the General Counsel
Lesley N. Salafia
Attorney

Via Hand Delivery

January 9, 2014

Kimberly R. Martone
Director of Operations
Office of Health Care Access
Department of Public Health
410 Capitol Avenue
MS#13HCA
P.O. Box 340308
Hartford, CT 06134

RECEIVED
JAN 10 2014
OFFICE OF
HEALTH CARE ACCESS

Re: Certificate of Need Application
Acquisition of Human Subject Research 3T MRI Scanner at the University of Connecticut

Dear Ms. Martone,

Enclosed please find the University of Connecticut's original Application for a Certificate of Need for the Acquisition of a Human Subject Research 3T MRI Scanner at the University of Connecticut at Storrs, Connecticut, along with a $500 application fee check, four (4) hard copies of the application with appendices, and an electronic copy of the application and appendices submitted on CD. Copies of the published public notices are attached at Appendix I of this application.

The Proposed MRI will be used for academic research purposes only and will not provide clinical or health care services or training for clinical purposes.

Please do not hesitate to contact me if I can offer additional information.

Thank you in advance for your time and attention.

Sincerely,

Lesley N Salafia

Lesley N. Salafia

Enc.

343 MANSFIELD ROAD, UNIT 1177
STORRS, CT 06269-1177
PHONE 860 486 5796
FAX 860.486 4369
lesley.salafia@uconn.edu
www.generalcounsel.uconn.edu

Application Checklist

Instructions:

1. **Please check each box below, as appropriate; and**
2. **The completed checklist *must* be submitted as the first page of the CON application.**

☒ **Attached is the CON application filing fee in the form of a certified, cashier or business check made out to the "Treasurer State of Connecticut" in the amount of $500.**

For OHCA Use Only:

Docket No.: 14-31889-CON **Check No.:** 551836
OHCA Verified by: KR **Date:** 1-10-14

☒ **Attached is evidence demonstrating that public notice has been published in a suitable newspaper that relates to the location of the proposal, 3 days in a row, at least 20 days prior to the submission of the CON application to OHCA. (*OHCA requests that the Applicant fax a courtesy copy to OHCA (860) 418-7053, at the time of the publication)*** See Appendix I.

☒ **Attached is a paginated hard copy of the CON application including a completed affidavit, signed and notarized by the appropriate individuals.**

☒ **Attached are completed Financial Attachments I and II.** See Appendix H.

☒ **Submission includes one (1) original and four (4) hard copies with each set placed in 3-ring binders.**

Note: A CON application may be filed with OHCA electronically through email, if the total number of pages submitted is 50 pages or less. In this case, the CON Application must be emailed to ohca@ct.gov.

Important: For CON applications(less than 50 pages) filed electronically through email, the singed affidavit and the check in the amount of $500 must be delivered to OHCA in hardcopy.

☒ **The following have been submitted on a CD**

1. **A scanned copy of each submission in its entirety, including all attachments in Adobe (.pdf) format.**
2. **An electronic copy of the documents in MS Word and MS Excel as appropriate.**

UNIVERSITY OF CONNECTICUT
STORRS, CONNECTICUT 06269

VENDOR NO. 15953-3 DATE 12/27/13 CHECK NO. **551836**

DATE	INVOICE NO.	PO #	DOC NUMBER	AMOUNT	DISCOUNT	NET AMOUNT
12/20/13	MRI/CERT/12192013		785858	500.00	0.00	500.00
Page #1			TOTALS>	500.00	0.00	500.00

RELYCO (800) 777-RELY (7359)
U.S. Pat.# 6,095,407

UNIVERSITY OF
CONNECTICUT
STORRS, CONNECTICUT 06269

51-44
119

BANK OF AMERICA
Accounts Payable Account

CHECK NO. 551836

CHECK DATE	CHECK AMOUNT
12/27/2013	*********$500.00

VOID AFTER 120 DAYS

PAY *FIVE HUNDRED DOLLARS AND ZERO CENTS*

TO THE ORDER OF
State of CT Ofc of Treasurer
Office of Health Care Access
410 Capitol Avenue MS #13HCA
Hartford CT 06134-0308

AUTHORIZED SIGNATURE

THE BACK OF THIS DOCUMENT CONTAINS AN ARTIFICIAL WATERMARK - HOLD AT AN ANGLE TO VIEW

[redacted]

See Reverse Side For Easy Opening Instructions

UNIVERSITY OF CONNECTICUT
ACCOUNTS PAYABLE
3 NO. HILLSIDE RD. UNIT 6080
STORRS, CT 06269-6080

SO-385208 • 11Z-VG

State of CT Ofc of Treasurer
Office of Health Care Access
410 Capitol Avenue MS #13HCA
Hartford CT 06134-0308

AFFIDAVIT

Applicant: University of Connecticut

Project Title: Acquisition of Human Subject Research 3T MRI Scanner at the University of Connecticut at Storrs

I, Richard Gray, Executive Vice President for Administration and CFO
(Individual's Name) (Position Title – CEO or CFO)

of the University of Connecticut being duly sworn, depose and state that
(Hospital or Facility Name)

University of Connecticut's information submitted in this Certificate of
(Hospital or Facility Name)

Need Application is accurate and correct to the best of my knowledge.

Signature

Date 1/8/2014

Subscribed and sworn to before me on January 8, 2014

Donna M. Balskus

Notary Public/Commissioner of Superior Court

My commission expires:

DONNA M BALSKUS
NOTARY PUBLIC
MY COMMISSION EXPIRES
JULY 31, 2017

State of Connecticut
Office of Health Care Access
Certificate of Need Application

Instructions: Please complete all sections of the Certificate of Need ("CON") application. If any section or question is not relevant to your project, a response of "Not Applicable" may be deemed an acceptable answer. If there is more than one applicant, identify the name and all contact information for each applicant. OHCA will assign a Docket Number to the CON application once the application is received by OHCA.

Docket Number:	
Applicant:	University of Connecticut
Contact Person:	Lesley N. Salafia, Esq.
Contact Person's Title:	Attorney
Contact Person's Address:	University of Connecticut Office of the General Counsel 343 Mansfield Road, Unit 1177 Storrs, CT 06269-1177
Contact Person's Phone Number:	860-486-5796
Contact Person's Fax Number:	860-486-4369
Contact Person's Email Address:	lesley.salafia@uconn.edu
Project Town:	Mansfield
Project Name:	Acquisition of Human Subject Research 3T MRI Scanner at the University of Connecticut at Storrs
Statute Reference:	Section 19a-638(a)(9), C.G.S.
Estimated Total Capital Expenditure:	$3,000,000 to $4,000,000 for the MRI equipment, plus approximately $4,000,000 in related facility construction costs

1. Project Description: Acquisition of Equipment

a. Please provide a narrative detailing the proposal.

Pursuant to Connecticut General Statutes section 19a-638(a)(9), the University of Connecticut (the "University") is seeking approval to acquire and install a 3T MRI scanner (the "Proposed MRI") at its Storrs Campus. The Proposed MRI will be used for functional magnetic resonance imaging ("fMRI") research and will be located at the University's Phillips Communication Sciences Building, 850 Bolton Road, Unit 1085, Storrs, CT 06269 (the "UConn MRI Center"). The Proposed MRI would be the first functional MRI scanner owned and operated at the Storrs Campus. Currently, the University faculty performing such research must conduct their research off-campus through arrangements with other academic centers, including Brown and Yale.

As background, fMRI technology uses a combination of a magnet and radio frequencies to study oxygen flow to areas of the brain. More specifically, the fMRI technology shows the researcher where the blood is rich in oxygen and where it is not. Resulting images help researchers map which parts of the brain are used for speech, hearing, vision and motor skills.[1]

> ***Conventional MRI uses a powerful magnet and radio waves to safely and noninvasively produce images of the brain or other structures inside your body. In the early 1990s, researchers thought up a new way to use this imaging technology: as a research tool rather than a diagnostic method. Putting the "f" in fMRI, these researchers focus on function. Using an MRI scanner, they monitor the flow of blood to different regions of the brain as their research subjects respond to a specific stimulus—a sound, an image, even a touch. While conventional MRI results in snapshots of what's inside the body, fMRI produces movies starring the brain.***[2]

The UConn MRI Center will serve the University's research and academic community. Specifically, the Proposed MRI will be used exclusively for research purposes on volunteer human subjects for studies conducted by University professors and research staff within various academic departments, including but not limited to, the Departments of Psychology, Physiology and Neurobiology, Linguistics, Kinesiology, Speech-Language-and-Hearing-Sciences, and Economics. Research studies using the fMRI technology will study brain correlates of typical and atypical language processing, developmental disabilities (e.g. autism spectrum disorders or dyslexia), decision making, and the processing of emotional or social stimuli. Individual MRI scans would be compiled into study results for future dissemination of scientific research. Research subjects would not be provided with

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[1] See http://www.technologyreview.com/article/401111/functional-mri/.
[2] See http://www.apa.org/research/tools/fmri-adult.pdf.

any health care services. More specifically, the Proposed MRI will not be used in connection with the delivery of health care services.

The University proposes to acquire the Proposed MRI because of its desired Signal-to-Noise ratio and the time required to acquire a typical scan have made 3 Tesla or "3T" scanners the standard research tool in cognitive neuroscience and other brain research areas. Currently, Storrs Campus researchers are using 3T scanners at other sites in the region and/or collaborate with researchers elsewhere that employ 3T scanners. Other top-tier, public, research-intensive universities all have one or more research-dedicated 3T scanners (see <u>Appendix B</u>, MRI Steering Committee Progress Report for web addresses of MRI Centers at comparable universities).

The UConn MRI Center would be operated wholly separate from the University of Connecticut Health Center ("UCHC") in order to maintain the Proposed MRI for the dedicated research purposes of the University's faculty and to avoid compromising the research goals of the UConn MRI Center or interfering with the utilization needs of UCHC. Data generated by the UConn MRI Center will be used for research and not treatment purposes.

The research subjects for the fMRI research studies would be volunteers typically recruited from the Mansfield, Connecticut community, University students, staff, or faculty members of the Storrs Campus.

The UConn MRI Center will be renovated to accommodate various research space and support functions for the Proposed MRI. Although the overall project budget for the renovation is expected to be approximately Eight Million Dollars ($8,000,000), the capital expenditures for the Proposed MRI and associated equipment are expected to be approximately Three and One Half Million Dollars ($3,500,000). Construction and the establishment of the UConn MRI Center will comply with all safety standards from the American College of Radiology for Magnetic Resonance Imaging. The University's Division of Environmental Health and Safety is involved in the design and functioning of the UConn MRI Center in consultation with an outside firm experienced in the construction of MRI facilities. Staff of the UConn MRI Center will maintain safety and performance standards set by the American College of Radiology.

If approved, the UConn MRI Center will operate as a non-profit research entity that will rely on research grants from federal agencies and private foundations, as well as on internal operational support from the University, for its operating costs. The initial capital expenditures for this proposal were allocated by the University's Board of Trustees as part of internal appropriations for scientific research initiatives.

The UConn MRI Center is an essential component to the University's academic research mission and initiatives. As stated in the University's Mission Statement,

The University of Connecticut is dedicated to excellence demonstrated through national and international recognition. As Connecticut's public research university, through freedom of academic inquiry and expression, we create and disseminate knowledge by means of scholarly and creative achievements, graduate and professional education, and outreach. Through our focus on teaching and learning, the University helps every student grow intellectually and become a contributing member of the state, national, and world communities. Through research, teaching, service, and outreach, we embrace diversity and cultivate leadership, integrity, and engaged citizenship in our students, faculty, staff, and alumni. As our state's flagship public land and sea grant institution, we promote the health and well-being of Connecticut's citizens through enhancing the social, economic, cultural, and natural environments of the state and beyond.[3]

The UConn MRI Center is likewise an integral component of the University's Academic Plan, which establishes Health and Human Behavior as one of the University's three Focused Areas of Excellence.[4] This focused area of interdisciplinary excellence grounded in biomedical science is an important factor guiding the development of the University's existing research, teaching and public engagement initiatives. As defined within the University's Academic Plan, the University aspires to further develop these focused areas of excellence into practical and active research centers.

GOAL 3: RESEARCH, SCHOLARSHIP, AND CREATIVE ACTIVITY Enhance the benefits to the state, nation, and world from faculty, staff, and student research, scholarship, and creative activity by increasing productivity, building on our existing strengths and focused areas of excellence, developing a stronger extramural funding portfolio, and expanding the infrastructure that supports research and strengthens our ability to translate new discoveries into practical applications, including our capacity in the area of technology transfer.[5]

Additionally, it is hoped that knowledge gained through the described research studies conducted at the UConn MRI Center will provide long-term benefits to the residents of the State of Connecticut.

b. Provide letters that have been received in support of the proposal.

Letters have been attached to this proposal as part of Appendix A.

[3] See http://provost.uconn.edu/mission-statement/.
[4] See http://www.academicplan.uconn.edu/files/UConnAcademicPlan.pdf.
[5] Id.

c. Provide the Manufacturer, Model, Number of slices/tesla strength of the proposed scanner (as appropriate to each piece of equipment).

The Proposed MRI will be a wide bore 3 Tesla MRI scanner. In accordance with State of Connecticut procurement practices, the University has released a competitive RFP for its acquisition, and will be seeking proposals from Siemens, Philips and GE. Thus, the acquired model could be one of the following: a 3T Siemens Prisma, a 3T Philips Ingenia or a 3T GE Discovery. Upon approval from OHCA and the selection of an MRI scanner, an update with the exact specifications will be given to OHCA when a contract is near execution with the applicable vendor.

d. List each of the Applicant's sites and the imaging modalities and other services currently offered by location.

The University (other than on the UCHC, which is considered a separate State entity for these purposes) does not have an MRI scanner on any of its campuses. The Philips Communication Science Building that will house the UConn MRI Center currently conducts research studies relating to communication processes and communication disorders. Volunteer human research subjects are utilized in these studies. Although the University has a DPH-licensed infirmary and a child care center, these services are not related to the operations of the UConn MRI Center.

UCHC is not an applicant to this proposal and is considered a separate State entity for State licensing purposes.

2. Clear Public Need

a. Explain why there is a clear public need for the proposed equipment. Provide evidence that demonstrates this need.

UConn researchers currently conduct many research studies related to cognitive neuroscience, communication processes, and communication disorders. However, the University is severely limited in conducting research in the areas of brain correlates of typical and atypical language processing, developmental disabilities (e.g. autism spectrum disorders or dyslexia), decision making, and the processing of emotional or social stimuli. University researchers must travel to other research institutions in and out of Connecticut in order to conduct research utilizing fMRI. Currently, at least seven (7) researchers from the University's Department of Psychology and from the interdisciplinary Cognitive Science program lease session time on other research-dedicated scanners from research institutions in Connecticut or Rhode Island. In addition to facilitating and advancing the research of these individual faculty members, fMRI capability on the Storrs Campus would encourage other current University faculty to use this research tool to advance their research studies, and it will help to recruit the best new research faculty to the

University. In addition, other researchers from other institutions could potentially come to the University to lease session time on the Proposed MRI.

Many universities have one or more MRI centers, including the state flagship universities in Michigan, Texas, North Carolina, Wisconsin, California, and Illinois. Of UConn's current peer universities (University of Georgia, University of Iowa, Iowa State, University of Minnesota, University of Missouri, Ohio State University, Purdue University, and Rutgers University), only one (Iowa State) does not have an on-campus imaging center either in place or under construction. Regionally, Brown, Harvard, Yale, Dartmouth, Boston University and the University of Massachusetts all have academic and research focused MRI centers. The availability of MRI scanners at almost all of these universities attests to the scientific value of this technology for a wide variety of academic disciplines, including cognitive neuroscience, behavioral genetics, and educational neuroscience, all of which are research strengths of the University.

A research-dedicated UConn MRI Center located at the Storrs Campus will allow University researchers to have greater access to necessary fMRI equipment, greater flexibility in scheduling their research, greater control over their research, and an enhanced ability to secure federal research grants. Otherwise, the failure to have the UConn MRI Center at the Storrs Campus for research purposes will limit the University's ability to attract federal research grants relative to those universities and academic research sites that have the MRI technology. In addition, having the UConn MRI Center on the Storrs Campus will facilitate collaborative research among University faculty, who can gather conveniently in a single place to present and share findings and collaborate on future studies.

Additional information is included as part of <u>Appendix B</u>, "UConn MRI Center: Progress Report."

Copies of the published public notice of this intended filing are attached at <u>Appendix I</u>.

b. Provide the utilization of existing health care facilities and health care services in the Applicant's service area.

Currently, there is no research MRI scanner available within the University's service area of Mansfield, Tolland or Windham. Although there are MRI scanners at the Tolland Imaging Center and at Windham Hospital, these MRI scanners are used for clinical purposes. Furthermore, they have magnet strengths lower than 3T and thus would not be of value to University researchers.

c. Complete **Table 1** for each piece of equipment of the type proposed currently operated by the Applicant at each of the Applicant's sites.

Table 1: Existing Equipment Operated by the Applicant

Provider Name Street Address Town, Zip Code	Description of Service *	Hours/Days of Operation **	Utilization ***
Not Applicable			

* Include equipment strength (e.g. slices, tesla strength), whether the unit is open or closed (for MRI)
** Days of the week unit is operational, and start and end time for each day; and
*** Number of scans/exams performed on each unit for the most recent 12-month period (identify period).

There are no MRI scanners or related equipment currently operated at the Storrs Campus or any of the University's regional campuses, including the Avery Point, West Hartford, School of Law, Torrington, Waterbury or Stamford campuses.

d. Provide the following regarding the proposal's location:

i. The rationale for locating the proposed equipment at the proposed site;

The Storrs Campus was selected as the location for the UConn MRI Center to enable the greatest availability and flexibility for magnet time for the University's faculty. The UConn MRI Center was specifically selected due to its ideal site parameters for an MRI scanner. The University hired a consulting firm to conduct a variety of analyses on prospective locations on the Storrs Campus. The selected Philips Communication Science Building provided the most centralized location, space availability and the greatest level of safety for the UConn MRI Center. Currently, there is an existing concrete bunker attached to the UConn MRI Center that will house the Proposed MRI. The concrete bunker will serve as additional shielding in combination with the radio frequency shielding to provide the greatest level of safety and research consistency.

ii. The population to be served, including specific evidence such as incidence, prevalence, or other demographic data that demonstrates need;

The University will typically and primarily recruit volunteer subjects from Mansfield and surrounding towns as well as from the University community. Since the Proposed MRI will not be utilized to provide health care services, the issues of prevalence and incidence are inapplicable.

All volunteer research subjects recruited for research studies at the UConn MRI Center will grant Informed Consent in accordance with the University's Institutional Review Board ("IRB") applicable policies. In some cases, dependent upon the individual research study and research budget, volunteers might be compensated for their time. Information about the IRB's oversight of the proposed UConn MRI Center, and a copy of the IRB's protocols for the involvement of

human subjects in research, including Informed Consent, are attached as <u>Appendix J</u>.

iii. How and where the proposed patient population is currently being served;

There is no current population of subjects being served in the service areas for research purposes. University researchers currently conducting MRI studies travel to locations outside of the service area to conduct the research described herein.

iv. All existing providers (name, address) of the proposed service in the towns listed above and in nearby towns;

Although there is no research-dedicated, 3T MRI scanner in the described service area of Tolland, Mansfield, and Windham, the following providers have clinical MRI scanners of different Tesla strengths:

1) **Tolland Imaging Center, 6 Fieldstone Commons, Suite E, 159 Merrow Road, Tolland, CT 06084**

2) **Windham Hospital, 112 Mansfield Avenue, Willimantic, CT 06226**

v. The effect of the proposal on existing providers; and

This proposal will have no impact on existing clinical service providers in the service areas of Mansfield, Tolland and Windham, as the Proposed MRI will be used for research purposes only and will not be offering clinical services. Indirectly, providers of clinical services may benefit from the basic scientific research produced utilizing the Proposed MRI.

vi. If the proposal involves a new site of service, identify the service area towns and the basis for their selection.

The typical service area towns would be Mansfield, Tolland, and Windham for the recruitment of research participants. The primary reason for recruiting from the University and Mansfield population will be for the convenience of the subjects and to increase the ease with which research is conducted given proximity to the research site. Although the typical recruitment population will primarily be University students, faculty and staff, as well as some Mansfield residents, it is probable that some subjects may be located in areas neighboring Mansfield. Again, no health care services will be provided to any individuals, and therefore, there are no applicable service areas.

e. Explain why the proposal will not result in an unnecessary duplication of existing or approved health care services.

The Proposed MRI will be utilized solely for research purposes and not clinical purposes. Therefore, there will be no duplication of any existing or approved health care services.

3. Actual and Projected Volume

a. Complete the following tables for the past three fiscal years ("FY"), current fiscal year ("CFY"), and first three projected FYs of the proposal, for each of the Applicant's existing and proposed pieces of equipment (of the type proposed, at the proposed location only). In Table 2a, report the units of service by piece of equipment, and in Table 2b, report the units of service by type of exam (e.g. if specializing in orthopedic, neurosurgery, or if there are scans that can be performed on the proposed scanner that the Applicant is unable to perform on its existing scanners).

Table 2a: Historical, Current, and Projected Volume, by Equipment Unit

	Actual Volume (Last 3 Completed FYs)			**Projected Volume (First 6 Months, and First 3 Full Operational FYs)****			
	FY ****	FY ****	FY ****	FY 2015 (6 mos)	FY 2016	FY 2017	FY 2018
3T MRI	NA	NA	NA	182 use hours	600 use hours	1000 use hours	1250 use hours
Total				182 use hours	600 use hours	1000 use hours	1250 use hours

* For periods greater than 6 months, report annualized volume, identifying the number of actual months covered and the method of annualizing. For periods less than six months, report actual volume and identify the period covered.
** If the first year of the proposal is only a partial year, provide the first partial year and then the first three full FYs. Add columns as necessary.
*** Identify each scanner separately and add lines as necessary. Also break out inpatient/outpatient/ED volumes if applicable.
**** Fill in years. In a footnote, identify the period covered by the Applicant's FY (e.g. July 1-June 30, calendar year, etc.).

Table 2b: Historical, Current, and Projected Volume, by Type of Scan/Exam

	Actual Volume (Last 3 Completed FYs)			**Projected Volume (First 6 Months, and First 3 Full Operational FYs)****			
	FY ****	FY ****	FY ****	FY 2015 (6 mos)	FY 2016	FY 2017	FY 2018
Research	NA	NA	NA	182 use hours	600 use hours	1000 use hours	1250 use hours
Total				182 use hours	600 use hours	1000 use hours	1250 use hours

* For periods greater than 6 months, report annualized volume, identifying the number of actual months covered and the method of annualizing. For periods less than six months, report actual volume and identify the period covered.
** If the first year of the proposal is only a partial year, provide the first partial year and then the first three full FYs. Add columns as necessary.
*** Identify each type of scan/exam (e.g. orthopedic, neurosurgery or if there are scans/exams that can be performed on the proposed piece of equipment that the Applicant is unable to perform on its existing equipment) and add lines as necessary.
**** Fill in years. In a footnote, identify the period covered by the Applicant's FY (e.g. July 1-June 30, calendar year, etc.).

The University's Fiscal Year is from July 1st to June 30th. Unit of service is calculated in terms of use hours, as internal and external grant charges will be accrued on an hourly basis. There is no actual volume, as no research MRI time is currently being provided. For projections, it is estimated that the Proposed MRI will be operationally used for fifty (50) weeks per year with two (2) weeks of service time. FY 2015, as a partial period, is expected to have one hundred eighty-two (182) hours of use time at seven (7) hours per week for twenty six (26) weeks as the UConn MRI Center develops its operations and user base and its internal policies and procedures. For FY 2016, it is expected that usage will ramp up to twelve (12) hours per week given that the UConn MRI Center will be fully operational. In FY 2017, it is expected that twenty (20) hours per week of use time will be established, for which there will be a net gain for the UConn MRI Center due to billable hours and Office of Sponsored Program rates on grants for plant and administrative costs. In FY 2018, the operational goal is twenty-five (25) hours per week. All time on the Proposed MRI will be research time, and thus table 2a and 2b are effectively the same.

b. Provide a breakdown, by town, of the volumes provided in Table 2a for the most recently completed full FY.

This is Not Applicable as there is no current equipment and no current location. This will be a new equipment installation.

c. Describe existing referral patterns in the area to be served by the proposal.

As this is a new installation and will be for research purposes only, there is no existing referral pattern or any planned referral system. For soliciting prospective subjects, IRB requests for human subject participation will be disseminated through channels such as University email list-servs, the student newspaper at Storrs entitled the *Daily Campus*, and other localized communication channels specific to the Storrs Campus.

d. Explain how the existing referral patterns will be affected by the proposal.

This is Not Applicable as existing referral patterns will not be affected by this proposal. This proposal is for research purposes only.

e. Explain any increases and/or decreases in volume seen in the tables above.

FY 2015 will be a half-year of operation because the UConn MRI Center will have just opened with brand new staffing. Therefore, it is expected that initial usage may be light, with approximately seven (7) use hours per week. It is expected that in FY 2016, as the UConn MRI Center becomes fully operational, use time will ramp up to twelve (12) hours per week. The eventual goal is to achieve at least twenty (20) hours per week of use time to cover operational expenses, which is expected to occur in FY 2017.

f. Provide a detailed explanation of all assumptions used in the derivation/ calculation of the projected volume by scanner and scan type.

It is estimated that the Proposed MRI will be operationally used for fifty (50) weeks out of the year. FY 2015, as a partial period, is expected to have one hundred eighty-two (182) hours of use time at seven (7) hours per week for twenty-six (26) weeks. For FY 2016, it is expected that usage will increase to twelve (12) hours per week given that the UConn MRI Center will be fully operational. In FY 2017, it is expected that there will be twenty (20) hours per week of use time. This would be in-line with the University's benchmark peers for research-dedicated MRI center operations, such as Brown University which opened a 3T MRI suite in 2008. All time on the Proposed MRI will be research time; thus table 2a and 2b are effectively the same.

g. Provide a copy of any articles, studies, or reports that support the need to acquire the proposed scanner, along with a brief explanation regarding the relevance of the selected articles.

The report presented to the University's senior administration for this proposal, "UConn MRI Center: Progress Report," has been attached as Appendix B. This report includes the prospective research to be conducted, the potential user base, and other considerations.

Five representative articles employing fMRI methods, and conducted by UConn faculty, are offered in Appendix L. Below are brief reviews of these articles:

- **In Braze, Mencl, Tabor, Pugh, Constable, Fulbright, Magnuson, van Dyke, & Shankweiler (UNIFICATION OF SENTENCE PROCESSING VIA EAR AND EYE: AN FMRI STUDY, 2009, *Cortex, Volume 47*), fluent readers were given both verbal and written versions of English passages in which a mistake had been embedded. They found that two areas of the brain (left and frontal cortex) were differentially sensitive to language errors, whether in oral or written form. Thus, there is a common brain architecture sensitive to errors in both forms of linguistic input. The study suggests that our 'language brain' processes written and oral speech similarly, even though reading and writing develop much later in children.**

- **In Landi, Frost, Mencl, Preston, Jacobsen, Lee, Yrigollen, Pugh, and Grigorenko (THE COMT VAL/MET POLYMORPHISM IS ASSOCIATED WITH READING RELATED SKILLS AND CONSISTENT PATTERNS OF FUNCTIONAL NEURAL ACTIVATION, 2013, *Developmental Science, Volume 16*), a gene previously found to be associated with differences in memory, attention, and executive function was discovered to be associated with reading ability. Two groups of elementary school children, differing in which allele of the COMT gene was present, were given several reading tests and an fMRI task involved matching words to pictures of simple objects. Children with the MET allele of the COMT gene had better reading scores as well as patterns of increased brain activation in the left occipitotemporal junction and fusiform gyrus, patterns similar to those associated with better readers. This study is one of the first to link gene variation, brain activation, and behavior in any cognitive domain.**

- **In Myers, Blumstein, Walsh, & Eliassen (INFERIOR FRONTAL REGIONS UNDERLIE THE PERCEPTION OF PHONETIC CATEGORY INVARIANCE, 2009, *Psychological Science, Volume 20*), 18 healthy adults listened to small units of language (syllables) while in the scanner and pressed a button when they heard a change in the syllable. The purpose was to identify regions of the brain responsible for the formation of categories of language sounds. The left inferior frontal sulcus showed consistent activation when syllables changed, adding new data to other studies showing that this left cortical brain area is involved in computing category representations.**

- **In Pugh, Frost, Sandak, Landi, Rueckl, Constable, Seidenberg, Fulbright, Katz, & Mencl (EFFECTS OF STIMULUS DIFFICULTY AND REPETITION ON PRINTED WORD IDENTIFICATION: AN FMRI COMPARISON OF NONIMPAIRED AND READING-DISABLED ADOLESCENT COHORTS, 2008, *Journal of Cognitive Neuroscience, Volume 20*), a group of reading disabled adolescents was compared with a group of non-impaired readers. Both groups were asked to identify real versus nonsense words in a functional MRI study. Whereas the left posterior cortex became *less* active in non-impaired readers when words were made easier to identify (e.g., they were more common English words), the same region became *more* active in the reading disabled group. This study suggests that reading disabled adolescents have disrupted, but not wholly disabled or inactive, brain architecture underlying reading abilities.**

- **In Eigsti, Schuh, Mencl, Schultz, & Paul (THE NEURALNDERPINNINGS OF PROSODY IN AUTISM, 2011, *Child Neuropsychology, Volume 18*), 16 adolescents diagnosed with high-functioning autism were compared with 11 typically developing individuals. Both groups were given a relatively simple language task in a functional MRI study; they were asked to identify whether**

simple 3-word sentences were about a living creature. However, sentences were spoken in either an angry or neutral tone. When processing these emotionally-laden sentences, the brains of adolescents with high-functioning autism had great activation in areas typically devoted to planning, memory, and attention. Thus, more cognitive effort was required to process simple emotional content in the individuals with high functioning autism; language processing is less automatic in these individuals.

4. Quality Measures

a. Submit a list of all key professional, administrative, clinical, and direct service personnel related to the proposal. Attach a copy of their Curriculum Vitae.

CVs of members of the University's end user group have been attached as <u>Appendix C</u>. Staffing for the UConn MRI Center, including a Director, Associate Director, Physicist, and Technician is currently being pursued, and the applicable job descriptions for their postings have been included in <u>Appendix C</u>.

Attached CVs include:

Jeffrey Seemann, Vice President for Research
Richard Gray, Executive Vice President for Administration and Chief Financial Officer
James A. Green, Head, Department of Psychology, co-Chair, MRI Steering Committee; Professor
Jay Rueckl, co-Chair, MRI Steering Committee; Associate Professor and Head of the Perception, Action, Cognition division, Department of Psychology
Kenneth Pugh, Professor
Emily Myers, Assistant Professor
James Magnuson, Associate Professor
Inge-Marie Eigsti, Associate Professor
Nicole Landi, Assistant Professor

b. Explain how the proposal contributes to the quality of health care delivery in the region.

Although this proposal will not directly impact the quality of health care delivery in the region because the Proposed MRI will be used for research purposes only, it is expected that the research performed on this fMRI technology will provide key insights into various areas of cognitive neuroscience, behavioral genetics, and educational neuroscience and will thus enable the continued development and improvement of health care practices and technology. For example, as explained in the publication "THE NEURAL UNDERPINNINGS OF PROSODY IN AUTISM," by Eigsti et al, attached in <u>Appendix L</u>, studies utilizing fMRI technology will help physicians understand developmental disorders such as autism, especially the

unique brain adaptations associated with the disorder. As the State's flagship university, enhanced opportunities to assist faculty-lead research may also contribute to the education of undergraduate students who may become future health care practitioners if they eventually pursue advanced degrees and clinical training in the health care field.

5. Organizational and Financial Information

a. Identify the Applicant's ownership type(s) (e.g. Corporation, PC, LLC, etc.).

The University is a State Agency with a Board of Trustees appointed by the Governor and elected by constituents of the University.

b. Does the Applicant have non-profit status?
☒ Yes (Provide documentation) ☐ No

Documentation is attached as Appendix D.

c. Provide a copy of the State of Connecticut, Department of Public Health license(s) currently held by the Applicant and indicate any additional licensure categories being sought in relation to the proposal.

The University will not be seeking additional DPH licensure as the UConn MRI Center will be utilized for research purposes only and will not operate as a health care facility. The University has a DPH-licensed infirmary and a child care center, but these facilities are not related to or impacted by the operations of the UConn MRI Center. Documentation regarding these DPH licenses is attached for informational purposes as Appendix E.

d. Financial Statements

i. If the Applicant is a Connecticut hospital: Pursuant to Section 19a-644, C.G.S., each hospital licensed by the Department of Public Health is required to file with OHCA copies of the hospital's audited financial statements. If the hospital has filed its most recently completed fiscal year audited financial statements, the hospital may reference that filing for this proposal.

ii. If the Applicant is not a Connecticut hospital (other health care facilities): Audited financial statements for the most recently completed fiscal year. If audited financial statements do not exist, in lieu of audited financial statements, provide other financial documentation (e.g. unaudited balance sheet, statement of operations, tax return, or other set of books.)

Audited financial statements for the University from FY 2002 to FY 2011 are available at: http://accountingoffice.uconn.edu/generalacct.html.

Audited financial statements for the University for FY 2012 are attached as <u>Appendix F</u>.

Audited financial statements for the University for FY 2013 are not yet complete. FY 2013 audited financial statements are expected to be available in January or February 2014. The University will gladly supplement this application with the FY 2013 statements upon their release as requested by OHCA.

e. Submit a final version of all capital expenditures/costs as follows:

Table 3: Proposed Capital Expenditures/Costs

Medical Equipment Purchase	$0
Imaging Equipment Purchase	$3,225,000
Non-Medical Equipment Purchase	$35,000
Land/Building Purchase *	$0
Construction/Renovation **	$4,225,000
Other Non-Construction (Specify)	$0
Total Capital Expenditure (TCE)	$7,450,000
Medical Equipment Lease (Fair Market Value) ***	$0
Imaging Equipment Lease (Fair Market Value) ***	$0
Non-Medical Equipment Lease (Fair Market Value) ***	$0
Fair Market Value of Space ***	$0
Total Capital Cost (TCC)	**$0**
Total Project Cost (TCE + TCC)	**$7,450,000**
Capitalized Financing Costs (Informational Purpose Only)	N/A: State Bond Fund Rates
Total Capital Expenditure with Cap. Fin. Costs	$7,450,000

* If the proposal involves a land/building purchase, attach a real estate property appraisal including the amount; the useful life of the building; and a schedule of depreciation.
** If the proposal involves construction/renovations, attach a description of the proposed building work, including the gross square feet; existing and proposed floor plans; commencement date for the construction/ renovation; completion date of the construction/renovation; and commencement of operations date.
*** If the proposal involves a capital or operating equipment lease and/or purchase, attach a vendor quote or invoice; schedule of depreciation; useful life of the equipment; and anticipated residual value at the end of the lease or loan term.

Note that construction costs includes construction ($3,500,000), design services ($350,000), telecommunications ($35,000), construction administration ($90,000), project management and architectural engineering expenses ($150,000), relocation of existing space uses ($10,000), environmental costs ($60,000), insurance and legal costs ($10,000), and miscellaneous expenses ($20,000). Additional information is available at: http://boardoftrustees.uconn.edu/wp-content/uploads/2013/10/2013-10-23-Attachment-08-fMRI-PlanningBudget-10.23.13.pdf and attached as <u>Appendix G</u>. Space allocation and floor plan are also included in <u>Appendix G</u>.

f. List all funding or financing sources for the proposal and the dollar amount of each. Provide applicable details such as interest rate; term; monthly payment;

pledges and funds received to date; letter of interest or approval from a lending institution.

UConn 2000 Phase III – FY14 DM	**$4,700,000**
UConn 2000 Equipment	**$3,225,000**
University Plant Funds	**$75,000**

UConn 2000 money is secured through State bond funds. Additional information is attached in Appendix G.

NOTE: $550,000 has been set aside for project contingency costs for the construction process.

g. Demonstrate how this proposal will affect the financial strength of the state's health care system.

This proposal will not have a direct impact on the financial strength of the State's health care system because the Proposed MRI would be used for research purposes only. However, it will indirectly benefit the strength of the State's health care system by improving the quality of available research for cognitive neuroscience, behavioral genetics, and educational neuroscience to help provide stronger techniques and technology for the marketplace. As the State's flagship university, this will also provide enhanced educational research opportunities for students who may become future practitioners in the State in the area of health care.

6. Patient Population Mix: Current and Projected

a. Provide the current and projected patient population mix (based on the number of patients, not based on revenue) with the CON proposal for the proposed program.

Table 4: Patient Population Mix

	Current FY *****	**Year 1 FY *****	**Year 2 FY *****	**Year 3 FY *****
Medicare*	NA	NA	NA	NA
Medicaid*	NA	NA	NA	NA
CHAMPUS & TriCare	NA	NA	NA	NA
Total Government	NA	NA	NA	NA
Commercial Insurers*	NA	NA	NA	NA
Uninsured	NA	NA	NA	NA
Workers Compensation	NA	NA	NA	NA
Total Non-Government	NA	NA	NA	NA
Total Payer Mix	NA	NA	NA	NA

* Includes managed care activity.
** New programs may leave the "current" column blank.
*** Fill in years. Ensure the period covered by this table corresponds to the period covered in the projections provided.

Because the Proposed MRI will serve research populations only and will not engage in clinical activity, this table is Not Applicable.

b. Provide the basis for/assumptions used to project the patient population mix.

Because the Proposed MRI will serve research populations only and will not engage in clinical activity, this table is Not Applicable.

7. Financial Attachments I & II

a. Provide a summary of revenue, expense, and volume statistics, without the CON project, incremental to the CON project, and with the CON project. **Complete Financial Attachment I.** (Note that the actual results for the fiscal year reported in the first column must agree with the Applicant's audited financial statements.) The projections must include the first three full fiscal years of the project.

Financial Attachment I-A is attached in Appendix H. This is a non-profit facility. Four fiscal years have been provided because the Proposed MRI would be operational for a partial fiscal year only in FY 2015.

b. Provide a three year projection of incremental revenue, expense, and volume statistics attributable to the proposal by payer. **Complete Financial Attachment II.** The projections must include the first three full fiscal years of the project.

Because the UConn MRI Center will be used for research purposes only and will not have commercial or governmental health insurance payers, this item is Not Applicable. Accordingly, Financial Attachment II is attached in Appendix H, but all items are Not Applicable.

c. Provide the assumptions utilized in developing **both Financial Attachments I and II** (e.g., full-time equivalents, volume statistics, other expenses, revenue and expense % increases, project commencement of operation date, etc.).

It is assumed that there will be a billable rate of $600/hour per use time on grants. It is assumed that a .50 FTE Director, full-time Associate Director, full-time MRI Technician, and .25 FTE Physicist will be hired by FY 2016. It is expected that the Director and Associate Director will be the first hires and will staff the operation in FY 2015. It is assumed that the Supplies and Drugs expenses will have a per-procedure cost of $75 per use and that each use will be one hour; this number was obtained by MD Buyline reports for 3T MRI scanners. Fringe rates are assumed to be the standard fringe rates as projected by the University for members of the AAUP and UCPEA unions (i.e. 35.3% AAUP in FY2015; 37% AAUP / 46% UCPEA in FY2016; 38% AAUP / 47% UCPEA in FY2017; 39% AAUP / 48% UCPEA in FY2018).

Use rates for the Proposed MRI are proposed at $600/hour and will be scheduled in one hour slots. The University believes that it is easier to manage billing in hourly increments and include the cost of preparation and analysis into the hourly rates. The University has therefore determined that its effective rate at $600/hour would put it in-line with comparable research institutions in the State, but would make its facility competitively-priced to assist in the ramping-up of operations and usage, especially since the Proposed MRI would be next-generation and state-of-the-art.

The current applicable Office of Sponsored Programs Facilities & Administration rate on grants is 58% as negotiated with the Department of Health and Human Services.[6]

d. Provide documentation or the basis to support the proposed rates for each of the FYs as reported in Financial Attachment II. Provide a copy of the rate schedule for the proposed service(s).

Because the Proposed MRI will be used for research purposes only and will not have third-party commercial or governmental insurance payers, this item is Not Applicable.

e. Provide the minimum number of units required to show an incremental gain from operations for each fiscal year.

Incremental revenue and cost projections are shown in Appendix H. Given that this is not a clinical operation, calculations are not based upon units, but rather upon hourly use rates billable to funding grants.

f. Explain any projected incremental losses from operations contained in the financial projections that result from the implementation and operation of the CON proposal.

Incremental losses for each of the FY 2015 and FY 2016 are due to a number of factors. First, FY 2015 is a partial year of operation. Second, MRI research has not been conducted on the Storrs Campus before; as such, there is a level of ramp-up expected and a level of conservatism with use hour projections. Also, this revenue and cost model assumes that direct operation of the UConn MRI Center is attributable for all costs and revenues; this is not a full accounting of the benefits/revenues derived or other costs that could be attributable to these other benefit/revenue generating activities. There are benefits derived from staff that are not directly assignable to the UConn MRI Center, particularly research, teaching and grant generation as may be provided by the Director and Associate Director. Additionally, researchers will not have to waste time traveling and will have greater scheduling accessibility to the fMRI than they would if they were to rely on other research sites. Although data generated from the MRI sessions will be directly used

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6 See http://osp.uconn.edu/budgetprep.php.

by the billable principal investigator, the data may also be used in other research projects and thus generate additional grant opportunities for the University and other derived sources of revenue. As such, the University anticipates an operational loss for direct UConn MRI Center operations in FY 2015 and 2016 but an overall gain in institutional wealth and prestige through this project. The University is financially prepared to assume short-term financial losses in direct operations of the UConn MRI Center.

g. Describe how this proposal is cost effective.

The UConn MRI Center project was reviewed by a consulting team of Svigals & Partners, MRA Engineering and Consultation, and BR+A Consulting Engineer, LLC. Various cost estimates were developed prior to moving forward on the initiative. For construction services and the acquisition of the Proposed MRI, a competitive public bid process will be utilized by the University's Procurement Services team following State of Connecticut procurement practices, ensuring that the University receives the best available pricing at the appropriate level of quality. The University will also utilize data on MD Buyline and information provided by the consulting team to ensure that it receives the best available pricing on the overall equipment purchase.

Funding for this research proposal is secured through UConn 2000 State bond funds. Additional information is attached in Appendix G.

In terms of available alternatives, this proposal is cost-effective because University researchers must otherwise travel to other universities such as Harvard and Brown, resulting in a loss of grant money and valuable time spent traveling to out-of-state institutions. The UConn MRI Center would not only help the University keep existing grant dollars within the State, but it would also increase the University's competitiveness in attracting future grant dollars. It is expected that the ongoing operation of the UConn MRI Center will break even in FY 2017, but it is also possible that the University will be able to exceed that mark.

Additionally, this proposal will serve the greater need of attracting corporate research partners as part of the Technology Park initiative, which is in-line with the economic goals of the State Legislature and *Next Generation Connecticut*.[7] The State's economic plan hopes to position Connecticut as a leader in the creation of 21st Century jobs focusing in technology, engineering, and math (STEM) education, research and innovation, including a nexus in bioscience. Research expansion in these disciplines will generate sustainable economic growth through short- and long-term job creation while continuing advances in health care and health care access,

[7] See http://today.uconn.edu/blog/2011/08/gov-malloy-on-campus-for-tech-park-bill-signing/; http://www.mse.engr.uconn.edu/mse-students-meet-governor-malloy-at-next-generation-connecticut-celebration.php; and http://today.uconn.edu/blog/2011/12/gov-malloy-and-president-herbst-on-revitalizing-connecticuts-economy/.

ultimately positioning Connecticut as a leader in these fields. The benefits of the UConn MRI Center will be felt throughout the State and region in the form of new jobs, private industry partnerships, research innovations, and investment from private industry.

<u>Appendix: Table of Contents</u>

APPENDIX A:
LETTERS OF SUPPORT

University of Connecticut
Office of the President

Susan Herbst
President

December 6, 2013

Connecticut Department of Public Health
Office of Health Care Access
410 Capitol Avenue
Hartford, CT 06134

Ladies and Gentlemen:

The University of Connecticut has a strong cadre of excellent scholars whose research depends critically on Magnetic Resonance Imaging. Currently these scholars must travel to other institutions to accomplish their research, which makes achieving their goals more challenging and costly, and makes interdisciplinary collaboration at UConn more difficult. UConn, therefore, proposes to acquire an MRI instrument to support its researchers locally.

This new MRI instrument will be located on the University's main campus and be dedicated to research only. It will therefore permit scholars from a variety of disciplines across campus to collaborate easily, to extend their research programs into new cutting-edge areas through ready access to this important tool, and to accomplish their work much more efficiently. Beyond this, the presence of a research MRI at UConn will allow us to attract top new faculty who will recognize the advantage of being at an institution with state of the art equipment. It can also serve as an additional resource to researchers elsewhere in the state who need this tool for their work.

This is an important investment in the success of UConn's faculty and research initiatives, and will help secure UConn's position among the nation's leading public research universities. I urge you to support this request.

Sincerely,

Susan Herbst

An Equal Opportunity Employer

Gulley Hall
352 Mansfield Road Unit 2048
Storrs, Connecticut 06269-2048

Telephone: (860) 486-2337
Facsimile: (860) 486-2627

UCONN
UNIVERSITY OF CONNECTICUT

Office of the Provost
Mun Y. Choi, Ph.D.
Provost & Executive Vice President
for Academic Affairs

December 9, 2013

Division of Office of Health Care Access
Connecticut Department of Public Health
410 Capitol Avenue
Hartford, CT 06134

To Whom it May Concern:

Through Bioscience Connecticut and Next Generation Connecticut, the State has made substantial investments in the University of Connecticut's infrastructure and faculty to advance research and education in the Science, Technology, Engineering, and Math disciplines. In response to this commitment, unprecedented across the nation, the University has launched cutting-edge research programs in many areas, including an array of cognitive and brain sciences, where our strong and growing interdisciplinary cohort of researchers will propel Connecticut forward as a leader in this field.

To attract the best faculty and students and succeed as a top research institution, we must provide the state of the art instrumentation needed to support our major research initiatives. In particular, our researchers in the Departments of Psychology, Physiology and Neurobiology, Linguistics, Kinesiology, Speech-Language-and-Hearing-Sciences, and Economics need direct access to an MRI. UConn does not currently have an MRI dedicated to research, forcing our best scholars to travel elsewhere to use instruments at other institutions. We therefore propose to build an MRI center on the main UConn campus. This center will be for research only, and will not be used for clinical or training purposes.

This is an important investment in the success of Connecticut's flagship university. I urge you to support this request.

Sincerely,

Mun Y. Choi
Provost

352 MANSFIELD ROAD, UNIT 1086
STORRS, CT 06269-1086
PHONE 860.486.4037
FAX 860.486.6379
mun.choi@uconn.edu

UCONN
UNIVERSITY OF CONNECTICUT

December 9, 2013

Division of Office of Health Care Access
Connecticut Department of Public Health
410 Capitol Avenue
Hartford, CT 06134

Dear Office of Health Care Access:

The University of Connecticut is seeking to build a Center for Brain Imaging on the Storrs Campus. The most significant piece of equipment for this center is a 3 Tesla, magnetic resonance imaging scanner. Currently, Storrs-based faculty must travel to remote locations (e.g., Brown University, New Haven) to conduct their research, which puts UConn at a disadvantage in research excellence. The acquisition of fMRI capability will allow UConn researchers not only to save time and money but also to build a stronger network of cognitive neuroscience researchers on the Storrs campus.

A distinct advantage of the fMRI scanner at UConn-Storrs will be its use only for research. Many MRI Centers serve both health care and research needs, and researchers often end up with a small portion of the available time for scanning because of the demand by physicians and other health-care providers. The MRI resources at Storrs will be used solely for research, allowing our strong group of cognitive neuroscientists to come together in a collaborative environment to make strides in understanding the relations between brain, genes, neural networks, and behavior. President Obama launched the BRAIN initiative last March, a reminder that understanding brain, behavior, and cognition remains a national priority and a research activity that is still relatively young.

As UConn moves forward with initiatives such as Next Generation Connecticut, an fMRI unit on the Storrs campus will help ensure that the best cognitive neuroscientists can be attracted to, and remain at, our flagship public university. I urge you to support this important research activity at UConn.

Sincerely,

Jeffrey Seemann
Vice President for Research

Office of the Vice President for Research
438 WHITNEY ROAD EXTENSION, UNIT 1006
STORRS, CT 06269-1006
PHONE 860.486.3619
FAX 860.486.5381
research.uconn.edu

University of Connecticut
College of Liberal Arts and Sciences

Office of the Dean

December 10, 2013

Division of Office of Health Care Access
Connecticut Department of Public Health
410 Capitol Avenue
Hartford, CT 06134

Dear Sir:

I write to express my strong support for the functional Magnetic Resonance Imaging facility planned for the Storrs campus of the University of Connecticut. This research-only facility will keep UConn competitive with other top 20 public research universities.

Currently, our faculty doing fMRI research must travel to remote locations such as Providence and New Haven to carry out their projects. This travel time reduces the time available for research and limits the ability of our faculty to build collaborations in cognitive neuroscience that are centered at UConn.

Construction of this facility will allow us to continue a program of recruiting the best scientists in the country to Storrs and will help solidify our stature as a leading center for research in the cognitive neuroscience of language.

Thank you for your consideration.

Sincerely,

Jeremy Teitelbaum
Dean and Professor of Mathematics

215 Glenbrook Rd Unit 4098
Storrs, Connecticut 06269-4098

Telephone: (860) 486-2713
Facsimile: (860) 486-0304
web: www.clas.uconn.edu

University of Connecticut
Department of Linguistics

College of Liberal Arts and Sciences

10 December 2013

Division of Office of Health Care Access
Connecticut Department of Public Health
410 Capitol Avenue
Hartford, CT 06134

To whom it may concern:

I am writing, on behalf of the Department of Linguistics, University of Connecticut, to offer my enthusiastic support for the proposal to acquire a research-oriented MRI facility on the Storrs campus. This proposal comes at a key point in the development of the Brain and Cognitive Sciences, and in the renewed focus on STEM research generally. Bringing a research-oriented MRI unit to Storrs is essential to establishing and solidifying the University's position as a leading institution for research and teaching in this critical area, and is vital to the University's remaining competitive as a major national research institution.

Our ability to attract—and retain—the best teachers and researchers in the Cognitive Sciences, including Linguistics, is intimately tied to our ability to provide world-class research facilities, at the very least comparable to what our peer and aspirant institutions are able to provide. To take one example, last year we recruited Associate Professor J. Sprouse, an internationally renowned researcher and winner of multiple awards from the *Linguistic Society of America*, away from the University of California. Prof. Sprouse's research and teaching expertise includes neuro-imaging of language functions, and the promise of increased investment in the Cognitive Sciences at the University of Connecticut was a major factor in our recruiting success. Without access to a dedicated neuro-imaging facility on the Storrs campus, our faculty, such as Prof. Sprouse, are at a competitive disadvantage.

The University of Connecticut is internationally recognized as a leading institution in Linguistics. We have outstanding faculty with expertise in neuro-imaging. Established interdisciplinary collaborations leave us poised to be able to capitalize on existing strengths and firmly establish ourselves as one of the top 5 centres nationally for research on the Cognitive Science of language. A research-oriented MRI facility is a vital part of that initiative.

Sincerely,

Jonathan D. Bobaljik
Professor and Department Head

jonathan.bobaljik@uconn.edu

Oak Hall (East SSHB)
365 Fairfield Way Unit 1145
Storrs, Connecticut 06269-1145

Telephone: (860) 486-4229
Facsimile: (860) 486-0197
web: www.linguistics.uconn.edu

University of Connecticut
Department of Speech, Language, and Hearing Sciences

College of Liberal Arts
and Sciences

December 9, 2013

Division of Office of Health Care Access
Connecticut Department of Public Health
410 Capitol Avenue
Hartford, CT 06134

RE: MRI scanner at UConn

To Whom It May Concern:

I am writing this letter to inform you that the Department of Speech, Language, and Hearing Sciences (SLHS) at the University of Connecticut is in full support of an MRI system at the UConn campus in Storrs. Currently, our faculty must travel to Hartford, Providence, or New Haven to complete their studies. An MRI unit on campus will reduce travel time and allow our faculty to work more efficiently with colleagues and graduate students in our program and across the University. The acquired imagining system will move the University, and our program, into a league with other highly ranked universities that use similar technologies in their research. This technology will allow our faculty to study the neuroscience of communicative disorders more effectively and will help attract world renowned researchers to our program. Therefore, SLHS faculty is extremely excited to have the opportunity to utilize a research-only MRI unit that is housed on the Storrs campus.

Thank you for your consideration.

Sincerely,

B Grela

Bernard Grela, Ph.D., CCC-SLP
Associate Professor and Department Head

An Equal Opportunity Employer

850 Bolton Rd., U-85
Storrs, Connecticut 06269-1085

Telephone: (860) 486-2817
Facsimile: (860) 486-5422
e-mail: slhs.uconn.edu
web: www.slhs.uconn.edu

University of Connecticut Health Center

Frank M. Torti, M.D., M.P.H.
Executive Vice President for
Health Affairs
Dean, School of Medicine

January 2, 2014

Division of Office of Health Care Access
Connecticut Department of Public Health
410 Capitol Avenue
Hartford, CT 06134

Dear OHCA:

This letter is in support of the University of Connecticut's proposal to acquire a 3 Tesla Magnetic Resonance Imaging scanner at the Storrs campus. This scanner will be used for human research only and not for clinical use. The primary research activities will be functional MRI scans that describe how the human brain is active when responding to language or text, processing visual and auditory stimuli, or making decisions. Such tasks are now standard cognitive neuroscience paradigms, and UConn currently lags behind other top research universities in acquiring such capability.

UConn faculty currently engaged in such research must conduct their studies at other universities in the Northeast, thereby hampering collaborations among UConn researchers and slowing progress on important research questions. Because UConn is embarking on a faculty hiring plan related to the STEM disciplines, it is more important than ever to have fMRI capabilities on the Storrs campus in order to attract the best faculty and advance the research mission of the university. Three Tesla MRI scanners are the current default devices for fMRI, even though lower strength magnets are very useful for clinical, health purposes. Currently, there is no MRI capability at the Storrs campus.

With the proposed MRI scanner, UConn will join other Research I universities in devoting a 3 Tesla fMRI scanner for research only. Cutting-edge research on the relations between brain, cognition, behavior, and genes is a national research priority, as evidenced by President Obama's BRAIN initiative, announced last spring.

I urge you to support the acquisition of this important research tool at the UConn Storrs campus.

Sincerely,

Frank M. Torti, M.D., M.P.H.

An Equal Opportunity Employer

Suite AG087
263 Farmington Avenue, Mail Code 1920
Farmington, Connecticut 06030

Telephone: (860) 679-2594
email: ftorti@uchc.edu

EASTERN CONNECTICUT STATE UNIVERSITY
83 WINDHAM STREET • WILLIMANTIC, CONNECTICUT 06226 • 860-465-5000

December 12, 2013

Division of Office of Health Care Access
Connecticut Department of Public Health
410 Capitol Avenue
Hartford, CT 06134

To Whom it May Concern,

This letter is in enthusiastic support of the University of Connecticut Psychology Department's application to acquire an MRI (fMRI) machine at their Storrs campus. As we understand it, the machine would be used for research using human participants only, and would be available to faculty at ECSU and to others as well. There is no similar resource for researchers in northeastern Connecticut, so currently to use this technology faculty must travel quite a distance (which also complicates the recruitment of human participants).

Such a resource would provide benefits to a multitude of constituents. The students and faculty at UConn would benefit of course as would the students and faculty of Eastern Connecticut State University. ECSU Psychology faculty are active in research and several would seek to use the technology. Having easier access to MRI and fMRI technology would also expand the opportunities for research grant applications, which would potentially infuse the geographic area with grant money. Finally, the State of Connecticut would benefit from the outcome of research activities in that findings would not only add to the knowledge base but would showcase the state's public universities as the quality institutions we know them to be.

Please let me know if you have any questions.

Sincerely,

Wendi J. Everton, Ph.D.

Wendi J. Everton, Ph.D.
Professor and Chair, Department of Psychology
Eastern Connecticut State University

APPENDIX B: PROGRESS REPORT

UCONN MRI CENTER: PROGRESS REPORT

MRI STEERING COMMITTEE

November 5, 2012

Co-Chairs:

James Green (Psychology)

Jay Rueckl (Psychology, Haskins Laboratory)

Members:

Paul Betts (Biology Central Services)

Inge-Marie Eigsti (Psychology)

R. Holly Fitch (Psychology, Cognitive Science)

James Magnuson (Psychology, IGERT)

Terence Monahan (Environmental Health and Safety)

Emily Myers (Speech, Language, and Hearing Sciences)

Ken Pugh (Psychology, Haskins Laboratories)

John Robitaille (Architectural and Engineering Services)

Joseph Sweet (Purchasing)

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i. EXECUTIVE SUMMARY

UConn has a growing user base for an MRI Center; unfortunately, UConn faculty are spending grant dollars elsewhere in order to conduct their studies using Magnetic Resonance Imaging (MRI) technology. In addition to lost money and time, faculty members at UConn are also losing the opportunity to develop collaborations with each other and to take advantage of neuroimaging tools already on the Storrs campus. New collaborations and new external funding opportunities would be available if an MRI Center were convenient to the UConn faculty. In addition, such a center would enhance recruitment of the best faculty and graduate students to the university. UConn's current hiring plans could realize a much higher potential with the promise of an MRI Center at Storrs. Such a center would be useful not only to researchers studying structure and function of the brain, but the same center could also be used to study joint structure and function, to perform spectroscopy, to do research on image processing and on nonlinear methods of data reduction (to name just a few potential applications). To coordinate the effort to develop a UConn MRI center, a steering committee has been formed, and the committee has heard formal presentations from three prospective MRI vendors, toured possible sites on campus, and done a site visit at the MRI Center at Brown University. The current report shares information gained from each of these activities; in addition, the report makes the case that investment in an MRI Center would further UConn's aspirations to be recognized as a top tier Research Intensive university.

I. BACKGROUND

Recent faculty hires and new success in funding collaborative research in cognitive neuroscience sparked the current effort to develop capabilities on the Storrs campus for magnetic resonance imaging (MRI) and functional magnetic resonance imaging (fMRI). Although these research tools would be new to the Storrs campus, they are by no means new technologies. Each of our aspired to universities has one or more MRI Centers, including the state flagship universities in Michigan, Texas, North Carolina, Wisconsin, North Carolina, University of Michigan, University of Texas, California, and Illinois (see Appendix E). Of UConn's current peer universities (University of Georgia, University of Iowa, Iowa State, University of Minnesota, University of Missouri, Ohio State University, Purdue University, and Rutgers University), only one (Iowa State) does not have on-campus imaging center either in place or under construction. Regionally, Brown, Harvard, Yale, Dartmouth, Boston University and the University of Massachusetts all have MRI Centers. The availability of MRI at almost all of these universities attests to the scientific value of this technology for a wide variety of academic disciplines, including cognitive neuroscience, behavioral genetics, and education, all of which are strengths of UConn.

Magnetic resonance imaging (MRI) is a technology that involves the use of a high-strength magnetic field to allow for 3D visualization of the internal structure of both biological tissue and certain non-biological materials. Given that MRI involves no radiation, MRI poses minimal risk to human and animal subjects. Functional MRI, or fMRI, is the use of MRI to monitor the flow of oxygenated blood in the brain, and has become a powerful and dominant tool in the study of brain function in both impaired and unimpaired individuals, and in both humans and animals. The brain's response to visual and auditory stimuli can be visualized because the participant sees or hears presentations while in the MRI. Then, active brain areas use oxygen in the blood and the blood hemoglobin becomes differentially susceptible to magnetic fields. One relatively low cost addition to a standard MRI unit allows for visualization of the fiber tracks connecting different areas of the brain. Another allows for spectroscopic analysis of brain cells for concentrations of neurotransmitters (e.g., GABA) that are critical for brain function. A typical MRI scanner is picture below.

Cognitive Neuroscience. Cognitive neuroscience seeks to provide an integrated understanding of the psychological, computational, and neural mechanisms of cognition. Research in cognitive neuroscience has grown exponentially over the past decade, due in large part to rapid advances and increased availability of neuroimaging technology, including in particular MRI.

Research at UConn reflects this development, as faculty in Speech, Language, and Hearing Sciences (SLHS), Engineering, Linguistics, Physiology and Neurobiology (PNB), and Psychology are already engaged in research aimed at understanding the neural mechanisms underlying basic cognitive processes (including language, perception, and memory) as well as psychological or developmental disorders (such as autism, impairments in language and reading, and the consequences of traumatic brain injury). (This research uses both fMRI and a variety of other methods—see Appendix B.) Institutionally, cognitive neuroscience is of direct relevance to two interdisciplinary programs (Cognitive Science and Neuroscience) and is the focus of an ongoing cluster-hire search that will bring three more cognitive neuroscientists to the UConn community. Moreover, cognitive neuroscience was a central focus of two successful center-building grants: the NIH P30 grant on "Emergence, structure and neurobiological basis of typical and atypical language", and the ongoing NSF IGERT training program on "Language Plasticity – Genes, Brain, Cognition, and Computation" (see Appendix C for details of the IGERT grant). The more general programs in Cognitive Science at UConn have been supported for many years by CLAS, and UConn now offers both an undergraduate degree and a graduate certificate in Cognitive Science (see www.cogsci.uconn.edu). Currently, the faculty of the Cognitive Science program (including members of the Psychology, Linguistics, Philosophy, and Speech, Language, and Hearing Sciences departments) are seeking to obtain support for a center or institute for Cognitive Science at UConn. The MRI initiative would be a critical part of the growth and long-term success of such a center.

With regard to MRI research in particular, UConn cognitive neuroscientists already employ MRI methods to study (a) the neural bases of language and developmental language disorders, including topics such as speech perception, language comprehension, skilled reading and reading acquisition, bilingualism, and the role of cortical and subcortical learning mechanisms in language plasticity and language disorders; (b) the mechanisms underlying developmental dyslexia, the effects of reading intervention, and the diagnostic utility of MRI measures; (c) autism, including studies of language comprehension (e.g., prosody) and recovery from autism; and (d) the cognitive linguistic consequences of traumatic brain injury; and (e) treatment outcomes for aphasia. At present, this research is conducted at scanning facilities in New Haven, Providence, and New York (and in collaboration with international colleagues working in Jerusalem, Beijing, Taipei, and San Sebastian, Spain). Much of the research conducted nationally could be moved to Storrs the moment a scanner came online.

Behavioral Genetics and Animal Research. Behavior genetic analyses correlate genes and environments with behavioral, cognitive, and neural phenotypes. An obvious tenet of behavior genetics is that the more data one has describing phenotypes, the more likely it is that correlations will be discovered. An MRI Center adds the possibility of adding brain structure and function to the range of phenotypes that can be described using straight cognitive and behavioral tests. Genes identified by **molecular genetic analysis** can be experimentally manipulated in **animal models** but can be linked to brain structure and behavior in humans via correlational analysis. There is a clear linkage here to Bioscience Connecticut and the collaboration with Jackson Laboratories, as personalized medicine can be more effectively delivered if the brain correlates of genetic anomalies are mapped prior to delivering treatment. An overly simplified causal analysis links genes to brain structure to behavior, cognition, and disease (with all linkages moderated by environmental variables). Without the ability to link genetic variation to variation in brain structure and function, a critical pathway in this linkage is missing.

Therefore, an MRI Center should support animal research. However, configuring the MRI Center to support animal (rodent) research would require an additional/supplemental dedication of space and equipment.   However, given the diverse potential applications of MRI methods in existing UConn behavioral genetic research, coupled with the capability for the MRI center in Storrs to serve as an interface with UConn's Jackson Laboratories and Bioscience Connecticut Initiatives, the benefits of supporting animal research clearly outweigh the costs. Options for adding the capability to perform imaging of animal brains to an MRI Center include purchasing a special insert for a standard size human magnet (see photo below) or purchasing a second, smaller scanner to site in the same location. Either option would provide higher spatial and temporal resolution for the smaller rodent brain while retaining optimal signal-to-noise ratio.

Given the number of on-campus faculty who currently conduct research in the neurodevelopmental and/or neurobehavioral domains (Psychology: Fitch, Salamone, Chrobak, Markus, Read; PNB: Conover) as well as other potential imaging applications with rodents (e.g., tumor research – ENG: Zhu; PHARM: Burgess, Lu; MCB; Giardina), the potential animal user-base for these facilities is clearly present. Moreover, all of the Principal Investigators listed above have current or recent Federal funding, indicating the potential for obtaining new support for on-site use of these methods. For example, where post mortem techniques are currently used to assess altered neural development as a function of genetic factors in rodents (meaning that subjects are sacrificed prior to ascertaining brain data), the use of in vivo techniques to image neural anomalies in living rodents would create a truly momentous advance in on-campus research capabilities.

Educational neuroscience. Educational neuroscience is an emerging discipline that extends the theories and methods of cognitive neuroscience to the fields of educational psychology, education theory, and other related disciplines. Educational neuroscience seeks to more clearly define the ways in which neuroscience data can contribute to the field of education and, more specifically, to the understanding of cognition and learning. The relationship between neuroscience and education can be viewed as a three-part methodological framework—a Discovery stage (i.e., imaging studies focused on the brain regions associated with particular cognitive functions), a Functional Connectivity stage (i.e., an examination of the dynamic properties of the activations and the relationships between brain regions during the execution of a cognitive task), and a Pedagogical Evaluation stage (i.e., a bridge to pedagogical interventions based on the previous stages).

Investigations of the brain bases of reading and mathematics could provide a deeper understanding of what is required for competence in these domains and why some individuals fail to achieve competence in them. Cognitive neuroscience methods provide new ways to evaluate the effects of remediation and may provide diagnostic measures that predict outcomes for at-risk children.

Several UConn research efforts exemplify this approach. For example, a recently completed doctoral dissertation in the Neag School of Education used fMRI to investigate the neurocognitive processes engaged as students solve Integration problems in Calculus. As well, members of the Educational Psychology Department, the Psychology Department, and Haskins Laboratory are involved in a number of funded projects investigating reading and reading impairment, including in particular a pending, multi-site program project grant that aims to provide a detailed and integrated neurobiological and cognitive characterization of "treatment resisters"—developmental dyslexics who do not respond to generally successful interventions—and to contrast this neurocomputational characterization of the treatment resisters with those of treatment responders. With regard to educational neuroscience, it is worth noting that Thomas DeFranco, Dean of the School or Education, supports the effort to establish an MRI Center in Storrs and wants Neag School of Education faculty to be among its user base.

Other disciplines. Finally, we note that MRI methods are used in a variety of disciplines in addition to those discussed above. For example, social psychologists, clinical psychologists, economists, and political scientists have used fMRI to study the brain mechanisms underlying social and emotional processes and decision making. At UConn, one member of the Center for Health, Intervention, and Prevention (CHIP) is currently seeking funding to use fMRI to study decision making related to health behavior and risk. It should be noted that not all uses of MRI technology involve brain neuroimaging. "Whole-body" MRI can provides high-quality images of bones, joints, organs, and other soft tissues. Although whole-body MRI often takes place in a medical setting, it also provides opportunities of relevance to the UConn research community. For example, members of the Kinesiology Department in the Neag School of Education have expressed an interest in using MRI technology to examine anatomical and functional changes in muscles and organs associated with functional mobility and balance related to injuries, aging, exercise training and rehabilitation programs. (Actually, it is expected that there will be an influx of research funds in the coming years to study concussive injuries from both professional sports and military service.) Finally, the continuing evolution of MRI technology and methods creates research opportunities for physicists, engineers, computer scientists, and statisticians. In the Computer Science and Engineering Department, for example, Dr. Jinbo Bi is very interested in bringing an MRI Center to Storrs in order to continue her research on methods of image processing. Peter Burkhard in MCB is looking for an MRI imaging system to visualize living tissue for his work on nanoparticles and cellular proteins.

II. IMPACT: RESEARCH, EDUCATION, OUTREACH

Given the emergence of cognitive neuroscience as a field of inquiry and the critical role of fMRI in that field, the acquisition of an MRI facility would have a significant impact on the university's scientific productivity and reputation. In addition, because MRI technology has a variety of applications, the scientific impact of a scanner facility would clearly extend to the broader UConn community. Moreover, the presence of a scanner in Storrs would advance both the educational and outreach missions of the university.

Impact on Research and Scholarship. The acquisition of an MRI Center would facilitate ongoing MRI research, create the opportunity for individual scientists and scientific programs to extend their research in new and promising directions, and have numerous other direct and indirect benefits for UConn and UConn scientists. As indicated above, a significant number of UConn scientists are already engaged in MRI research. The presence of an MRI center in Storrs would allow them to conduct this research more efficiently and to couple their MRI research more closely with other lines of research already conducted on campus.

The presence of an MRI center would create research opportunities for other faculty members as well, including both members of the broader cognitive science/cognitive neuroscience community at UConn and (as discussed above) researchers working in behavioral genetics, educational, and a host of other fields. These uses of the imaging facility could gain more breadth and depth through strategic hiring plans, through mechanisms that promote collaboration among faculty members, and by the availability of scanner time for pilot research that would lead to external funding.

In addition to facilitating and promoting the establishment of specific lines of research, the establishment of an MRI facility in Storrs would have a variety of synergistic benefits for UConn and UConn scientists. A scanner facility would act as an interdisciplinary hub for research and other activities, especially if plans for the facility can incorporate space for other labs employing other cognitive neuroscience (see Appendix B), offices for the IGERT training program, or a proposed Cognitive Science Institute (the establishment of which is proposed in a document that under development by the Cognitive Science Steering Committee). Consequently, it would (a) promote the development of scientific theories that span several traditionally distinct disciplines (see Appendix C); (b) promote the integration of basic and translational research on key public health and educational issues; (c) foster collaboration among members of various academic departments and programs, including in particular units that are already widely acknowledged as areas of strength within the university (e.g. Psychology, PNB, the Neag School of Education); (d) support, and draw strength from, the significant state and university investment in Bioscience Connecticut; (e) enhance our ability to capitalize on institutional connections with Haskins Laboratories and numerous international sites; and (f) enhance the university's ability to recruit and retain top-quality scientists, and enhance the ability of those scientists to successfully compete for external funding. (With regard to the last point, it is worth noting that the kinds of research afforded by an MRI center are supported by NSF, NIH, NEA, IES, and other federal agencies.)

Educational Impact. At both the graduate and undergraduate levels, there is a strong (and, to an unfortunate level, as yet unmet) demand for cognitive neuroscience training at UConn. The creation of an MRI facility would address this demand by providing more research opportunities on campus and by impacting core curricula in several departments. In addition, the operational model for the imaging facility can be designed to provide opportunities for graduate students to conduct unfunded fMRI research. Collectively, these changes in curriculum and research opportunities would improve both undergraduate and graduate education, better prepare students for careers in science, technology, and medicine, and make them more competitive in the job market. For example, the Kinesiology Program is keen to use an MRI Center as a training facility for their graduate students, who need extensive knowledge of radiological reports and images to optimize treatment plans for their rehabilitation patients. For undergraduate students across several programs, an MRI facility would enhance their readiness and competitiveness for graduate programs and medical schools.

Impact on Outreach and Service. The coupling of clinical, translational, and basic science research creates exciting opportunities relevant to the service mission of the university. The MRI facility would support research with could directly or indirectly impact clinical and educational practices. In addition, we would explore mechanisms for the dissemination of knowledge to clinicians, educators, parents, and the general public, and we would seek to impact public policy at the state and federal levels. It is likely that a Storrs MRI Center might become a 'regional hub' for MRI research, drawing users from nearby institutions such as ECSU, Wesleyan University, and Connecticut College.

III. RECOMMENDATIONS

The primary purpose of this report is to document the need for and potential impact of the acquisition of an MRI facility in Storrs. However, because we have learned much about technical issues, space and siting considerations, operational costs and potential revenue streams, we take this opportunity to report the perspective of the scientific community on these matters.

Business Model

- **The MRI Center should be expected to generate revenue sufficient to cover operating expenses, but this revenue cannot be expected to pay for initial acquisition and construction costs.** Operating costs (including personnel, service contracts, and miscellaneous expenses) are estimated to fall in the range of \$500,000 to \$650,000. Given this, the MRI center would be self-sufficient if the scanner was used for funded research about 20-25 hours each week.

- **Self-sufficiency should be expected in 4-6 years.**

  Although external funding to support some use of the scanner is already in place, moving grants from existing facilities, development of the user base and the successful pursuit of adequate funding to cover the MRI Center's annual budget would likely take 4-6 years.

Personnel

- **Staffing of the MRI Center should begin by hiring a Director**.

  The staff of the Center could be configured in a number of ways to address both operational and strategic needs. Because the configuration of the rest of the staff is contingent on the skills and background of the Director, and because an appropriate Director could be expected to provide expertise to the planning of the Center, contribute to the development of the user base, and both attract and facilitate the pursuit of external funding, it would be wise to hire a Director as early as possible. One attractive model for this hire would be to hire a senior level faculty member (into any of a number of departments) whose appointment would be split 50% time in an academic department and 50% as the administrator director of the MRI Center (funded by revenue from the center). (Possibly a candidate for this position will be identified via the ongoing cluster-hire search in Cognitive Science, although given the skills and stature required of a Director, a targeted search may be the best option.)

- **Members of the staff should have faculty appointments, as appropriate.**

  Not all members of the MRI Center staff would be candidates for faculty positions. However, in the case of the Director and possibly others (e.g., a physicist, an associate director), faculty appointments would serve several purposes: They would help integrate the MRI center with the academic mission of the university; they would likely enhance the educational impact of the Center; they would encourage members of the staff to have their own research pursuits; and they would lower the operational budget of the center.

Uses

- **The MRI Center should be used exclusively for research**.

  Preliminary consideration of clinical uses of the facility revealed that although clinical uses of the scanner could provide a supplemental revenue stream, the costs associated with regulatory approval and administrative, operational, and facilities requirements far outweigh the benefits of adapting and certifying the facility for this use.

- **The MRI Center should support both neuroimaging and whole-body imaging**.

  Given both current research and likely future directions, the MRI center should be configured to support both adult and pediatric human research. In addition, it should support whole-body imaging as well as neuroimaging—equipping the facility to do whole-body imaging is relatively inexpensive and expands the potential uses of the scanner substantially.

- **The MRI Center should support animal research**.

  Configuring the MRI Center to support animal (rodent) research would impose costs in terms of both space and equipment. However, given the potential use of MRI methods in behavioral genetic research, the possible role of the MRI center in connecting Storrs-based faculty with Jackson Laboratories and Bioscience Connecticut, and other possible applications, the benefits of supporting animal research outweigh the costs.

- **The MRI Center should support related research methods**.

  Configuring the MRI Center to support *spectroscopy, diffusion tensor imaging, and FLAIR imaging* is critical to the vision of a broad and integrative facility for the Storrs campus (Appendix B). These additional functionalities can be added to the cost of the basic scanner at minimal cost. However, they would make the MRI Center much more useful to researchers in the Biologies, Chemistry, and Physics. The "cost" for this use primarily involves devoting sufficient space to the MRI Center such that there are rooms for actual equipment and also for staff.

User Base

- **Activities should be held to increase knowledge of (and interest in) MRI research**.

  Such activities could include meetings of likely MRI users, colloquia or a talk series (with internal or external speakers), symposia or mini-conferences, neuroimaging courses.

- **Future faculty hires should be targeted at growing the user base**.

  An ongoing cluster hire in Cognitive Science could bring up to three new faculty members who might make use of the MRI center. Future cluster or regular hires could place likely MRI users in a variety of schools and departments (Appendix A contains a partial list of faculty at UConn who have expressed an interest in pursuing research using an MRI Center.)

- **The pursuit of external funding to support MRI research should be encouraged**.

  When the MRI Center is established, scanner time should be made available for pilot work yielding data that could be used in external grant applications. Other mechanisms for promoting external grant proposals should be explored.

Siting and space

- **The MRI Center should be sited near the center of campus**.

  The advantages of a central location are many: The MRI Center would be close to numerous laboratories where related research involving both behavioral and other cognitive neuroscience methods are now conducted, facilitating the movement between research locations and promoting collaboration and community-building (in fact, empirical research has clearly shown that physical proximity is one of the best predictors of collaboration and research productivity[1]); The MRI Center would be close to classrooms and faculty offices, minimizing the extent to which work in the MRI Center would conflict with faculty obligations and student course schedules; the MRI Center would be accessible to UConn undergraduates, who would serve as the participants in many of the MRI experiments; Many of the non-student populations involved in research (e.g., individuals with aphasia, autism, dyslexia) already visit central campus to participate in other behavioral research and to receive services. In some cases, these participants may need to do EEG, audiometric, clinical, NIRS, or advanced behavioral testing in existing laboratories on campus. In sum, locating the MRI center proximal to existing departments and laboratories on central campus is likely to provide significant benefits to research productivity, to MRI participants, and to brain research at UConn more generally.

  [1]Lee, K., Brownstein, J. S., Mills, R. G., & Kohane, I. S. (2010). Does collocation inform the impact of collaboration? *PLoS One, 5*(12), e14279.

- **A small number of dedicated parking spots will be required**.

  To make the Center accessible to non-student research populations (e.g., individuals with aphasia, autism, dyslexia) a small number of parking spots should be available.

- **The Center will require approximately 3,500 to 4,000 square feet of space.**

  The MRI equipment itself is highly sophisticated and requires specialized physical and support facilities. Some of these considerations include electrical and cooling supplies, air circulation (especially for animal research), vibration dampening, specialized shielding, and zones of security surrounding the magnet itself. These considerations only pertain the locating and supporting the equipment itself. But the vision for an MRI Center that is part of a network of collaborative research projects involving many different types of science calls for a large, multiple use facility. Such a facility would include the following:

Scanner Room
Control Room
Equipment Room
Mock Scanner Room
Waiting Room
Family Restroom & Lockers
Two Behavioral/Psychological Testing Rooms
Director's Office
Manager' Office
Technician's Office
Data Analysis and Graduate Student Room
Conference Room
Animal Preparation room
2nd Scanner room (future use)

Note that in terms of space, the capacity for animal research only adds about 200 square feet to the space requirements. Note, too, that the final item (2nd Scanner room) follows from the next recommendation.

- **Plan for growth.**

  After the MRI Center is established, either moving it or making substantial renovations would be both expensive and disruptive. As UConn's MRI community grows and prospers, and as MRI technology evolves (or new technologies develop), the ability to expand and adapt will be important, and should be part of the plan from the beginning. For example we believe that future innovations in animal research will create the need for a dedicated 7T small bore magnet for animals, and it would behoove the University to plan in advance for this possibility by setting aside potential space, if not simply adding a smaller magnet now dedicated for animal research.

- **The MRI Center should be housed with other related facilities.**

  As noted, UConn's scientists utilize a number of cognitive neuroscience technologies in addition to MRI. Siting in the MRI Center and laboratories that use these other methods in the same building would facilitate collaboration and create new research opportunities, particularly with regard to 'multi-modal' imaging (the acquisition of data from MRI and another method, such as EEG, either simultaneously or in close temporal proximity). Although situating the MRI Center and other cognitive neuroscience laboratories in proximity to each other should perhaps have the higher priority, we note that there would also be significant value in locating the MRI Center near other spaces dedicated to related interdisciplinary activities, including the IGERT training program and the Cognitive Science program.

Instrumentation and selection of vendors.

- **A 3 Tesla scanner with a 60 mm bore should be acquired**.

  More powerful scanners are now available, but 3T magnets are more affordable, more appropriate for most current and contemplated uses, and methodologically more advanced. Current UConn faculty collaborate with other researchers both nationally and internationally who use 3T scanners.

- **The instrumentation requirements associated with likely potential uses should be further explored**.

  Scanners are generally sold with a package of ancillary equipment (coils, etc.) that serve a variety of functions. However, some uses require additional instrumentation. For example, the Brown University MRI Center owns a gradient insert, which creates a smaller magnetic field and makes small animal imaging feasible with the whole body scanner. Multi-modal imaging and other uses (spectroscopy, DTI) will also impose instrumentation constraints. The identification of these constraints and subsequent cost/benefit analyses should be performed before the acquisition of the scanner is put out to bid.

- **Vendor-University partnerships and compatibility with facilities at other sites should be considered in the selection of a vendor.**

  Partnerships with a vendor provide cost-saving opportunities and can make new technological and methodological innovations available to university researchers. Compatibility with other imaging facilities at other universities and institutions provides more opportunities for collaboration and generating additional revenue streams.

Going Forward

- **Consultant**.

  A good next step would be for the University to seek the expertise of a consultant to interview various and prospective end users at the University and identified University partners in order to evaluate end user needs, develop those needs into a program, and make recommendations for that program. With that program in mind, the consultant will review existing University space and space that will be coming online and provide recommendations as well as rough costing for the identified options. The University will need to provide the consultant with access to decision makers within AEBS, the Provost's office, and the MRI Steering Committee.

- **Development of the user base**.

  The steering committee is eager to facilitate the establishment of an MRI Center in whatever way it can. One contribution would be to continue the process of developing a user base and identifying the demands that different research activities place on instrumentation, space, siting, and so forth. A number of mechanisms are available, including meetings of interested parties and scholarly activities such as colloquia and symposia. A particular focus should be the use of an MRI center for animal research. Meetings with the leadership of Jackson Labs and Bioscience Connecticut and consulting with scientists at other institutions who use MRI in animal research would be particularly valuable.

APPENDIX A

USER BASE

To give an idea of the breadth of background of potential users, we provide a list of UConn faculty who have expressed a desire to have a MRI Center on the Storrs campus.

Department of Psychology

Robert Astur: has a track record of publication in fMRI studies of schizophrenia and of motor control under the influence of alcohol. Currently seeking funding to buy scanning time time at the Institute of Living in Hartford.

Chi-Ming Chen: a neuroscientist integrating methods of EEG, transcranial magnetic stimulation (TMS), and magnetic resonance imaging techniques to study brain function in mental health and neurophysiological disorders, especially schizophrenia

Kimberly Cuevas: a cognitive neuroscientist using EEG to study the development of executive function. Wishes to collaborate with Astur and combine EEG and fMRI methods.

Inge-Marie Eigsti: has a history of publication on fMRI studies of Autism Spectrum Disorders, International adoption, and ADHD. Has been PI or co-I on three funded grants involving fMRI.

Deborah Fein: a world expert in Autism Spectrum Disorders, seeking funding from NIH to establish an Autism Center of Excellence, for which fMRI methods are essential.

R. Holly Fitch: her studies of the long-term effects of early brain lesions in mice could be greatly enhanced via MRI technology, which would allow multiple assessments of the developing brain over the lifespan (rather than post-mortem analysis).

Rick Gibbons: currently seeking external funding with collaborators at Dartmouth to use their MRI facility in studies of decision making related to health behavior and risk.

James Magnuson: Principal Investigator of the NSF IGERT grant on the genetic, brain, and developmental processes related to language development.

Jay Rueckl: Principal Investigator on the recently awarded, 5-year Program Project grant at Haskins Laboratory, a portion of which uses fMRI methods to study speech perception and production, skilled reading, and reading disorders.

Ken Pugh: Director of Haskins Laboratory and established expert in fMRI studies of language and cognitive processes in children and adults with reading disorders.

Computer Science and Engineering

Jinbo Bi: Dr. Bi has a track record of publication in image processing; she is currently seeking sources of images to continue this line of research

Molecular and Cell Biology

Peter Burkhard: a protein scientist engineering nanoparticles for MRI imaging applications. He is looking for MRI instrumentation to visualize tumors in living organisms.

Neag School of Education: Curriculum and Instruction*/Mathematics Department*

Tom DeFranco: Supervised dissertation research on the neurocognitive processes involved in identifying integration techniques in Calculus. As Dean of the Neag School of Education, supports efforts to use MRI to advance educational neuroscience.

Neag School of Education: Kinesiology

Carl Maresh, Jeff Anderson , Craig Denegar, Lindsay DiStefano , Michael Joseph , William Kraemer , Jeff Volek : These faculty in Kinesiology would use MRI technology to examine anatomical and functional changes in muscles and organs associated with functional mobility and balance related to injuries, aging, exercise training and rehabilitation programs.

Physiology and Neurobiology

Joanne Conover : collaborating with UCHC and others to examine post-mortem rodent brains for hypertensities using FLAIR imaging. She has said she could potentially use 5 to 10 hours per month of scanning time if an MRI Center were on the Storrs campus.

Speech, Language, and Hearing Sciences

Emily Myers: Dr. Myers is currently paying for time at the MRI Center at Brown University and at Hartford Hospital for her studies of language brain processes in speech perception, second language acquisition, and in the study of language recovery following aphasia.

Carl Coelho: Is involved in the Vietnam Head Injury Study (VHIS) a prospective, long-term follow-up study of a cohort of 1,221 Vietnam veterans, which has stretched over more than 40 years. This project has been supported by the Department of Defense and NINDS. This project has applied MRI in its investigation of the consequences of traumatic brain injury (TBI).

As can be seen from the current list, potential users of and MRI Center vary widely in expertise, affiliation, and interests. Rueckl, Pugh, and Myers have active grants accounting for 7 to 10 hours per week of scanning time. Astur is in the process of submitting a grant to buy time at the Institute of Living. Given that the above list is not exhaustive, it seems highly likely that, over the course of 3 to 5 years, enough users could secure external funding to account for 20 hours per week of paid time on the magnet at the MRI Center. Of course, external grants that pay for time on a scanner will also bring in Facilities and Administrative costs to the university; these extra funds have not been figured into the business model for the MRI Center's personnel and other operating costs.

APPENDIX B

METHODS OF COGNITIVE NEUROSCIENCE

Research in cognitive neuroscience involves a wide variety of methods. Below is a brief description of the most relevant of these methods. For each method, examples of the kinds of research currently being conducted by UConn faculty members are provided.

MRI Methods

Magnetic resonance imaging (MRI). Magnetic resonance imaging makes use of the property of nuclear magnetic resonance (NMR) to image nuclei of atoms inside the body. MRI provides high-quality anatomical images of structures (e.g. bones, organs) within the body. In cognitive neuroscience, MRI images of the brain (‘anatomicals’) are used to constrain the analysis of functional imaging (fMRI) data, to compare the brain structure of individuals from different subject populations, and to identify the structures affected by strokes or other traumatic brain injury.

Functional neuroimaging (fMRI). Functional neuroimaging (fMRI) methods record physiological changes associated with blood supply to the brain. These hemodynamic changes indicate which brain regions are engaged when a person performs a specific mental task. fMRI is most commonly used to investigate how the activation of specific brain regions changes as a function of perceptual stimulation and cognitive and motor task demands. An increasingly important approach focuses not simply on the activation of specific regions considered in isolation, but rather on the *connectivity* among brain regions—the coordinated activity of a network of neural structures. UConn scientists use fMRI to investigate a wide variety of issues, including the neural bases of psycholinguistic processes, reading impairment, and autism.

Magnetic Resonance Spectroscopy (MRS) allows in-vivo measurement of neurochemistry, including expression of glutamate and GABA (the major excitatory and inhibitory neurotransmitters respectively), and recent studies on neurocognitive disorders suggest links between abnormal expression of these neurotransmitters and performance on cognitive tasks.

Diffusion weighted tensor imaging (DTI) allows measurement of the integrity of white matter tracts and a rapidly expanding literature indicates meaningful links between variation in these pathways and language related behaviors, e.g., dyslexia and reading impairments.

FLAIR (fluid attenuation inversion recovery) is a particular type of MRI imaging that removes the influence of cerebrospinal fluid on the image. FLAIR is useful for imaging brain lesions in the areas near the ventricles and for imaging brain areas under conditions of brain edema.

Other Methods

Electroencephalography: (EEG). Electroencephalography involves the use of scalp electrodes to measure the summed electrical activity of large populations of synchronously active neurons. Changes in the EEG signal that are time-locked to an event (e.g., a perceptual stimulus) are called event-related potentials (ERPs). At UConn, EEG/ERP techniques are used to study a variety of topics, including audition, autism, language processing, and schizophrenia. In addition, EEG can be recorded in an MR environment; therefore, EEG-MR studies have the ability to investigate research hypotheses with high temporal and spatial resolution.

Transcranial magnetic stimulation (TMS): TMS is a non-invasive method that uses electromagnetic induction to generate weak and rapid electric currents in the brain using a changing magnetic field. TMS fills a gap left open by methodological limitations of other non-invasive techniques for studying the human brain. Other non-invasive methods are useful for detecting changes in brain activity correlated with tasks, but can leave unclear whether such activations are necessary in a causal sense. TMS can circumvent this problem and directly manipulate neural activity with high spatial and temporal specificity in any health volunteer. At UConn, TMS methods are used to investigate a variety of topics such as working memory, auditory and visual sensory processing, and functional connectivity between cortical areas. In recent years, concurrently combined TMS and fMRI has been designed to study interregional interactions in the human brain and the possible functional consequences. The TMS-fMRI combination is well-suited for studying the immediate effects of TMS on cortical networks with the spatial specificity from fMRI. In addition, TMS can be combined with EEG recordings.

Near Infrared spectroscopy (NIRS). Near-infrared spectroscopy (NIRS) is a noninvasive diffuse optical-imaging technique that measures local metabolic demand in the surface of the cortex due to differential absorption of light by oxygenated and deoxygenated blood. These measurements are made by placing an infrared light source on the scalp; these wavelengths of light scatter in the tissue, are absorbed differently dependent on the amount of oxygen in the blood, and are detected by optical sensors also placed on the scalp. Thus, similar to fMRI, NIRS uses hemodynamic information to reveal neural activity associated with cognitive processing. NIRS can be used with adults, but because it is relatively unaffected by head movements and because its sensitivity diminishes with skull thickness, it is often used to study neural processes in infants in children. At present, UConn scientists use NIRS to study processes such as the development of speech perception and production and adaptation to cochlear implants.

Single- and multiple-unit recording. Single-unit recording refers to the use of an electrode to record the electrophysiological activity of an individual neuron. In multiple-unit recording, the electrophysiological activity of a number of neurons (e.g., 20-100) is recorded simultaneously. Single- and multiple-unit recording provides a technique for relating the activity of individual neurons to the processes involved in perception, action, and cognition. At UConn, for example, these methods are used to address a variety of issues related to learning and memory auditory, visual, and olfactory perception, and motor function.

Behavioral neuropharmacology. A wide array of methods can be used to investigate the neurochemical basis of behavior. At UConn this includes the use of drugs in combination with cognitive tasks, with the aim of characterizing the neurochemical mechanisms involved in various aspects of cognition, developing useful biomarkers for diseases, and identifying new treatment strategies with both pre-clinical and clinical studies.

Atypical populations. An important component of cognitive neuroscience is research on atypical populations. Not only can such research point towards more effective treatments for 2 conditions such aging, Alzheimer's, and autism, but it can also lead to a deeper understanding of the neural bases of cognition more generally. UConn faculty members study a variety of atypical conditions, including autism, aging and Alzheimer's disease, brain trauma, dementia, dyslexia, and specific language impairment.

Behavioral genetics. Research in behavioral genetics is concerned with both understanding the mechanisms of gene expression and identifying the genetic markers of various psychological conditions. One ongoing research project that exemplifies this approach is a collaboration between members of PNB and BNS. This collaboration, funded by a multi-million NIH Program Project, studies the neurodevelopmental and cognitive consequences of genetic anomalies associated with human disabilities—in particular, the effects on cortical functional mapping and sensory/cognitive processing of dyslexia risk genes (as identified through human epidemiological research) that can be experimentally "deactivated" in the fetal rodent brain through the use of innovative RNA interference transfection techniques.

Computational modeling. In addition to collecting empirical data, cognitive neuroscientists also build and test theories through simulations of neural network models. UConn faculty members use computational modeling in two ways. One approach is to ask how intelligent behavior emerges from the interactions of a large network if highly idealized neuron-like units. In another approach the properties of the model neurons are constrained to capture relevant properties of real neurons as accurately as possible. In the former case, the performance of the model is typically evaluated against behavioral data; in the latter case, the benchmark is typically physiological data..

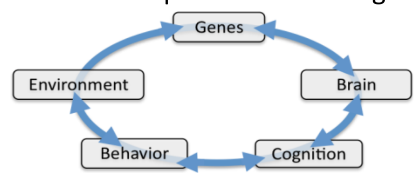
Summary. Cognitive neuroscience makes use of a variety of methodologies. Some are invasive (e.g., single-unit recording, drug probes), while others are not (e.g., EEG, fMRI). Some provide excellent temporal resolution (e.g., EEG, ERP), while others provide relatively poor temporal resolution but exquisite spatial resolution (e.g., fMRI). Some studies can be performed on college sophomores, but others require the recruitment of atypical members of the community. Given these contrasts among methods, the fact that cognitive neuroscience incorporates all of them is anything but accidental—it is essential to the progress that we are making in unlocking the mysteries of the brain. It is also important to recognize that the building blocks for a strong cognitive neuroscience program at Storrs are already in place. UConn's faculty includes researchers with expertise in many facets of cognitive neuroscience, and its physical plant already includes the facilities needed for most of the relevant methods. The exception to this last statement is, of course, fMRI.

APPENDIX C

INTEGRATIVE GRADUATE EDUCATION AND TRAINING (IGERT)

The following text is excerpted from the IGERT training gran proposal Language Plasticity - Genes, Brain, Cognition, and Computation (PI: James Magnuson). It is included here to illustrate the kinds of sweeping scientific goals that an MRI facility would support. Note that although the IGERT grant focused specifically on language and language plasticity, the proposed theoretical framework is readily generalized to cognitive processing more broadly.

C.2.2 A unified systems approach to language. Fig. 4 schematizes our vision of the unifying theoretical and empirical framework required to synthesize cognitive and biological approaches to language. We need experimental investigations of forward and backward influences among environment, genes, brain, sensation/cognition, and behavior, couched in a unifying theoretical framework where these dimensions form a loop. Rather than linking genes directly to behavior, we can achieve a deeper understanding if we use cognitive theory to organize behavioral data to detect patterns and systematicities that would not otherwise be apparent. For example, the implications of links between low working memory and poor theory of mind (understanding of others' mental states, crucial for conversational implicature) were not immediately obvious, but can be related by a psychological theory in which theory of mind depends upon specific aspects of working memory and other cognitive functions (Eigsti & Schuh, 2008), leading to new insights into cognition as well as the disorder.

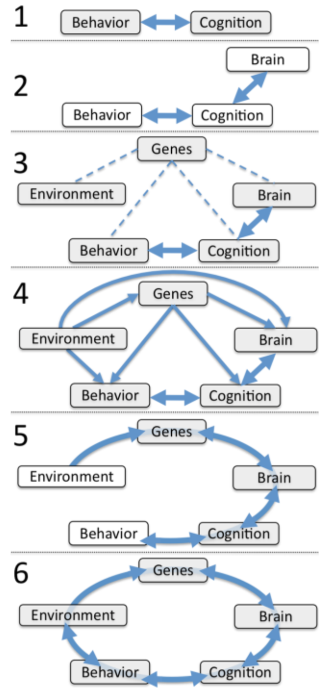


The great challenge, though, is building this unified theoretical approach to language science given that it cannot be done within a single discipline, a single population or even a single species. The range of variation within typically developing individuals is often insufficient to constrain biostatistical analyses needed to assess which genetic patterns associate with behavioral, cognitive, or neurobiological phenotypes. Including populations with acquired or developmental disabilities as well as typical populations provides greater variation and thus a much stronger foundation for genetic analysis. The greatest challenge is comparisons of species. How does one achieve an animal model of human language?

While it is likely that language-specific (and human-specific) genes modulate in part the development of neural systems underpinning language, it is certain that language represents one of the most pleiotropic (where genes influence multiple traits) domains of human behavior. Numerous neural regions provide "scaffolding" to language functions (memory, attention, sensory processing). These regions in turn develop under the modulatory regulation of independent genetic factors, with homologs to most of these found in other mammalian species. As such, any genetic factors that turn out to be "uniquely human" modulators of neural and language development will likely represent a small subset of the factors in play in the developmental trajectory of human language. The hypothesis that language is built on cognitive functions and neurobiological structures that are shared across species is bolstered by the growing list of genes implicated in human language disorders that exhibit homologs in rodent and avian species (e.g., Bishop, 2009; Galaburda et al., 2006; Fisher &Francks, 2006; Paracchini et al., 2007).

C.2.3 Achieving synthesis requires the 6-part research strategy described next and in Fig. 5.

1. Cognitive theories (linguistic, psychological, computational models) organize and explain behavior across ages and typical and atypical populations. In particular, we search for nonlinguistic cognitive, social, and sensory factors on which language development depends.



2. **Functional brain region** data (functional magnetic resonance imaging [fMRI], electroencephalography [EEG] and near-infrared spectroscopy [NIRS]) are measured in experiments motivated by cognitive theory, with the goal of going beyond localization to an understanding of what functions are actually performed in selectively activated circuits. Constraining computational models from the cognitive level based on spatiotemporal brain data is a key part of this process.
3. **Behavior genetic** analyses correlate genes and environment with behavioral, cognitive, and neural phenotypes, in the context of cognitive-based theories. An obvious tenet of behavior genetics is that the more data one has describing phenotypes, the more likely it is that correlations will be discovered. Data mining a large battery of linguistic and nonlinguistic assessments has the potential to turn up unexpected connections, and so inform cognitive theories. However, the more precisely an experiment isolates a theoretically relevant linguistic or nonlinguistic ability, the more informative genetic connections will be, and this will be a primary benefit of strengthening links to cognitive theory (rather than the modal focus on disorders).
4. Genes identified by behavior genetics and environmental variables are experimentally manipulated in **animal models** using methods of **molecular and behavioral neuroscience.** Linking patterns causally to human language requires close integration with human cognitive and neurobiological data and theory. Successful integration depends on maximally analogous behavioral and imaging techniques with humans and animals. Data from paths in steps 3 and 4 are used to create theories of how environment-gene factors drive development of intermediate neural and cognitive phenotypes, and how those manifest behaviorally.
5. Human developmental studies (correlational) are coupled with animal studies (experimental) to examine how behavior feeds back to affect gene expression and all other levels – closing the loop (panel 6).

APPENDIX D

GRANT ACTIVITY

The first part of this appendix is a list of active, recent, and pending external grants that involve fMRI. Following this is more general information about grant activity within the Psychology department. This appendix is included to provide evidence of our ability to successfully compete for the external funding that would be needed to support the operation of the MRI facility.

GRANTS INVOLVING fMRI RESEARCH

Ongoing:

National Institute for Child Health and Development. Neurocognitive determinants of second language adolescent literacy development. 7/1/11-6/30/16. Direct Costs: $2.5M. PI: Ken Pugh. Investigators include Jay Rueckl. *This RO1 investigates neurocognitive bases of 2nd-language literacy acquisition in Hebrew-English, English-Hebrew, and Spanish-English bilinguals.*

National Institute for Child Health and Development. Neurobiological Predictors of Spoken and Written Language. 5/10/11-3/31/16. Direct Costs: $2.2M. PI: Ken Pugh. Investigators include James Magnuson, Jay Rueckl. *This RO1 investigates the role of neurocognitive learning and memory consolidation mechanisms in typical and disabled reading acquisition*

National Institute for Child Health and Development. Nature and acquisition of the speech code and reading. 9/1/12 - 8/31/17. Direct costs $3.9M. PI: Jay Rueckl. *This Program project grant consisting of four projects:*

Project I*:* The neurobiological foundations of typical and atypical literacy acquisition, Project Leader: Ken Pugh. Investigators include Heather Bortfeld. *Investigates neurocognitive processes in transition to literacy in typically developing and reading-disabled children, focusing on the link between speech perception/production and reading.*

Project II: Speech production, speech perception, and orthography: Reciprocal influences. Project Leader: James Magnuson. Investigators include Emily Myers. *Investigates neurocognitive processes in speech perception and production and the impact of literacy on speech.*

Project III: Toward a Universal Theory of Reading. Project Leader: Jay Rueckl*. Studies neurocognitive bases of skilled reading, focusing on differences within and between linguistic communities*

Project IV: Examinations of skilled and impaired spoken and written comprehension processes Project Leader: Nicole Landi (Haskins Laboratories.) Investigators include Whit Tabor. *Focuses the cognitive and neurobiological processes that contribute to individual* *differences in comprehension of spoken and written language.*

American Speech, Language, Hearing Foundation. Neurobehavioral response to increased treatment dosage in chronic aphasia. 10/1/12-12/30/13. Direct Costs: $10,000. PI: Jennifer Mozeiko. Investigators include: Emily Myers and Carl Coelho. This doctoral dissertation fellowship investigates neurobehavioral response to intensive language treatment for individuals with aphasia.

National Institutes on Deafness and other Communication Disorders (NIDCD). The Neural Bases of Statistical and Referential Cues to Phonetic Category Structure. 1/1/08-12/31/11 (in no-cost extension). Direct Costs: $300,000, Project Leader: Emily Myers. This R03 *focuses on the neural systems that enable listeners to use bottom-up and top-down cues to learn non-native speech contrasts. Primary method is fMRI.*

Recently completed:

National Alliance for Research on Schizophrenia and Depression (NARSAD) Young Investigator Award. 7/1/03 – 12/31/06. $60,000. PI: Inge-Marie Eigsti Joint attention and core attentional mechanisms in autism spectrum disorders. *Used fMRI to assess low-level attentional processes and their impact on joint attention in autism..*

National Institute for Child Health and Development. 7/01/06-6/30/10. *Autism and Related Disorders: Development and Outcome.* PI: F.R Volkmar (Yale). Investigators included Inge-Marie Eigsti. *The major goals of this program project grant (PO1) were are to understand mechanisms of dysfunction in autism, integrating advances in neuropsychology, developmental psychopathology, cognitive neuroscience and genetics into understanding the clinical manifestations.*

National Institute for Child Health and Development. 7/01/06-6/30/11. Language Functioning in Optimal Outcome Children with a History of Autism. PI: DA Fein. Investigators included Inge-Marie Eigsti. *This RO1 used neuropsychological testing and structural and functional MRI measures to characterize a group of optimal outcome adolescents who met criteria for ASD when they were younger but no longer do, possibly due to intensive early interventions.*

National Institute for Child Health and Development. Nature and acquisition of the speech code and reading. 5/1/07-4/30/11. Direct costs: $5M. PI: Carol Fowler. Project leaders included Carol Fowler, Ken Pugh, Jay Rueckl, and Len Katz. Investigators included Michael Turvey. *This program project grant investigated the neurocognitive bases of speech perception and production, reading, reading disability, and the interrelationships among these processes.*

NIH/NIDCD Intramural Funding. Neuroimaging of discourse processing. 1/1/08-12/30/09. Direct Costs: $250,000. PI: Allen Braun. Investigators included Carl Coelho. This pilot project used MRI to identify brain regions involved in discourse comprehension and production.

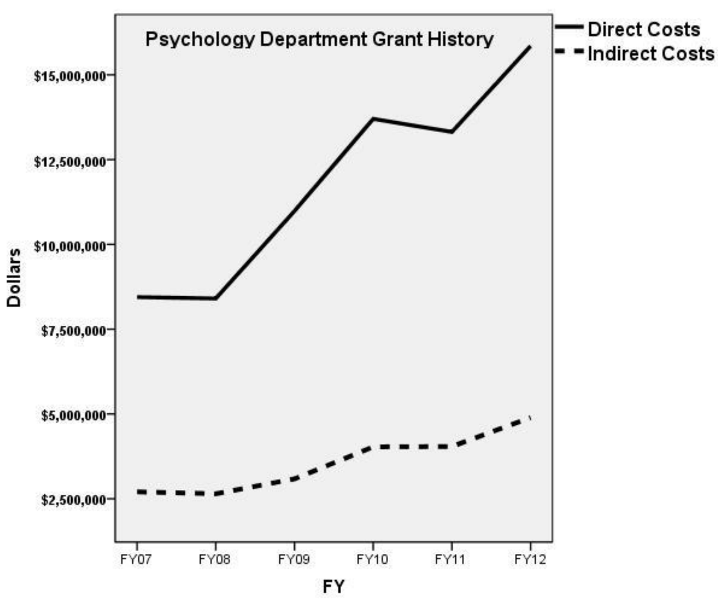
Pending:

National Institute for Child Health and Development. Neurocognitive bases of treatment resistance in developmental dyslexia. Under review. Direct costs: $3,750,000. PI: Robert Morris (Georgia State University). Project leaders include Ken Pugh. Investigators include Jay Rueckl. *This program project grant's overarching goal is to provide the first detailed and integrated neurobiological and cognitive characterization of "treatment resisters"—developmental dyslexics who do not respond to general successful interventions. A related goal is to contrast this neurocomputational characterization of the treatment resisters with those of treatment responders.*

National Institute on Deafness and Other Communication Disorders. The role of frontal and temporal brain areas in the perception of phonetic categories. R01 mechanism, Under review. Direct costs: $1,250,000. PI: Emily Myers. *This project investigates the role of frontal brain areas in the perception of native language speech sounds as well as the acquisition of new, non-native speech sounds. To do this studies of brain-injured individuals with language impairment are paired with fMRI studies of normal brain function.*

RECENT FUNDING HISTORY: PSYCHOLOGY DEPARTMENT

Fiscal Yr	Direct Costs	Indirect Costs	Total Costs	#Grants	# of unique P.I.'s
FY07	$8,446,144	$2,702,554	$11,148,698	68	42
FY08	$8,404,800	$2,647,372	$11,052,172	59	41
FY09	$10,985,411	$3,086,233	$14,071,644	68	46
FY10	$13,701,045	$4,031,194	$17,732,239	84	48
FY11	$13,316,778	$4,040,754	$17,357,532	108	62
FY12	$15,853,164	$4,893,440	$20,746,604	218	57



APPENDIX E

LINKS TO MRI FACILITIES AT ASPIRANT AND PEER INSTITUTIONS

ASPIRANT INSTITUTIONS

1) U Michigan Ann Arbor: http://fmri.research.umich.edu/users/update.php
   Note that Michigan added a *second* magnet this summer and plans to replace their old magnet some time in 2013.

2) U Texas Austin: https://www.irc.utexas.edu/index.html
   UTA is having a grand opening for their new Imaging Research Center on May 10th, 2012.

3) UC – San Diego: http://neuro.ucsd.edu/2page.php?id=TN

4) UC – Berkeley: http://bic.berkeley.edu/

5) U Wisconsin Madison: http://www.medphysics.wisc.edu/research/fmri/research/fmri.php

6) UNC Chapel Hill: http://www.med.unc.edu/bric/research-services?searchterm=fMRI

7) UVA: http://www.medicine.virginia.edu/research/cores/MolecularImagingCore

8) U Illinois Urbana-Champaign: http://bic.beckman.illinois.edu/resources.html

PEER INSTITUTIONS

1) University of Georgia: http://www.psychology.uga.edu/BIRC/

2) University of Iowa: https://mri.radiology.uiowa.edu/about_facility.html

3) University of Minnesota: http://www.brain.umn.edu/methods/fMRI.html

4) University of Missouri: http://bic.missouri.edu/

5) Ohio State University: http://ccbbi.osu.edu/

6) Purdue University: http://mri.ecn.purdue.edu/

7) Rutgers University: http://rubic.rutgers.edu/

8) Iowa State University: MRI facility only at Veterinary School

APPENDIX C:
KEY PERSONNEL CVs

Jeffrey R. Seemann, Ph.D.

University of Connecticut
Storrs, CT 06269
jeff.seemann@uconn.edu

Education:

1977	BA with Honors, Biology	Oberlin College Oberlin, Ohio
1982	PhD, Biological Sciences	Stanford University Stanford, California
1982-1983	Postdoctoral Fellow	Australian National University Canberra, Australia
1983-1984	Postdoctoral Fellow	Department of Plant Biology Carnegie Institution of Washington Stanford, California

Academic Appointments:

1984-1987	Assistant Research Professor	Biological Sciences Center Desert Research Institute, Reno University of Nevada System
1987-1992	Associate Professor	Department of Biochemistry University of Nevada, Reno
1992-2001	Professor	Department of Biochemistry University of Nevada, Reno
1997-2004	Adjunct Senior Research Scientist	Lamont-Doherty Earth Observatory Columbia University
2001-2009	Professor	Department of Cell and Molecular Biology University of Rhode Island

Academic Appointments: cont'd

2009- 2012	Professor	Department of Biochemistry and Biophysics Department of Biology Texas A&M University
2013-present	Professor	Department of Molecular and Cell Biology University of Connecticut

Administrative Appointments:

1989-1991	Chair (Head)	Department of Plant Science College of Agriculture University of Nevada, Reno
1990-2001	Chair (Head)	Department of Biochemistry College of Agriculture, Biotechnology and Natural Resources School of Medicine University of Nevada, Reno
2001-2009	Dean	College of the Environment and Life Sciences University of Rhode Island
2001-2009	Director	RI Agricultural Experiment Station University of Rhode Island
2001-2009	Director	RI Cooperative Extension University of Rhode Island
2009-2012	Vice President for Research	Texas A&M University
2011-2012	Chief Research Officer	The Texas A&M University System
2013-present	Vice President for Research	University of Connecticut

Honors and Awards:

1976-1977	Honors Research Program	Oberlin College
1977	Sigma Xi	Oberlin College
1977-1982	Biology Fellowship	Stanford University
1977	Botanical Society of America	Travel Award
1983-1984	McKnight Foundation Fellowship	Carnegie Institution
1986	Visiting Research Fellowship	Australian National University
1987	Who's Who in the West	
1989	Gamma Sigma Delta	University of Nevada, Reno
1991	College of Ag Outstanding Researcher	University of Nevada, Reno
2003	Highly Cited Researcher	Current Contents, ISI
2004	Workforce Development Award	RI Technology Council

Research-Related Appointments and Duties:

Ad Hoc Grant Reviewer - NSF, USDA-CRGO/NRI, DOE, NIH (multiple programs for all), BARD

Ad Hoc Journal Reviewer - Australian Journal of Plant Physiology, Canadian Journal of Botany, Crop Science, Ecology, FEBS Letters, Global Change Biology, Journal of Biological Chemistry, Journal of Experimental Botany, Nature, Photosynthesis Research, Physiologia Plantarum, Planta, Plant Physiology, Plant Cell and Environment, Plant Physiology and Biochemistry, Proceedings of the National Academy of Sciences (USA)

Member, Environmental Stress Program Grant Review Panel, Competitive Research Grants Office, USDA, 1988

Member, Editorial Board of Plant Physiology, 1989-1992

Member, Photosynthesis Program Grant Review Panel, Competitive Research Grants Office, USDA, 1990

Member, NSF Directorate for Biological, Behavioral and Social Sciences RTG Site Review Committee, 1991

Member, Plant Responses to Environment Program Grant Review Panel, National Research Initiative Competitive Grants Office, USDA, 1992

Ad hoc member, CSRS Western Region Regional Research Implementation Committee, 1992

Member, Integrative Plant Biology Program Grant Review Panel, National Science Foundation, 1994-1997

Principal Investigator, Nevada Desert FACE Facility, 1995-2001

Research-Related Appointments and Duties: cont'd

Member, Science Advisory Committee, Biosphere 2/Columbia University, 1995-1996

Member, Plant Responses to Environment Program Grant Review Panel, National Research Initiative Competitive Grants Office, USDA, 1999

Top Secret Security Clearance, Defense Industrial Security Clearance Office, 2011-present

Administrative Appointments:

Administrative Advisor, USDA Regional Project WRCC-85, "Molecular Detection of Phytopathogens", 1992-1996

Director, Nevada NSF EPSCoR Program, 1997-1998

Member, Board of Directors, Slater Center for Environmental Biotechnology, Economic Policy Council, State of Rhode Island, 2001- 2002

Member/Chair, Administrative Heads Section Subcommittee on "Science on the Hill" Exhibit, NASULGC, 2001-2003

Liaison, Northeast Regional Association of Experiment Station Directors to Board of Governors and Executive Board, USDA Northeast Regional Aquaculture Center, 2001-2003

Administrative Advisor, USDA Regional Project NE-187, "Best Management Practices for Turf Systems in the East", 2001-2003

Member, Executive Board, University of Rhode Island Transportation Center, 2001-2004

Member, Advisory Board, Rhode Island Natural History Survey, 2001-2009

Member, Lt. Governor's (RI) Emergency Management Advisory Council Domestic Preparedness Subcommittee, 2002-2009

Chair, Board of Directors, Slater Center for Marine and Environmental Technology, Samuel Slater Technology Fund, State of Rhode Island, 2002-2005

Member, RI Department of Health Biomonitoring Scientific Advisory Board, 2002-2004

Member, Executive Committee, Northeast Regional Association of Experiment Station Directors, 2002-2006

Chair, Northeast Administrative Heads Section, NASULGC, 2003-2005

Administrative Appointments: cont'd

Member, ESCOP Partnership Committee, 2003-2004

Project Director, Rhode Island EPSCoR Program, 2003-2009

Member, Tech Collective Board of Directors, 2004-2005

Founding Chair, BioGroup, RI Life Sciences Consortium, 2004-2005

Chair, Administrative Heads Section, NASULGC, 2006-2007

Member, Hubert H. Humphrey Fellowship Program Institutional Selection Committee, 2009

Member, New England Association of Schools and Colleges, Inc. (NEASC) Commission on Institutions of Higher Education Evaluation Team for the University of Vermont, 2009

Member, Board of Directors, Research Valley Partnership, 2009-2012

Member, Houston Technology Center Advisory Board, 2009-2012

Councilor, Oak Ridge Associated Universities, 2009-2012

Member, Texas Healthcare and Biosciences Institute Board of Directors, 2010-2012

Member, Southeastern Universities Research Association Board of Trustees, 2010-2012

Executive Director, Texas A&M System Office of Sponsored Research Services, 2012

Chairman of the Board, Texas A&M Research Foundation, 2012

Member, Executive Committee of the APLU Council on Research Policy and Graduate Education, 2013-present

Executive and Legislative Appointments:

Member, Governor's Blue Ribbon Panel on Science and Mathematics Education (appointed by Governor), 2004-2006

Co-Chair, Rhode Island Science and Technology Advisory Council (appointed by Governor), 2005-2009

Member, Slater Technology Fund Board of Directors (appointed by Governor), 2005-2009

Member, Connecticut Stem Cell Research Advisory Committee (appointed by Connecticut General Assembly House Majority Leader), 2008-2009

Executive and Legislative Appointments: cont'd

Chairman, State Energy Program Review Team, Rhode Island Office of Economic Recovery and Reinvestment (appointed by Governor), 2009

Member, Rhode Island Science and Technology Advisory Council (appointed by Rhode Island General Assembly Speaker of the House), 2009-2010

Member, Commission on Connecticut's Future (appointed by Connecticut Senate Speaker Pro Tempore), 2013-present

Other Professional Activities:

Participant, 1st SAES/ESCOP Leadership Development Course, 1991-1992

Full Courses Taught (University of Nevada, Reno):

Biochemistry 121 - Current Topics in Biochemistry and Molecular Biology
Biology 330 - Plant Biology
Biology 355 - Plant Physiology
Biochemistry 412/612 - Plant Biochemistry
Biochemistry 420, 421 - Critical Skills in Biochemistry and Molecular Biology
Biochemistry 718 - Plant Metabolism

Research Interests:

1. Physiology, biochemistry, and molecular biology of photosynthetic carbon metabolism, and particularly the regulation of the CO_2-fixing enzyme, ribulose-1,5-bisphosphate carboxylase/oxygenase.

2. Ecology, physiology, biochemistry and molecular biology of photosynthetic responses and adaptations to environment (light, salinity, temperature, water deficits, and nitrogen).

3. Responses of terrestrial ecosystems to global change, and particularly ecosystem- through molecular-level responses of plants to rising atmospheric CO_2.

Peer Reviewed Journal Publications:

1. Benzing, D.H., J. Seemann, and A. Renfrow (1978) The foliar epidermis in Tillandsiodeae (Bromeliaceae) and its role in habitat selection. American Journal of Botany 65:359-365.

2. Benzing, D.H. and J. Seemann (1978) Nutritional piracy and host decline: a new perspective on the epiphyte-host relationship. Selbyana 2:133-148.

Peer Reviewed Journal Publications: cont'd.

3. Chiariello, N., C. Field, H.A. Mooney, and J. Seemann (1980) Architecture and thermal relations of *Veratrum californicum* (Liliaceae), a snowbank emergent. Madrono 27(3):113-121.

4. Ball, J.T., J. Keeley, H. Mooney, J. Seemann and W. Winner (1983) Relationship between form, function and distribution of two *Arctostaphylos* species (Ericaceae) and their putative hybrids. Oecologia Plantarum 4:153-164.

5. Seemann, J.R., M.R. Badger, and J.A. Berry (1984) Variation in the specific activity of RuBP carboxylase between species utilizing different photosynthetic pathways. Plant Physiology 74:791-794.

6. Downton, W.J.S., J.A. Berry, and J.R. Seemann (1984) Tolerance of photosynthesis to high temperature in desert plants. Plant Physiology 74:786-790.

7. Evans, J.R. and J.R. Seemann (1984) Differences between wheat genotypes in specific activity of RuBP carboxylase and the relationship to photosynthesis. Plant Physiology 74:759-765.

8. Seemann, J.R., J.A. Berry and W.J.S. Downton (1984) Photosynthetic response and adaptation to high temperature in desert plants. A comparison of gas exchange and fluorescence methods for studies of thermal tolerance. Plant Physiology 75:364-368.

9. Seemann, J.R. and C. Critchley (1985) Effects of salt stress on the growth, ion content, stomatal behaviour and photosynthetic capacity of a salt-sensitive species, *Phaseolus vulgaris* (L.). Planta 164:151-162

10. Seemann, J.R., J.A. Berry, S.M. Freas and M.A. Krump (1985) Regulation of ribulose bisphosphate carboxylase activity *in vivo* by a light modulated inhibitor of catalysis. Proceedings of the National Academy of Sciences (USA) 82:8024-8028.

11. Seemann, J.R., W.J.S. Downton and J.A. Berry (1986) Temperature and leaf osmotic potential as factors in the acclimation of photosynthesis to high temperature in desert plants. Plant Physiology 80:926-930.

12. Sharkey, T.D., J.R. Seemann and J.A. Berry (1986) Regulation of ribulose-1,5-bisphosphate carboxylase in response to changing partial pressure of O_2 and light in *Phaseolus vulgaris*. Plant Physiology 81:788-791.

13. Seemann, J.R. and T.D. Sharkey (1986) Salinity and nitrogen effects on photosynthesis, ribulose 1,5-bisphosphate carboxylase and metabolite pool sizes in *Phaseolus vulgaris* L. Plant Physiology 82:555-560.

Peer Reviewed Journal Publications: cont'd.

14. Sharkey, T.D., J.R. Seemann and R.W. Pearcy (1986) The contribution of metabolites to post-illumination CO_2 assimilation in response to lightflecks. Plant Physiology 82:1063-1068.

15. Berry, J., G. Lorimer, J. Pierce, J. Seemann, J. Meeks and S. Freas (1987) Isolation, identification and synthesis of 2-carboxyarabinitol-1-phosphate, a diurnal regulator of ribulose bisphosphate carboxylase activity. Proceedings of the National Academy of Sciences (USA) 84:734-738.

16. Seemann, J.R., T.D. Sharkey, J.L. Wang and C.B. Osmond (1987) Environmental effects on photosynthesis, nitrogen use efficiency, and metabolite pools in leaves of sun and shade plants. Plant Physiology 84:796-802.

17. Seemann, J.R. and T.D. Sharkey (1987) The effect of abscisic acid and other inhibitors on photosynthetic capacity and the biochemistry of CO_2 assimilation. Plant Physiology 84:696-700.

18. Sage, R.F., R.W. Pearcy and J.R. Seemann (1987) The nitrogen use efficiency of C_3 and C_4 plants. III. Leaf nitrogen effects on the activity of carboxylating enzymes in *Chenopodium album* (L.) and *Amaranthus retroflexus* (L.). Plant Physiology 85:355-359.

19. Sharkey, T.D., J. Kobza, J.R. Seemann and R.H. Brown (1988) Reduced cytosolic fructose-1,6-bisphosphatase activity leads to loss of O_2 sensitivity in a *Flaveria* linearis mutant. Plant Physiology 86:667-671.

20. Kobza, J. and J.R. Seemann (1988) Mechanisms for light-dependent regulation of ribulose-1,5-bisphosphate carboxylase activity and photosynthesis in intact leaves. Proceedings of the National Academy of Sciences (USA) 85:3815-3819.

21. Sage, R.F., T.D. Sharkey and J.R. Seemann (1988) The *in vivo* response of the ribulose 1,5-bisphosphate carboxylase activation state and the pool sizes of photosynthetic metabolites to elevated CO_2 in *Phaseolus vulgaris* L. Planta 174:407-416.

22. Seemann, J.R., J.Kobza (1988) Genetic variation in the regulation of ribulose 1,5-bisphosphate carboxylase activity. Plant Physiology and Biochemistry 26:461-471.

23. Seemann, J.R., M.U.F. Kirschbaum, T.D. Sharkey and R.W. Pearcy (1988) Regulation of ribulose-1,5-bisphosphate carboxylase activity in *Alocasia macrorrhiza* in response to step changes in irradiance. Plant Physiology 88:148-152

24. Kobza, J. and J.R. Seemann (1989) Light-dependent kinetics of 2-carboxyarabinitol 1-phosphate metabolism and ribulose-1,5-bisphosphate carboxylase activity *in vivo*. Plant Physiology 89:174-179

Peer Reviewed Journal Publications: cont'd.

25. Sage, R.F., T.D. Sharkey and J.R. Seemann (1989) The acclimation of photosynthesis to elevated CO_2 in five C_3 species. Plant Physiology 89:590-596.

26. Kobza, J. and J.R. Seemann (1989) Regulation of ribulose-1,5-bisphosphate carboxylase activity during diurnal changes in irradiance. Plant Physiology 89:918-924.

27. Sharkey, T.D. and J.R. Seemann (1989) Mild water stress effects on carbon-reduction-cycle intermediates, ribulose bisphosphate carboxylase activity, and spatial homogeneity of photosynthesis in intact leaves. Plant Physiology 89:1060-1065.

28. Seemann, J.R. (1989) Light adaptation/acclimation of photosynthesis and the regulation of ribulose-1,5-bisphosphate carboxylase activity in sun and shade plants. Plant Physiology 91:379-386.

29. Kobza, J., B.d. Moore and J.R. Seemann (1989) Isolation of photosynthetically active protoplasts and chloroplasts from *Phaseolus vulgaris*. Plant Science 65:177-182.

30. Seemann, J.R., J. Kobza and B.d. Moore (1990) Metabolism of 2-carboxyarabinitol 1-phosphate and regulation of ribulose-1,5-bisphosphate carboxylase activity. Photosynthesis Research 23:119-130.

31. Ziska, L.H., J.R. Seemann and T.M. DeJong (1990) Salinity induced limitations on photosynthesis in *Prunus salicina*, a deciduous tree species. Plant Physiology, 93:864-870.

32. Pearcy R.W., J.R. Seemann (1990) The photosynthetic induction state of leaves in a soybean canopy in relation to light regulation of ribulose-1,5-bisphosphate carboxylase and stomatal conductance. Plant Physiology, 94:628-633.

33. Moore, B.d. and J.R. Seemann (1990) $^{14}CO_2$ labelling studies of 2-carboxyarabinitol 1-phosphate synthesis. Plant Cell Physiology 31:969-974.

34. Sage, R.F., T.D. Sharkey, J.R. Seemann (1990) Regulation of ribulose-1,5-bisphosphate carboxylase activity in response to light intensity and CO_2 in the C_3 annuals *Chenopodium album* L. and *Phaseolus vulgaris* L. Plant Physiology 94:1735-1742.

35. Winicov, I., J.R. Seemann (1990) Expression of genes for photosynthesis and the relationship to salt tolerance of alfalfa (*Medicago sativa*) cells. Plant Cell Physiology 31:1155-1161.

36. Cramer, G.R., R. Abdel-Basset, J.R. Seemann (1990) Salinity-calcium interactions on root growth and osmotic adjustment of two corn cultivars differing in salt tolerance. Journal of Plant Nutrition, 11:1453-1462.

Peer Reviewed Journal Publications: cont'd.

37. Moore, B.d., J. Kobza, J.R. Seemann (1991) Measurement of 2-carboxyarabinitol 1-phosphate in plant leaves by isotope dilution. Plant Physiology 96:208-213.

38. Shirzadegan, M., P. Christie, J.R. Seemann (1991) An efficient method for isolation of RNA from tissue cultured plant cells. Nucleic Acids Research 19:6055.

39. Pons, T.L., R.W. Pearcy, J.R. Seemann (1992) Photosynthesis in flashing light in soybean leaves grown in different conditions. 1. Photosynthetic induction state and regulation of ribulose-1,5-bisphosphate carboxylase activity. Plant, Cell and Environment 15:569-576.

40. Moore, B.d., T.D. Sharkey, J. Kobza, J.R. Seemann (1992) Identification and levels of 2'-carboxyarabinitol in leaves. Plant Physiology 99:1546-1550.

41. Moore, B.d., J.R. Seemann (1992) Metabolism of 2'-carboxyarabinitol in leaves. Plant Physiology 99:1551-1555.

42. Sage, R.F., J.R. Seemann (1993) Regulation of ribulose-1,5-bisphosphate carboxylase/oxygenase activity in response to reduced light intensity in C_4 plants. Plant Physiology 102:21-28.

43. Moore, B.d., E. Isidoro, J.R. Seemann (1993) Distribution of 2-carboxyarabinitol among plants. Phytochemistry 34:703-707.

44. Sage, R.F., C.T. Reid, B.d. Moore, J.R. Seemann (1993) Long-term kinetics of the light-dependent regulation of ribulose-1,5-bisphosphate carboxylase/oxygenase activity in plants with and without 2-carboxyarabinitol 1-phosphate. Planta191:222-230.

45. Moore, B.d., J.R. Seemann (1994) Evidence that 2-carboxyarabinitol 1-phosphate binds to ribulose bisphosphate carboxylase *in vivo*. Plant Physiology 105:731-737.

46. Moore, B.d., M. Hackett, J.R. Seemann (1995) Hamamelitol purification, identification by electrospray ionization mass spectrometry, and quantification in plant leaves. Planta 195:418-425.

47. Moore, B.d., O. Kiirats, T. Charlet, J.R. Seemann (1995) Levels of carboxyarabinitol 1-phosphate and related photosynthetic compounds during leaf development in *Phaseolus vulgaris*. Plant and Cell Physiology 36:1097-1103.

48. Moore, B.d., T.D. Sharkey, J.R. Seemann (1995) Intracellular localization of CA1P and CA1P phosphatase activity in leaves of *Phaseolus vulgaris* L. Photosynthesis Research 45:219-224.

Peer Reviewed Journal Publications: cont'd.

49. Griffin, K.L., P.D. Ross, D.A. Sims, Y. Luo, J.R. Seemann, C.A. Fox, J.T. Ball (1996) EcoCells: A tool for mesocosm scale measurements of gas exchange. Plant, Cell and Environment 19:1210-1221.

50. Griffin, K.L. and J.R. Seemann (1996) Plants, CO_2 and photosynthesis in the 21st century. Chemistry and Biology 3:245-254.

51. Charlet, T., B.d. Moore, J.R. Seemann (1997) CA1P phosphatase from leaves of *Phaseolus vulgaris* and other species. Plant Cell Physiology 38: 511-517.

52. Moore, B.d., J.N. Talbot, J.R. Seemann (1997) Function of leaf hamamelitol as a compatible solute during water-stress treatment of *Hedera helix* L. Plant, Cell and Environment 20:938-944.

53. Moore, B.d., D.E. Palmquist, J.R. Seemann (1997) Influence of plant growth at high CO_2 concentrations on leaf content of ribulose 1,5-bisphosphate carboxylase/oxygenase and intracellular distribution of soluble carbohydrates in tobacco, snapdragon, and parsley. Plant Physiology 115:241-248.

54. Gibeaut, D.M., J. Hulett, G.R. Cramer, J.R. Seemann (1997) Maximal biomass of *Arabidopsis thaliana* using a simple, low maintenance hydroponic method and favorable environmental conditions. Plant Physiology 115:317-319.

55. Sims, D., J.R. Seemann, Y. Luo (1998) The significance of differences in the mechanisms of photosynthetic acclimation to light, nitrogen, and CO_2 for return on investment in leaves. Functional Ecology 12:185-194.

56. Sims, D., J.R. Seemann, Y. Luo (1998) Elevated CO_2 concentration has independent effects on expansion rates and thickness of soybean leaves across light and nitrogen gradients. Journal of Experimental Botany 49:583-591.

57. Cheng, S., B.d. Moore, J.R. Seemann (1998) Effects of short- and long-term growth at elevated CO_2 on the expression of Rubisco genes and leaf carbohydrate accumulation in *Arabidopsis thaliana* (L.) Heynh. Plant Physiology 116:715-723.

58. Sims, D., Y. Luo, J.R. Seemann (1998) Comparison of photosynthetic acclimation to elevated CO_2 and limited nitrogen supply in soybean. Plant Cell and Environment 21:945-952.

59. Moore, B.d., S-H. Cheng, J. Rice, J.R. Seemann (1998) Sucrose cycling, rubisco expression, and prediction of photosynthetic acclimation to elevated CO_2. Plant, Cell and Environment 21:905-915.

Peer Reviewed Journal Publications: cont'd.

60. Huxman, T.E., E.P. Hamerlynck, Bd Moore, S.D. Smith, D.N. Jordan, S.F. Zitzer, R.S. Nowak, J.S. Coleman, J.R. Seemann (1998) Photosynthetic down-regulation in *Larrea tridentata* exposed to elevated atmospheric CO_2: Interactions with drought under glasshouse and field (FACE) exposure. Plant Cell and Environment 21:1153-1161.

61. Sims D., Y. Luo, J.R. Seemann (1998) Importance of leaf versus whole plant CO_2 environment for photosynthetic acclimation. Plant, Cell and Environment 21:1189-1196.

62. Griffin K.L., D.A. Sims, J.R. Seemann (1999) Altered nighttime CO_2 concentration affects the growth, physiology and biochemistry of soybean. Plant, Cell and Environment 22:91-99.

63. Moore, B.d., S-H. Cheng, D. Sims, Seemann, J.R. (1999) *Invited Review:* The biochemical and molecular basis for photosynthetic acclimation to elevated atmospheric CO_2. Plant, Cell and Environment *(Special Issue on Rising CO_2 Concentration)* 22:567-582.

64. Jordan D.N., S.F. Zitzer, G.R. Hendrey, K.F. Lewin, J. Nagy, R.S. Nowak, S.D. Smith, J.S. Coleman, J. R. Seemann (1999) Biotic, abiotic and performance aspects of the Nevada Desert Free-Air CO_2 Enrichment (FACE) Facility. Global Change Biology 5:659-668.

65. Sims D.A., W. Cheng, Y. Luo, J.R. Seemann (1999) Photosynthetic acclimation to elevated CO_2 in a sunflower canopy. Journal of Experimental Botany 50:645-653.

66. Hamerlynck, EP, TE Huxman, RS Nowak, S Redar, ME Loik, DN Jordan, SF Zitzer, JS Coleman, JR Seemann, SD Smith (2000) Photosynthetic responses of *Larrea tridentata* to a step-increase in atmospheric CO_2 at the Nevada Desert FACE Facility. Journal of Arid Environments 44:425-436.

67. Yoder, CK, P Vivin, LA DeFalco, JR Seemann, RS Nowak (2000) Root growth and function of three Mojave Desert grasses in response to elevated atmospheric CO_2 concentration. New Phytologist 145:245-256.

68. Taub, DR., JR Seemann, JS Coleman (2000) Growth in elevated CO_2 protects photosynthesis against high temperature damage. Plant, Cell and Environment 23:649-656.

69. Pataki, DE, TE Huxman, DN Jordan, SF Zitzer, JS Coleman, SD Smith, RS Nowak, JR Seemann (2000) Water use of two Mojave Desert shrubs under elevated CO_2. Global Change Biology 6:889-897.

Peer Reviewed Journal Publications: cont'd.

70. Smith, SD, TE Huxman, SF Zitzer, TN Charlet, DC Houseman, JS Coleman, LK Fenstermaker, JR Seemann, RS Nowak (2000) Elevated CO_2 increases productivity and invasive species success in an arid ecosystem. Nature 408:79-82.

71. Nowak, RS, LA DeFalco, CS Wilcox, DN Jordan, JS Coleman, JR Seemann, SD Smith (2001) Leaf conductance decreased under free-air CO_2 enrichment (FACE) for three perennials in the Nevada Desert. New Phytologist 150:449-458.

72. Gibeaut, DM, GR Cramer, JR Seemann (2001) Growth, cell walls and UDP-Glc dehydrogenase activity of *Arabidopsis thaliana* grown in elevated carbon dioxide. Journal of Plant Physiology 158:569-576.

73. Griffin, KL, OR Anderson, MD Gastrich, JD Lewis, G Lin, W Schuster, JR Seemann, DT Tissue, MH Turnbull, D Whitehead (2001) Plant growth in elevated CO_2 alters mitochondrial number and chloroplast fine structure. Proceedings of the National Academy of Sciences (USA) 98:2473-2478.

74. Wang, X, JD Lewis, DT Tissue, JR Seemann, KL Griffin (2001) Effects of elevated atmospheric CO_2 concentration on leaf respiration of *Xanthium strumarium* in light and in darkness. Proceedings of the National Academy of Sciences (USA) 98:2479-2484.

75. Nowak, RS, SF Zitzer, D Babcock, V Smith-Longozo, TN Charlet, JS Coleman, JR Seemann, SD Smith (2004) Elevated CO_2 does not conserve soil water in the Mojave Desert. Ecology 85:93-99.

76. Zou, X, JR Seemann, D Neuman, QJ Shen (2004) A *WRKY* Gene from creosote bush encodes an activator of the abscisic acid signaling pathway. Journal of Biological Chemistry 279:55770-55779.

Book Chapters:

1. Seemann, J.R. (1986) Mechanisms for the regulation of CO_2 fixation by ribulose-1,5-bisphosphate carboxylase. In: R. Marcelle, H. Clijsters, M. Van Poucke (eds.) Biological Control of Photosynthesis., Martinus Nijhoff Publishers, Dordrecht, Netherlands, pp 71-82.

2. Evans, J.R. and J.R. Seemann (1989) The allocation of protein nitrogen in the photosynthetic apparatus: costs, consequences, and control. In: W.R. Briggs (ed), Photosynthesis, Alan R. Liss Press, pp 183-205.

3. Cheng, S-H and J.R. Seemann (1998) Extraction and purification of RNA from plant tissue enriched in polysaccharides. In: *Methods in Molecular Biology*, *Vol. 86: RNA Isolation and Characterization Protocols.* R Rapley and DL Manning (eds). Humana Press Inc., Totowa, NJ, pp 27-32.

Book Chapters: cont'd.

4. Cheng, S., B.d. Moore, J.R. Seemann (1998) Purification of RNA from leaf carbohydrates in plants exposed to elevated atmospheric CO_2**.** In: Methods in Molecular Biology, R Rapley and DL Manning (eds). Humana Press Inc., Totowa, NJ.

Funded External Grants:

1. Salt Tolerance of Plants in Semiarid Agricultural Regions: Interactive Effects of Salinity, Nitrogen Nutrition and High Light on Water Use and Photosynthesis. USGS $15,000 (1985-1986).

2. Stress Effects on the Functioning and Efficiency of CO_2 Fixation. USDA Competitive Grants Environmental Stress Program $89,000 (1985-1987).

3. Salt Tolerance of Plants in Semiarid Agricultural Regions: Salinity Effects on Photosynthetic Metabolism.USGS $21,000 (1986-1987).

4. Mechanisms for the Control of RuBP Carboxylase Activity. NSF Metabolic Biology $85,000 (1986-1988).

5. Stimulation of Competitive Research in Plant Biology at the Desert Research Institute (with T.D. Sharkey). NSF EPSCoR Program $496,000 (NSF portion only) (1986-1991).

6. Dynamic Responses of Photosynthesis to Variable Light (R.W. Pearcy, P.I.). USDA Competitive Grants Photosynthesis Program (subcontract) $6,285 (1987-1988).

7. Environmental Stress Effects on Photosynthetic Carbon Metabolism. USDA Competitive Grants Environmental Stress Program $205,000 (1987-1990).

8. Light Regulation of Rubisco Activity and Photosynthesis. NSF Metabolic Biology $47,500 (1988-1989).

9. Metabolism of 2-Carboxyarabinitol 1-Phosphate and Regulation of Rubisco Activity. USDA Competitive Grants Photosynthesis Program $100,000 (1989-1991).

10. Acquisition of Plant Growth Chambers at the University of Nevada-Reno. NSF Instrumentation Program $40,000 (1990-1992) (plus $68,000 in College and Departmental matching funds).

11. CA1P and CA Metabolism in Photosynthesis. USDA National Research Initiative Competitive Grants Photosynthesis Program $86,000 (1991-1993).

12. Branched-Chain Monosaccharides in Leaves: Biochemistry and Environmental Responses. USDA National Research Initiative Competitive Grants Photosynthesis Program $110,000 (1993-1995).

Funded External Grants: cont'd.

13. Plant Responses to Rising Atmospheric CO_2 and Temperature. NSF EPSCoR Program $2,220,000 (1993-1998) (plus $2,220,000 in University matching funds).

14. HPAE-PAD System for the Identification and Measurement of Plant Carbohydrates. USDA National Research Initiative Competitive Grants Equipment Program (CoPI with B.d. Moore) $40,105 (1993).

15. Responses of Desert Vegetation to Increasing Atmospheric CO_2. DOE EPSCoR Program $500,000 (1994-1996)

16. Molecular Mechanisms Controlling Plant Responses to Elevated CO_2. NSF Integrative Plant Biology Program $242,985 (1995-1998).

17. Effects of Elevated CO_2 on a Mojave Desert Ecosystem. NSF/DOE/NASA/USDA Interagency Terrestrial Ecology and Global Change Program $415,000 (1995-1998) (CoPI with Stan Smith [PI], Tim Ball, Bob Nowak, Yiqi Luo)

18. Workshop: Plant Acclimation to Elevated CO_2. USDA Plant Responses to the Environment Program $5000 (1995-1996) (CoPI with David Wolfe and many others).

19. From Nuclear Bombs to Nuclear Genes: Use of the NTS Desert FACE Facility to Study the Molecular Biology of Plant Responses to Global Environmental Change. DOE-UNR Cooperative Program $48,818 (1997)

20. Responses of Desert Vegetation to Elevated Atmospheric Carbon Dioxide. DOE EPSCoR Program $380,000 (1996-1997) (with S. Smith, R. Nowak, J Coleman, CoPIs)

21. Construction of the Nevada Desert FACE Facility. DOE Nevada Operations Office $620,000 (1996-1997) (with S. Smith, R. Nowak, J Coleman, CoPIs)

22. Assessment of the Effect of the Variable Biosphere 2 Atmosphere on Plant Responses to Elevated CO_2. Biosphere 2 Research Incentive Grant $41,259 (1997-1998) (with K. Griffin, joint PI)

23. Plant Respiration at Elevated CO_2: Mechanisms of Response. NSF Ecological and Evolutionary Physiology Program $256,000 (1997-2000) (CoPI with K. Griffin)

24. The Nevada Desert FACE Facility: Responses of a Desert Ecosystem to Long-Term Elevated Atmospheric Carbon Dioxide. DOE EPSCoR Program $594,750 (1997-1999) (with S. Smith, R. Nowak, J Coleman, CoPIs)

25. Photosynthetic Acclimation, Carbohydrate Signaling and Molecular Control of Gene Expression at Elevated Atmospheric Carbon Dioxide. NSF Integrative Plant Biology Program $80,000 (1998-1999)

Funded External Grants: cont'd.

26. Effects of Elevated CO_2 on a Mojave Desert Ecosystem. NSF/DOE/NASA/USDA Terrestrial Ecology and Global Change Program. $1,300,000 (1998-2001) (with Stan Smith [PI], James Coleman, David Evans, Weixin Cheng, Robert Nowak, Brandon Moore, [CoPIs])

27. The Nevada Desert FACE Facility: Responses of a Desert Ecosystem to Long-Term Elevated Atmospheric Carbon Dioxide. DOE EPSCoR Program $297,375 (1999-2000) (with S. Smith, R. Nowak, J Coleman, [CoPIs])

28. EPSCoR: Research Infrastructure for Nevada's Growth - Targeting Research With Uniqueness and Excellence (RING-TRUE). NSF EPSCoR Program. $1,110,653 - genomics component only, (1999-2002) (Director of genomics component only, with James Coleman [PI], Dennis Lindle, Scott Tyler [CoPIs]

29. A Genomics Approach to Studying Ecosystem Responses to Elevated Atmospheric CO_2: Building a Foundation for Studies of Biodiversity. Nevada NSF EPSCoR Program. $50,000 (2000-2002) (with Charles Moehs and Christina Wells, Co-PIs).

30. Purchase of CO_2 for the Nevada Desert FACE Facility During Fiscal Year 2000. DOE Office of Science. $150,000 (2000-2001) (with James Coleman, Lynn Fenstermaker, Robert Nowak, and Stanley Smith, CoPI's).

31. Biotic Processes Regulating the Carbon Balance of Desert Ecosystems. DOE Office of Science Terrestrial Carbon Processes Program. $2,250,000 (2000-2003) (with James Coleman, Lynn Fenstermaker, Robert Nowak and Stanley Smith, CoPIs).

32. Environmental Sciences Research and Training Opportunities Program. EPA NHEERL/Atlantic Ecology Division. $700,000 (2002-2005) (Deborah Grossman-Garber, PI and numerous CoPI's).

33. Environmental Biotechnology in Rhode Island. USDA Special Research Grants. $2,796,000 (2002-2006) (with Terence Bradley, CoPI).

34. Project Jump Redux II: Strengthening and Diversifying our Future Workforce in the Food and Ag Sciences. USDA-CSREES Higher Ed Multicultural Scholars Program. $100,000 (2002-2006) (with D. Grossman-Garber, PI and numerous CoPI's).

35. Drawing a Roadmap to Research Excellence in Rhode Island. NSF EPSCoR Program. $429,153 (2003-2005).

36. Rhode Island EPSCoR: Catalyzing a Life Sciences Research, Education and Innovation Network. NSF EPSCoR Program. $6,750,000 (2006-2009) (with Andries van Dam, CoPI).

Funded External Grants: cont'd.

37. ARRA – Texas A&M University Interdisciplinary Life Sciences Building Build-Out. NIH National Center for Research Resources. $3,529,612 (2010-2013).

Richard D. Gray 860-486-3455

Senior Executive skilled in financial and operational management and negotiation

- In 2012 assumed direct responsibility for a majority of non-academic operating units in addition to the finance and budget areas and successfully reorganized several operating units to provide more efficient and higher quality service to the University community.
- Successfully reorganized and recruited two senior leaders in he Architectural and Building Services units.
- Executive sponsor of a University wide implementation of the Kuali Financial System replacing an outdated and unsupported financial system.
- Successfully balanced University budgets in the face of reductions in State support due to economic conditions
- Member of a variety of University governance committees
- Increased tax-exempt bond portfolio from $1.7 billion to $6.5 billion in eleven years.
- $3.8 billion and $1.7 billion outstanding to institutions of higher education and hospitals respectively.
- Achieved surpluses in ten successive years resulting in the funding of new programs while rebating over $3 million in fees to health, education and childcare non-profit clients.
- Negotiated the acquisition of $70 million in property from five separate owners including three public companies for the $700 million Adriaen's Landing/University of Connecticut urban development and football stadium projects in Hartford and East Hartford, Connecticut.
- Financial advisor to the former Governor on the proposed Bridgeport casino project.
- Obtained regulatory and financing approvals required for the development of $120 million in skilled nursing facilities in the for-profit and non-profit sectors.
- Speaker at state and national conferences on non-profit health and education finance.
- Adapted Sarbanes –Oxley principles to quasi-public authorities.
- Serves as secretary and member of the Board of Directors of the Connecticut Science Center in Hartford.
- Serves as Executive Director of the University of Connecticut Health Center Finance Corporation.

Government Advocacy Legislation and Regulation

- Managed the $9.0 billion debt portfolio of the State of Connecticut.
- Principal in the credit rating process that resulted in the upgrade of the general obligation debt of the State of Connecticut by a major rating agency.
- Principal in the drafting of the bonding section of the electric deregulation legislation enacted by the Connecticut General Assembly.
- Principal in the preparation Adriaen's Landing and the University of Connecticut football stadium at Rentschler Field plans to the Connecticut General Assembly. Negotiated with legislators and staff in successful effort to pass the legislation that appropriated funds for these projects.
- Member of the Governor's Advisory Panel on the loss of $220 million of taxpayer funds by the Connecticut Resources Recovery Authority as a result of the Enron bankruptcy and co-drafted legislation reorganizing this Authority.
- Financial advisor to the Governor and General Assembly on health, education and urban development issues.
- As a principal in a bipartisan team, developed tax-exempt bond pool and multi-bank loan guaranty program to finance quality childcare in Connecticut.
- Member of Governor Rell's Task force on the Future of Hospitals and collaborated in the writing of the final report to the Governor.
- Member of Governor Rell's Early Childhood Research and Policy Council.

Strategic Planning

- Authored and implemented the Strategic Business Plan for the Connecticut Health and Educational Facilities Authority.
- Authored the State of Connecticut Strategic Action Plan for Economic and Community Development. -1995

BA University of Connecticut 1972. **MBA** University of New Haven 1977.

Professional Experience

University of Connecticut Storrs, CT
Executive Vice President for Administration and Chief Financial Officer
April 2012 – Present

- Promoted to serve as Executive Vice President and Chief Financial Officer in 2012
- Oversight and management of all institutional finances
- Oversight and management of all institutional operations including Public Safety, Procurement, Architecture and University Planning, Facilities Operations, Human Resources, Labor Relations, Logistics Administration, and Infrastructure and Strategic Planning.

University of Connecticut Storrs, CT
Vice President and Chief Financial Officer

- Oversight and management of all institutional finances both at the University and the Health Center

Connecticut Health and Educational Facilities Authority Hartford, CT
Executive Director, 1996 – 2008

- Chief Executive Officer of CHEFA, ranked 74th of 5,000 national issuers of tax-exempt debt 1993 -2006.
- Responsible for the preparation and final approval of the annual Authority budget prior to presentation to the Board of Directors.
- Supervision of the investment of over $1.1 billion in client funds and $22 million in Authority reserves.
- Enhanced the Authority's role as an independent financial advisor to Connecticut's non-profit community.
- Expanded the Authority's market franchise to include childcare, charter school and non-traditional non-profit institutions.
- Established three grant programs to eligible Connecticut non-profit institutions – awards to date $11 million to 122 non-profit institutions.
- Responsible for health and education databases utilized by State government in the formation of public policy.
- Responsible for all Board of Director presentations, communication and Board education.
- The CHEFA Board granted leave of absence to the Executive Director for the period from February of 1998 until January of 1999 to become Deputy Treasurer of the State of Connecticut.

Aragorn Corporation Cheshire, CT
Consultant – Self Employed, 1994 – 1996

- Financial advisor to long-term care and assisted living industry in development, finance and regulatory matters.
- Commenced development of two assisted living facilities.

Connecticut Health Facilities Hartford, CT
Chief Financial Officer 1987 – 1994

- Raised $120 million in debt financing including conventional bank construction/permanent loans, tax-exempt municipal bonds and United States Department of Housing and Urban Development Section 232 financing.
- Responsible for acquisition analysis, long-term care business valuation and State of Connecticut Department of Social Services reimbursement analysis.
- Participated in the development of annual capital and operating budgets.
- Solely responsible for all financial forecasts utilized to in all financing applications.
- Obtained five Certificates of Need and zoning approvals to construct and renovate 450 long-term care facility beds.
- Managed all banking and financial relationships.
- Successfully lobbied State Legislature on restructuring of Medicaid reimbursement system.

Other Companies
Vice President Commercial Lending 1985-1987 Citytrust Hartford, CT

- Commercial business development and relationship management.
- $40 million loan portfolio.

Vice President Loan Workout Officer 1981-1985 American National Bank Hamden, CT

- Developed loan review and classified assets policies and procedures.
- Direct responsibility for Federal and State regulatory examinations.

Vice President Commercial Lending 1978-1981 Citytrust Danbury, CT

Assistant Vice President – Branch Manager 1974-1978 Union Trust New Haven, CT

- Retail and commercial lending in a high volume inner city bank branch.

Undergraduate Adjunct Faculty – 1982-1987 Quinnipiac University – Part Time Hamden, CT

- Lecturer in Finance and Economics

Associations and Board Affiliations

- National Association of State Treasurers
- State Debt Management Network
- Former Board Chair – The Connecticut Forum
- National Association of Health & Educational Facilities Finance Authorities
- Executive Committee of the Board of the Connecticut Science Center
- Connecticut Council of Philanthropy

Curriculum Vitae **December 2013**

JAMES A. GREEN

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University of Connecticut
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Phone (860) 486-3517 & FAX (860) 486-2760
James.Green@UConn.edu

Education:

1984-1986: Postdoctoral training in quantitative methods, University of Illinois at Urbana-Champaign

1974-1979: University of North Carolina at Chapel Hill
M.A. in Developmental Psychology (1977)
Ph.D. in Developmental Psychology (December 1979)

1969-1973: Bucknell University, B.A. in Psychology (1973)

Faculty Appointments and Research Positions

2011-Present Department Head & Professor, Department of Psychology, University of Connecticut

2000-present Professor, Department of Psychology, University of Connecticut

1998-2002 Associate Department Head and Coordinator of Undergraduate Studies, Department of Psychology, University of Connecticut

1992-2000: Associate Professor, Department of Psychology, University of Connecticut

1987-1992: Associate Professor in Residence, Department of Psychology, University of Connecticut

1985-1986: Visiting Assistant Professor, Department of Psychology, University of Illinois at Urbana-Champaign

1984-1986: Postdoctoral Fellow, Quantitative Division of the Department of Psychology, University of Illinois at Urbana-Champaign.

1981-1986: Adjunct Assistant Professor, Department of Psychology, Northern Illinois University.

1980-1982: Assistant Medical Research Professor, Departments of Pediatrics and Psychiatry, Duke University Medical Center.

Grants and Research Support

2009-2014 NICHD/NIH, "Early Detection of Pervasive Developmental Disorders"
Role: Co-Investigator; PI: Deborah Fein

2008-2011 NICHD/NIH, "Quantifying Children's Emotions with the Emotion Intensity Linkage Function Model," Role: PI on UConn subaward; PI: Michael Potegal

2005-2007: NIMH/NIH, "Quantifying the Time Course of Tantrum Anger,"
Role: Co-PI; PI: Michael Potegal

2002-2007 NICHD/NIH, "Early Detection of Pervasive Development Disorders,"
Role: Co-Investigator, PI: Deborah Fein

1986-1991: NICHHD/NIH--"Infant Cries: Development, Perception, and Function;"
Role: Co-Investigator; PI: Gwen E. Gustafson

1980-1984: Bureau of Maternal and Child Health--"Simultaneous Screening of Child Health and Development;" Role: Co-Investigator; PI: Raymond Sturner

1982-1983: NIMH/ADAMHA--"Visual Attention, Vocalization, and Social Communication;" Role: Principal Investigator

Teaching Experience

1986-2007: Introductory Psychology, Principles of Research, Measurement and Scaling, Quantitative Methods for the Behavioral Sciences, Advanced Developmental Psychology, Developmental Psychology, and Seminar in Quantitative Methods. Department of Psychology, University of Connecticut

1985-1986: Psychological Statistics, at the Department of Psychology, University of Illinois at Urbana-Champaign

1980-1982: Statistics and Research Design, at the General Pediatrics Fellowship Program, Duke University Medical Center.

1976-1977: Child Development, at the Department of Psychology, University of North Carolina

Publications

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Papers Presented

Sanborn, S. & Green, J. A. (2013, April). *Revisiting "Crying as a Sign": The Relationship Between Newborn Cry Acoustics and Language Production at 2.5 Years*. Presented at the Biennial meeting of the Society for Research in Child Development, Seattle.

Bisson, J., Sanborn, S., Eriksson, J., & Green, J. A. (2013, April). *Perceptions of Infant Crying via Multiple Modalities*. Presented at the Biennial meeting of the Society for Research in Child Development, Seattle.

Sanborn, S., Askar, P. & Green, J. A. (2013, April). *Exploring Rhythmic Vocal-Motor Coordination in Infants From 6 to 9 months.* Presented at the Biennial meeting of the Society for Research in Child Development, Seattle.

Broder, L., Green, J. A., & Gustafson, G. E. (2013, April). *The Role of Language and Self-Regulation in Toddler Temper Tantrums*. Presented at the Biennial meeting of the Society for Research in Child Development, Seattle.

Bisson, J., Green, J. A., & Potegal, M. (2013, April). *It Takes Two To Tango: A Unique Approach to Temper Tantrum Analysis.* Presented at the Biennial meeting of the Society for Research in Child Development, Seattle.

Broder, L. S., Elliot, K. M., Green, J. A., & Potegal, M. (June, 2012). *Correlates of individual differences in temper tantrums.* Presented at the International Conference on Infant Studies. Minneapolis.

Broder, L. S. & Green, J. A. (June, 2012). *Developmental changes in predictors of compliance*. Presented at the International Conference on Infant Studies. Minneapolis.

Sanborn, S. M., Whitney, P. G., Gustafson, G. E., & Green, J. A. (June, 2012). *"Soothable" infants mean business when they cry: Exploring the relation between infants' soothability and cry acoustics.* Presented at the International Conference on Infant Studies. Minneapolis.

Sanborn, S. M., Gustafson, G. E., & Green, J. A., & Lin, H-C. (June, 2012). *Are newborns' cry sounds shaped by their native language environment? A more appropriate analysis.* Presented at the International Conference on Infant Studies. Minneapolis.

Whitney, P. G., Syed, N., & Green, J. A. (June, 2012). *Attention in crawling and pre-crawling infants*. Presented at the International Conference on Infant Studies. Minneapolis.

Hardy, S., Knock, K., Green, J., Barton, M. Dumont-Mathieu, T. & Fein, D. A. (May, 2011). *A preliminary analysis of the ages and stages questionnaire (ASQ) compared to the modified checklist for autism in toddlers – Revised (M-CHAT-R)*. Presented at the International Society for Autism Research: San Diego.

Bisson, J. B., Gustafson, G. E., & Green, J. A. (April, 2011). *Caregivers' negative mood changes during infant crying are related to their caregiving behavior*. Presented at the Society for Research in Child Development: Montreal.

Whitney, P. G., & Green, J. A. (April, 2011). *Independent locomotion and infant emotion reactivity and regulation*. Presented at the Society for Research in Child Development: Montreal.

Hardy, S., Chlebowski, C., Barton, M., Green, J., Robins, D., Fein, D. (February, 2011). *Stability of Autism Spectrum Disorder Diagnoses Made During the Second Year of Life.* Presented at the International Neuropsychological Society, Boston, MA.

Herlihy, L., Green, J., Hardy, S., Knoch, K., Dumont-Mathieu, T., Barton, M., Robins, D.L., & Fein, D. (February, 2011). Potential sociodemographic disparities in screening but not rate of diagnosis of autism spectrum disorder in a population-based sample of toddlers. Poster displayed at International

Neuropsychological Society Annual Meeting, Boston.

Knoch, K., Herlihy, L., Dumont-Mathieu, T., Green, J., Barton, M., Fein, D., (February, 2011). *The Development of Repetitive and Stereotyped Behaviors: Changes in Frequency and Severity of High- and Low-Level Behaviors in Children with ASD*. Presented at the International Neuropsychological Society annual meeting, Boston, MA.

Chlebowski, C., Green, J.A., Barton, M., & Fein, D. (May, 2010) *Using the Childhood Autism Rating Scale (CARS) to Diagnose Autism Spectrum Disorders.* Presented at the International Meeting for Autism Research, Philadelphia, PA.

Knoch, K., Herlihy, L., Troyb, E., Boorstein, H., Dumont-Mathieu, T., Green, J., Barton, M., Fein, D., (May, 2010) *Repetitive and Stereotyped Behaviors from Age 2 to Age 4: A Look at the Development of High- and Low-Level Behaviors*. Presented at the International Meeting For Autism Research, Philadelphia, PA.

Robins, D. L., Pandey, J., Chlebowski, C., Carr, K., Zaj, J.L., Arroyo, M., Barton, M.L., Green, J.A., & Fein, D. (May, 2010) *M-CHAT Best7: A New Scoring Algorithm Improves Positive Predictive Power of the M-CHAT. P*resented at the International Meeting for Autism Research, Philadelphia, PA.

Barr, R. G., Fairbrother, N., Pauwels, J., Brant, J., Green, J., Miller, E., & Lee, C. (April, 2010). *Getting from crying to shaking: individual differences in frustration responses to prolonged infant crying.* Presented at the Helfer Society Meetings: Philadelphia.

Green, J. A., Gustafson, G. E., & Whitney, P. G. (March, 2010). *Multilevel modeling for analyzing episodes of real-time behavior.* Presented at the International Conference on Infant Studies, Baltimore.

Bisson, J. B., Gindin, L. S., & Green, J. A. (March,2010). *Embodied perception and adults' reactions to infants' cries*. Presented at the International Conference on Infant Studies, Baltimore.

Sanborn, S, & Green, J. A. (March, 2010). *Infants' responses to delayed auditory feedback during crying bouts*. Presented at the International Conference on Infant Studies, Baltimore.

Whitney, P. G. & Green, J. A. (March, 2010). *Coordination of infants' facial and vocal behaviors during emotional expressions in dyadic and solitary play*. Presented at the International Conference on Infant Studies, Baltimore.

Gindin, L. A., Bisson, J. B., Green, J. A., & Potegal, M. (March, 2010). *Temper Tantrums: Intensity, Duration, and Parent Behavior*. Presented at the International Conference on Infant Studies, Baltimore.

Lin, H-C. & Green, J. A. (March, 2010). Facial expression: A potential organizer of infant expressive behaviors? Presented at the International Conference on Infant Studies, Baltimore.

Boorstein, H., Verbalis, A., Barton, M., Green, J., Hodgson, S., & Fein, D. (February, 2010). *Regressive and non-regressive autism spectrum disorders: A comparison of developmental trajectories, autistic behaviors, and medical histories*. Paper presented at the annual meeting of the International Neuropsychological Society, Acapulco, Mexico.

Verbalis, A.D., Hodgson, S., Dumont-Mathieu, T., Barton, M., Green, J., & Fein, D. (February, 2010). Cognitive and Adaptive Stability in Male and Female Children with ASD. Poster session presented at the meeting of the International Neuropsychology Society, Acapulco, Mexico.

Carr, K., Pandey, J., Hodgson, S., Barton, M., Green, G., Fein, D. (May, 2009). *The concordance of repetitive behaviors in multiplex autism families*. Poster presented at International Meeting for Autism Research, Chicago.

Verbalis, A., Boorstein, H., Pandey, J., Hodgson, S., Dumont-Mathieu, T., Barton, M., Green, J., Fein, D. (May, 2009) *Longitudinal changes in cognitive ability in male and female children with ASD*. Paper presented at International Meeting for Autism Research, Chicago.

Whitney, P. G., Gindin, L. S., & Green, J. A. (April, 2009). *Emotional development through the transition to crawling*. Presented at the biennial meeting of the Society for Research in Child Development, Denver.

Bailey, J. M, Sanborn, S. M., & Green, J. A. (April, 2009). *Effects of infant crying on negative moods and caregiving behaviors*. Paper presented at the biennial meeting of the Society for Research in Child Development, Denver.

Green, J. A., Whitney, P. G., & Potegal, M. (2008, March). *Perceptual and acoustic analysis of vocalizations during temper tantrums*. Poster presented at the XVIth Biennial meeting of the International Society for Infant Studies, Vancouver.

Wilson, L.,(g) Boorstein, H.,(g) Pandey, J.,(g) Maltempo, A., Green, J., Dumont-Mathieu, T., Hodgson, S., Barton, M., & Fein, D. (2008, February) Differentiating ASD from other developmental delays in young children. Poster presented at the meeting of the International Neuropsychological Society, Waikoloa, HI.

Carr, K.,(g) Troyb, E., Hodgson, S., Barton, M. Green, J. and Fein, D. Diagnostic Stability Over Two Years Among Younger Siblings of Children with Autism Spectrum Disorders, May, 08. Presented at International Meeting for Autism Research, London.

Green, J. A., Whitney, P. G., & Potegal, M. (2008, March). *Perceptual and acoustic analysis of vocalizations during temper tantrums*. Poster presented at the XVIth Biennial meeting of the International Society for Infant Studies, Vancouver.

Stephen, D. G., Whitney, P. G., Green, J. A., & Dixon, J. A. (March, 2007). *Dynamic organization in infant crying*. Paper presented at the biennial meeting of the Society for Research in Child Development, Boston.

Lin, Hung-Chu, & Green, J. A. (March, 2007). *Infants' expressive behaviors during face-to-face interaction: Organization related to age and partner*. Paper presented at the biennial meeting of the Society for Research in Child Development, Boston.

Lin, Hung-Chu, Green, J. A., & Gustafson (March, 2007). *Triadic states of infant behavior during face-to-face interactions.* Paper presented at the biennial meeting of the Society for Research in Child Development, Boston.

Green, J. A. (March, 2006). *Crying and locomoting: Dynamic influences on mother-infant interactions*. Paper presented at the New England Conference on Infant Studies, Amherst, MA.

Miller, J. M., Gustafson, G. E., & Green, J. A. (April, 2005). *Effects of Infant Crying on Adults' Moods and Caregiving Behaviors,* Paper presented at the biennial meeting of the Society for Research in Child Development, Atlanta.

Chen, X., Gustafson, G. E., & Green, J. A. (April, 2005). *Protest Crying in Early Social Communication Development,* Paper presented at the biennial meeting of the Society for Research in Child Development, Atlanta.

Martin, R. M., Green, J. A., & Marola, J. (April, 2005). *Gender Differences in the Factors Related to Preschoolers Emotion Understanding*, *,* Paper presented at the biennial meeting of the Society for Research in Child Development, Atlanta.

Pandey, J., Toth, K., Kleinman, J., Dixon, P., Barton, M., Allen, S., Green, J. A., Dawson, G., & Fein, D. (April, 2005). *Detecting Autism Spectrum Disorders in Young Siblings of ASD Children*, Paper presented at the biennial meeting of the Society for Research in Child Development, Atlanta.

Dixon, P., Pandey, J., Kleinman, J., Esser, E.., Wilson, L, Boorstein, H., Barton, M., Hodgson, S., Dumont-Mathieu, T., Green, J., Chawarska, K., Volkmar, F., Daklin, A. and Fein, D. (February, 2005) *Presence of DSM-IV Criteria in Two-year-olds with ASD*. Presented International Neuropsychological Society, St. Louis.

Pandey, J., Toth, K., Kleinman, J., Dixon, P., Barton, M., Hodgson, S., Eser, E., Boorsetin, H., Wilson, L., Green, J., Dawson, G. and Fein, D. (February, 2005) *Detecting autism spectrum disorders in young siblings of ASD children*. Presented International Neuropsychological Society, St. Louis.

Esser, E., Boorstein, H., Dixon, P., Kleinman, J., Pandey, J., Wilson, L., Barton, J., Dumont-Mathieu, T., Green, J., Hodgson, S., Marshia, G. and Fein, D. (February, 2005). *Predictors of diagnosis in 4-year-olds with symptoms of autism spectrum disorders*. Presented International Neuropsychological Society, St. Louis.

Boorstein, H., Esser, E., Dixon, P., Kleinman, J., Pandey, J., Wilson, L., Barton, M.,. Dumont-Mathieu, T., Green, J., Hodgson, S., Marshsia, G. and Fein, D. (February 4, 2005) *Predictors of cognitive functioning in children with autism spectrum disorders*. Presented International Neuropsychological Society, St. Louis.

Wilson, L., Dixon, P., Kleinman, J., Pandey, J., Boorstein, H., Esser, E., Robins, D., Barton, M., Dumont-Mathieu, T., Green, J., Hodgson, S., Marshia, G. and Fein, D. (February 4, 2005) *Overview of the M-CHAT*. Presented International Neuropsychological Society, St. Louis.

Dixon, P., Pandy, J., Boorstein, H., Kleinman, J., Wilson, L., Esser, E., Dumont-Mathieu, T., Barton, M., Green, J., Allen, S., and Fein, D. (July, 2004) *Differentiating between ASD and other developmental disabilities using the Modified Checklist for Autism in Toddlers*. Paper presentation at the National Center of Birth Defects and Developmental Disabilities Conference, Washington, D.C.

Dumont-Mathieu, T., Wilson, L., Dixon, P., Kleinman, J., Pandey, J., Boorstein, H., Esser, E., Allen, S., Barton, M., Green, J., Marshia, G. and Fein, D. (July 2004) *Overview of the Modified Checklist for Autism in Toddlers*. Paper presentation at the National Center of Birth Defects and Developmental Disabilities Conference, Washington, D.C.

Lin, H-C. & Green, J. A. (2004, June). *Newborn Infant Crying: Acoustic Differences Related to Posture*. Paper presented at the 9th International Workshop on Infant Cry Research, Rymättylä, Finland.

Green, J. A., Gustafson, G. E., & Chen, X. (2004, May). *Development of a vocal communication system in infancy*. Paper presented at the International Conference on Infant Studies, Chicago.

Dixon, P., Kleinman, J., Pandey, J., Barton, M., Green, J., Allen, S. and Fein, D. (May, 2004). *Differentiating between autism spectrum disorders and other develomental disabilities using the Modified Checklist for Autism in Toddlers*. Presented at International Meeting for Autism Research, Sacramento.

Kleinman, J., Pandey, J., Dixon, P., Barton, M., Green, J., Allen, S., and Fein, D. (May, 2004). *Diagnostic stability over a two year time period in pre-schoolers with Autism Spectrum Disorders*. Presented at International Meeting for Autism Research, Sacramento.

Pandey, J., Dixon, P., Kleinman, J., Barton, M., Green, J., Allen, S., and Fein, D. (May, 2004). *The Modified Checklist for Autism in Toddlers (M-CHAT): An Update*. Presented at International Meeting for Autism Research, Sacramento.

Martin, R. M., Green, J. A., & Marola, J. (2004, April). *Correlates of preschoolers' emotion understanding*. Paper presented at the Conference on Human Development, Washington, D.C.

Dixon, P., Kleinman, J., Pandey, J., Lanz, S., Barton, M., Allen, S., Green, J., Marshia, G., Robins, D., and Fein, D.(February 2004). *Differentiating between Autism Spectrum Disorders and Other Developmental Disabilities Using the M-CHAT*. Presented at International Neuropsychological Society, Baltimore, MD.

Robins, D., Fein, D., Barton, M., Green, J., Dixon, P., Kleinman, J., Pandey, J. and Marshia, G. (April 2003). *The Modified Checklist for Autism in Toddlers (M-CHAT): Early detection of autism spectrum disorders*. Invited address at Society for Research in Child Development, Tampa.

Green, J. A., Robinson, N. E., & Gustafson, G. E. (2003, April). *Listening context changes perceived distress in infants' cries*. Poster presented at the Biennial Meeting of the Society for Research in Child Development, Tampa.

Lin, H-C. & Green, J. A. (2003, April). *Posture: A biomechanical constraint on newborn crying*. Paper presented at the Biennial Meeting of the Society for Research in Child Development, Minneapolis.

Dixon, P., Kleinman, J., Barton, M., Green, J. A., Allen, A., Robins, D., & Fein, D. (2003, February). *Agreement among four diagnostic instruments for PDD in 2-year-olds*. Poster presented at the International Neuropsychological Society Meeting, Honolulu.

Kleinman, J., Dixon, P., Barton, M., Green, J. A., Allen, A., Robins, D., & Fein, D. (2002, October). *Agreement among four diagnostic instruments for PDD in 2-year-olds*. Poster presented at the International Meeting for Autism Research, Orlando

Green J., Gustafson G.E., & Martin R.M. (2002, June). *Sequential analysis of physical proximity and crying in the first year of life*. Paper presented at the VIIIth International Workshop on Infant Cry Research. Padova, Italy.

Gustafson G.E,. & Green J.A. (2002, June). *Crying anchors a sound-meaning system in prelinguistic infants*. Paper presented at the VIIIth International Workshop on Infant Cry Research. Padova, Italy.

Gustafson, G. E., & Green, J. A. (April, 2002). *Cry sounds, vocalizations, and grunts combine to create a prelinguistic sound-meaning system*. Poster presented at the 13th Biennial International Conference on Infant Studies, Toronto.

Lin, H-C., & Green, J. A. (April, 2002). E*ffects of posture on newborn crying*. Poster presented at the 13th Biennial International Conference on Infant Studies, Toronto.

Martin, R. M., & Green, J. A. (April, 2002). *The use of causal explanations by mothers and their relation to children's gender and understanding of emotion*. Poster presented at the Southeastern Conference on Human Development, Charlotte.

Robins, D., Fein, D., Barton, M., Green, J., Janovicz, A., & Lord, J. (2002, February). *M-CHAT: Longitudinal perspective on early detection of autism spectrum disorders*. Poster presented at the International Neuropsychological Society, Toronto.

Robins, D., Fein, D., Barton, M., Green, J., & Janovicz, A. (November, 2001). *The Modified Checklist for Autism in Toddlers (M-CHAT): Longitudinal data suggests successful screening at 2 years old*. Paper presented at the International Meeting for Autism Research, San Diego.

Green, J. A, Martin, R. M., Borges, S. M., & Gustafson, G. E. (2001, April). *Infant-caregiver proximity and bouts of fussing in the first year of life*. Paper presented at the Biennial Meeting of the Society for Research in Child Development, Minneapolis.

Gustafson, G. E., Wood, R., & Green, J. A. (2001, April). *Perceived distress in young infants' cries: Temporal evolution, acoustic correlates, and individual differences*. Paper presented at the Biennial Meeting of the Society for Research in Child Development, Minneapolis.

Green, J. A. (April, 2001). *Sequential Analyses of Infant Fussing and Physical Proximity to the Mother*, Developmental Psychology Friday Speaker Series, University of Connecticut.

Robins, D., Fein, D., Barton, M., Green, J., & Janovicz, A. (2001, November). *The Modified Checklist for Autism in Toddlers (M-CHAT): Longitudinal data suggests successful screening at 2 years old*. Paper presented at the International Meeting for Autism Research, San Diego, CA.

Stephenson, R. C. W., Cillessen, A. H. N., & Green, J. A. (2000, September). *Friendship qualiies, self disclosure, and gender differences in adolescence*. Paper presented at the annual meeting of the Northeastern Social Psychology Association, Storrs, CT.

Davis, M. A., & Green, J. A. (2000, April). *A new scale for assessing attitudes toward homosexuality*. (Presented at the Annual Meeting of the Eastern Psychological Association, Baltimore.

Green, J. A., & Gustafson, G. E. (2000, January). *Crying: Multiple determinants of perceived meaning*.

Paper presented at the John & Johnson Pediatric Roundtable 2000, Palm Beach, Florida.

Smith, S. L., & Green, J. A. (1999, April). *Infant vocalizations across different social contexts*. Paper presented at the Biennial Meeting of the Society for Research in Child Development, Albuquerque.

Green, J. A., & Gustafson, G. E. (1999, April). *Development of cry and noncry sounds in social-interactional contexts*. Paper presented at the Biennial Meeting of the Society for Research in Child Development, Albuquerque.

Gustafson, G. E., & Green, J. A. (1998, April). *Perceiving the causes of infant crying.* Paper presented at the International Conference on Infant Studies, Atlanta.

Green, J. A., & Gustafson, G. E. (1997, July). *Crying behaviours: What kind of metric for infant distress*? Invited symposium presented at the 6th International Workshop on Infant Cry Research, Bowness-on-Windermere, England.

Gustafson, G. E., & Green, J. A. (1997, July). *Acoustic properties of cries change over a long cry bout*. Paper presented at the 6th International Workshop on Infant Cry Research, Bowness-on-Windermere, England.

Green, J. A., Gustafson, G. E., & McGhie, A. C. (1997, April). *Changes in infants' cries as a function of time in a cry bout*. Paper presented at the meeting of the Society for Research in Child Development, Washington, D. C.

Irwin, J. R., Green, J. A., & Gustafson, G. E., & Ostroff, W. (1996, April). *The role of the face in the perception of infant sounds: A first look*. Paper presented at the International Conference on Infant Studies, Providence.

Gustafson, G. E., Green, J. A., Irwin, J. I., Kalinowski, L. L., & Wood, R. M. (1996, March). *Does visual information affect adults' perception of infant sounds*? Paper presented at the Southeast Conference on Human Development, Birmingham.

Green, J. A., & Gustafson, G. E., & Kalinowski, L. L. (1995, March). *Surprising similarities in mothers' responses to infants' cries and vocalizations*. Paper presented at the biennial meeting of the Society for Research in Child Development, Indianapolis.

Gustafson, G. E., Green, J. A., & Kalinowski, L. L. (1995, March). *Crying and vocalizing: A nascent system for communicating different meanings*? Paper presented at the biennial meeting of the Society for Research in Child Development, Indianapolis.

Gustafson, G. E., & Green, J. A. (1994, September). *Perspectives on an ecological approach to social communicative development in infancy*. Invited presentation at an American Psychological Association Conference on Development, Changing ecological Approaches to development: Organism-environment mutualities, Storrs, CT.

Green, J. A., & Gustafson, G. E. (1993, March). *Continuities and discontinuities from infant crying to early speech.* Symposium presented at the biennial meeting of the Society for Research in Child

Development, New Orleans.

Gustafson, G. E., Green, J. A., & Kalinowski, L. L. (1993, March). *The development of communicative skills: Infants' cries and vocalizations in social context*. Paper presented at the biennial meeting of the Society for Research in Child Development, New Orleans.

Green, J. A., & Gustafson, G. E. (1992, July). *Crying beyond the newborn period: Implications for social development*. Paper presented at the Fourth International Workshop in Infant Cry Research, Munich, Germany.

Gustafson, G. E., Green, J. A., & Kalinowski, L. L. (1992, July). *Hearing the causes of crying: It's more difficult than it sounds*. Paper presented at the International Interdisciplinary Conference on Infant Cry Research: Clinical Implications and Applications, Munich, Germany.

Gustafson, G. E., Green, J. A., & Kalinowski, L. L., & Seidel, H. A. (1992, July). *The development of crying over the first two years*. Paper presented at the International Interdisciplinary Conference on Infant Cry Research: Clinical Implications and Applications, Munich, Germany.

Green, J. A. (1992, June). *Bias in psychological tests: A primer on psychometric issues*. Invited presentation at the Study Group on Growth and Development of High Risk Populations, Maternal and Child Health Bureau and the National Center for Education in Maternal and Child Health.

Sturner, R. A., Funk, S. G., & Green, J. A. (1991, July). *Opportunistic surveillance for developmental problems*. Paper presented at the 3rd International Workshop on the At-Risk Infant, Tel Aviv, Israel.

Gustafson, G. E., & Green, J. A. (1991, April). *Infant crying as a moving target for research*. Paper presented at the meeting of the Society for Research in Child Development, Seattle.

Green, J. A. (1990, April). *Methods for comparing two correlation matrices*. Paper presented at the International Conference on Infant Studies, Montreal, Canada.

Green, J. A. (1989, July). *Loglinear models for evaluating developmental data*. Paper presented at the 10th Biennial Meeting of the International Society for the Study of Behavioural Development, Jyväskylä, Finland.

Green, J. A. (1989, July). *Interrelations Among the Acoustic Features of Cries: How Many Features Do We Need?*" Paper presented at the 3rd International Workshop on Infant Cry Research, Helsinki, Finland.

Gustafson, G. E., Green, J. A., & DeConti, K. A. (1989, May). *Infants' cries and adults' responses*. Paper presented at the NIH-NICHHD Conference on the Biological and Social Aspects of Crying in Infants. Bethesda, MD.

Green, J. A. (1989, April). *Analysis of Categorical Data from Repeated Measurements*. Paper presented at the meeting of the Society for Research in Child Development, Kansas City, Missouri.

Gustafson, G. E., & Green J. A. (1988, April). *Women's behavioral responses to a crying baby*. Paper presented at the International Conference on Infant Studies, Washington, D.C.

Green, J. A. (1987, April). *Developmental applications of loglinear models for the analysis of* *cross-classified data*. Paper presented at the meeting of the Society for Research in Child Development, Baltimore.

Green, J. A., & Gustafson, G. E. (1986, April). *Parents' and nonparents' perceptions of cries as assessed by multidimensional scaling*. Paper presented at the International Conference on Infant Studies, Los Angeles.

Green, J. A. (1985, April). *Developmental changes in infant vocalizations as a function of social context*. Paper presented at the meeting of the Society for Research in Child Development, Toronto.

Gustafson, G. E., Green, J. A., & Jong, Y.-M. 1985, April). *Predicting cry aversiveness from acoustic attributes*. Paper presented at the meeting of the Society for Research in Child Development, Toronto.

Gustafson, G. E., & Green, J. A. (1984, August). *Identification and perception of infants' cries*. Paper presented at the meeting of the American Psychological Association, Toronto.

Green, J. A., & Gustafson, G. E. (1983, April). *Individual recognition of human infants on the basis of cries alone*. Presented at the meeting of the Society for Research in Child Development, Detroit.

Sturner, R. A., Funk, S. G., & Green, J. A. (1983, September). *Simultaneous technique for acuity and readiness testing (START): An update*. Presented at the 4th International Conference for At-Risk Children, Aspen.

Gustafson, G. E., & Green, J. A. (1981, April). *The development of infants' initiations to observers of mother-infant interactions*. Presented at the meeting of the Society for Research in Child Development, Boston.

Sturner, R. A., Green, J. A., & Funk, S. G. (1980, April). *Assessing problems of development during preschool hearing screening*. Presented at the meeting of the Ambulatory Pediatric Association, San Antonio.

Green, J. A., & Gustafson, G. E. (1978, April). *The interaction as a unit of analysis: A longitudinal study of mother-infant interactions*. Presented at the Southeastern Conference on Human Development, Atlanta.

Gustafson, G. E., & Green, J. A. (1978, April). *Locomotor development and its effects on mother-infant interactions*. Presented at the meeting of the Southeastern Conference on Human Development, Atlanta.

Green, J. A., & Cairns, R. B. (1976, September). *Postpartum aggression in female mice: Experiential and dyadic controls*. Presented at the meeting of the American Psychological Association, Washington, DC.

Professional Affiliations

International Society for Infant Studies
The Psychometric Society

Society for Multivariate Experimental Psychology
Society for Research in Child Development
Society of the Sigma Xi

Professional Activities

Reviewer for *Developmental Psychology*
Psychological Bulletin
Psychological Methods
Journal of Personality and Social Psychology
Journal of Comparative Psychology
Behavioral Assessment
Contemporary Psychology
Journal of Speech and Hearing Research
National Science Foundation (Social and Developmental Psychology and Psychobiology Directorates)
Acta Paediatrica Scandinavica
Social Development
Pediatric Research
Psychological Science

Special Reviewer for the Maternal and Child Health Bureau, Department of Health and Human Services:
June 13-15, 1990, November 7-9, 1990, June 5-7, 1991

Review Committee for research grants, Maternal and Child Health Bureau, Department of Health and Human Services:
June 1992 - November 1996

Invited Participant, 2nd through 10th International Workshops on Infant Cry Research, held in Finland, Germany, England, and Italy.

Editorial Board, *Child Development*, 1992-1997

Curriculum Vitae: **Jay G. Rueckl**
(Revised October 2013)

Personal Information

Born:	January 21, 1959, Green Bay, WI
Address:	Department of Psychology
	University of Connecticut
	Storrs CT 06269
Phone:	203-486-0565
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Academic Positions

Assistant Professor, Harvard University, 1986-1991
Associate Professor, Harvard University, since 1991-1993
Associate Professor, University of Connecticut, 1993-
Research Scientist, Haskins Laboratories, 1994-

Education

Bachelor of Science:	University of Wisconsin, 1981 (Psychology)
Master's:	University of Wisconsin, 1983
Ph.D.:	University of Wisconsin, 1986 (Cognitive Psychology)

Research Fellowships and Grants

Wisconsin Alumni Research Foundation Fellowship, 1981-1983. William F. Milton Foundation, 1987-1988, $5000.

Defense-University Research Instrumentation Program, "Computational Modeling of Cognitive Processes", 12/1/88-11/30/89, $65,027. (Co-PI with Stephen M. Kosslyn and Peter C. Gordon).

University of Connecticut Research Foundation, 1/1/94-12/31/94, $19,187

National Institute for Child Health and Development, HD-01994. (Project 4.) Senior Scientist (PI Carol Fowler). Title: Nature and acquisition of the speech code and reading. 2/1/95-1/31/96. $270713.

National Institute for Child Health and Development. (Projects 5 & 6). .) Senior Scientist (PI Carol Fowler). Title: Nature and acquisition of the speech code and reading. 2/1/96-1/31/01. $4539913

National Institute of Health. Title: Phonological Processes in Word Recognition, $73,617, 1/1/98-1/1/01.

National Institute for Child Health and Development. (Projects 4 & 6). Senior Scientist (PI Carol Fowler). Title: Nature and acquisition of the speech code and reading. 2/1/01-1/31/06. $4539913

University of Connecticut Research Foundation, 1/1/06-12/31/06, Title: The hand-movement paradigm: A technique for exploring the dynamics of word recognition. $13,403

National Institute for Child Health and Development. Project Leader (PI Carol Fowler). Title: Nature and acquisition of the speech code and reading. Project 2: Towards a neurobiological model of skilled reading. 12/1/06-11/30/11. $5,000,000.

University of Connecticut Research Foundation. (J. Magnuson, Co-PI). Phoneme Transposition Effects in Spoken Word Perception. 7/1/10-6/30/11. $22,800..

UConn Vice President for Research and Research Advisory Council. Magnuson, J..S (PI). (Co-PI). Equipment for PSERL (Psychology Electrophysiology Shared Resource Laboratory). $80,305.

National Institute of Deafness and Other Communicative Disorders (ARRA P30 DC010751-01). Lillo-Martin, D. (PI). (Rueckl: Co-I). Emergence, structure, and neurobiological bases of typical and atypical language development. 1/1/10-12/31/12. Total Costs $1.3M

National Institute for Child Health and Development. PI Ken Pugh. (Co-I, 11%) Title: Neurobiological Predictors of Spoken and Written Language. 8/1/10-7/31/15 Direct Costs: $2.6M.

National Institute for Child Health and Development. "The neural bases of skilled word recognition". Administrative supplement: 9/01/10-8/231/11. Direct Costs: $122,000.

National Institute for Child Health and Development. PI Ken Pugh. (Co-I, 11%) Title: Neurocognitive determinants of second language adolescent literacy development. 7/1/11-6/30/16. Direct Costs: $2.5M..

National Institute for Child Health and Development. PI J. Rueckl, Title: Nature and acquisition of the speech code and reading. (PI: 22%), 9/1/12-5/31/17, total award $7,230,000.

NIDCD F31 (1F31DC012748-01A1). PI: Karen Le. Predicting discourse ability in TBI: Cognitive and communicative factors. (Co-sponsor, along with Carl Coelho). Total award: $42.232. (3/1/2013-2/28/2015)

UCONN CLAS Innovative Teaching in Science Competition. Individual Differences in the Neurocognitive Bases of Language. $80000. September 2012-May 2014.

National Institute for Child Health and Development. PI R. Morris, Title: Neurocognitive bases of treatment resistance in developmental dyslexia. (Co-I: 5%). Total costs: $5,560,000. 7/1/13-6/30/18.

Research Workshops

University of Konstanz Morphology Workshop, 2008 (Lecturer)
University of Connecticut Workshop on Dynamics & Cognition, 2006 (Organizer)
Cortech Solutions EMSE Workshop on EEG/MEG, Atlanta, 2006 (Attendee)
Workshop on Nonlinear Dynamics, Brown University, 2000 (Attendee)
McDonnell Summer Institute in Cognitive Neuroscience, 1988 (Lecturer)
Carnegie-Mellon Connectionist Summer Institute, 1986 (Attendee)

Professional Service

Consulting Editor, The Cambridge Encyclopedia of the Language Science, 2006-2007

Associate Editor, *Memory and Cognition,* 2001-2005

Director, Cognitive Sciences Program, University of Connecticut, 1998-2006

Member, Editorial Board, *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 1995-2000

Member, Life Sciences Review Panel, University of Connecticut Research Foundation, 1993-1995

Guest Editor, *Language and Cognitive Proceesses*, Special Issue on Morphological Processing, 2011-2013

Associate Editor, *Frontiers in Language Psychology*, 2012-

<u>Ad Hoc Reviewer</u>

American Journal of Psychology
Behavioral and Brain Sciences
Brain and Language
Cognitive Psychology
Cognitive Science
Journal of Cognitive Neuroscience
Journal of Memory and Language
Language and Cognitive Processes
Memory and Cognition
National Science Foundation
Perception and Psychophysics
Psychonomic Bulletin and Review
Psychological Review
Psychological Science
Journal of Experimental Psychology: Human Perception and Performance
Journal of Experimental Psychology: Learning, Memory, and Cognition

Publications

Rueckl, J. G. and Oden, G. C. (1986). The integration of contextual and featural information in language processing. *Journal of Memory and Language, 25,* 445-460.

Oden, G. C. and Rueckl, J. G. (1986). Is the difference between *girl* and *gill* more than a letter? *Bulletin of the Psychonomic Society, 24,* 7-10.

Rueckl, J. G. (1988). Making the connection. Commentary on Smolensky. *The Behavioral and Brain Sciences, 11,* 50-51.

Rueckl, J. G. (1988). A fuzzy propositional account of contextual effects on word identification. In T. Zetenyi (Ed). *Applications of Fuzzy Set Theory in Psychology.* North Holland Press.

Rueckl, J. G., Cave, K. R., & Kosslyn, S. M. (1989). Why are "What" and "Where" processed by two cortical visual systems? A computational investigation. *Journal of Cognitive Neuroscience, 1*, 171-186.

Rueckl, J. G. (1990). Similarity effects in word and pseudoword repetition priming. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*, 374-391.

Rueckl, J. G. (1990). Review of "The cerebral computer: An introduction to the computational structure of the human brain." *American Journal of Psychology, 103,* 567-573.

Rueckl, J. G. (1991). Connectionism and the notion of levels. In T. Horgan & J. Tienson (Eds.), *Connectionism and the Philosophy of Science*, Kluwer Academic Publishers.

Rueckl, J. G., Suzuki, S., & Yeh, S. (1991). The locus of redundancy effects in letter detection. *Perception and Psychophysics, 49*, 412-421.

Oden, G. C., Rueckl, J.R., & Sanocki, T. (1991). Making sentences make sense, or words to that effect. In G. Simpson (Ed.). *Understanding Words and Sentences.* North-Holland Press.

Rueckl, J. G., & Kosslyn, S. M. (1992). What good is connectionist modeling? A dialogue. In A. F. Healy, S. M. Kosslyn, & R. Shiffrin (Eds.), *Papers in Honor of W. K. Estes.* Hillsdale, NJ: Erlbaum.

Rueckl, J. G. (1993). Making new connections. Review of "Connectionism and the Mind." *Contemporary Psychology, 38,* 58-59.

Gordon, P. G., Eberhardt, J. L., & Rueckl, J. R. (1993). Attentional modulation of the phonetic significance of acoustic cues. *Cognition*. *25*, 1-42.

Rueckl, J. G. (1993). Jumpnet: A multiple-memory systems connectionist archicture. *Proceedings of the 15th Annual Meeting of the Cognitive Science Society*. Erlbaum Publishers.

Rueckl, J. G., & Olds, E. M. (1993). When pseudowords acquire meaning: The effect of semantic associations on pseudoword repetition priming. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 3,* 515-527.

Rueckl, J. G., & Dror, I. (1994). The effect of orthographic-semantic systematicity on the acquisition of new words. To appear in C. Umilta & M. Moscovitch (Eds.), *Attention and Performance XV*. Hillsdale, NJ: Erlbaum.

Rueckl, J. G. (1995). Letter-level effect in repetition priming. *American Journal of Psychology, 108,* 213-234.

Rueckl, J. G. (1995). Ambiguity and connectionist networks: Still settling into a solution. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21,* 501-508.

Rueckl, J. G., Mikolinski, M., Raveh, M, Miner, C, & Mars, F. (1997). Morphological priming, fragment completion, and connectionist networks. *Journal of Memory and Language, 36,* 382-345.

Rueckl, J. G., & Mathew, S. (1999). A phonological component in visual implicit memory. *Memory and Cognition*, *27*, 1-11.

Rueckl, J. G., & Raveh, M. (1999). The influence of morphological regularities on the dynamics of a connectionist network. *Brain and Language*, *68*, 110-117.

Raveh, M., & Rueckl, J. G. (2000). Equivalent effects of inflected and derived primes: Long-term morphological priming in fragment completion and lexical decision. *Journal of Language and Memory, 42,* 103-119.

Rueckl, J. G. (2002). The dynamics of visual word recognition. *Ecological Psychology, 14,* 5-19.

Rueckl, J., Growney, R., & Robins, D. (2002). Psychology 132: Lab Manual. (6th edition).

Rueckl, J., Growney, R., & Robins, D. (2002). Psychology 132: Lab Manual. (7h edition). (Online version.)

Rueckl, J. G. (2002). A connectionist perspective on repetition priming. In J.S. Bowers & C. Marsolek, (Eds.), *Rethinking Implicit Memory*. Oxford University Press.

Feldman, L., Rueckl, J. G., DiLiberto, L., Pastizzo, M., & Vellutino, F., (2002) Morphological analysis by child readers as revealed by the fragment completion task. *Psychonomic Bulletin and Review, 9,* 529-535

Sandak, R., Mencl, W.E., Frost, S.J., Rueckl, J.G., Katz, L., Moore, D., Mason, S.A., Fulbright, R.K., and Constable, R,T., (2004). The Neurobiology of Adaptive Learning in Reading: A Contrast of Different Training Conditions. *Cognitive, Affective, and Behavioral Neuroscience*, *4*, 66-88.

Rueckl, J. G., & Galantucci, B. (2005). The Locus and Time Course of Morphological Priming. *Language and Cognitive Processes*., 20, 115-138.

Frost, S. J., Mencl, W. E., Sandak, R., Moore, D. L., Rueckl, J. G., Katz, L., Fulbright, R. K., & Pugh, K. R. (2005). An fMRI study of the trade-off between semantics and phonology in reading aloud. *NeuroReport*, 16, 621-624

Katz, L., Lee, C. H., Tabor, W., Frost, S. J., Mencl, W. E., Sandak, R., Rueckl, J. G., & Pugh, K. R. (2005). Behavioral and neurobiological effects of printed word repetition in lexical decision and naming. *Neuropsychologia*, *43*, 2068-2083.

Pugh, K. R., Sandak, R., Frost, S. J., Moore, D., Rueckl, J. G., & Mencl, W. E. (2006). Neurobiological studies of skilled and impaired reading: A work in progress. In G. D. Rosen (Ed.). Developing New Pathways in the Study of the Dyslexic Brain. (pp. 21-48). Baltimore: York Press.

Frost, S. J., Sandak, R., Mencl, W. E., Landi, N., Moore, D., Della Porta, G., Rueckl, J. G., Katz, L., & Pugh, K. R. (2007). Neurobiological and behavioral studies of skilled and impaired word reading. In E. Grigorenko & A. Naples (Eds.), *Single-Word Reading: Biological and Behavioral Perspectives*. (pp. 355-376). Mahwah: Erlbaum

Rueckl, J.G., & Aicher, K.A., (2008). Are CORNER and BROTHER Morphologically Complex? Not in the Long Term. *Language and Cognitive Processes*, *23*, 972-1001.

Pugh, K. R., Frost, S.J., Sandak, R., Rueckl, J.G., Constable, R.T., Della Porta, G., Moore, D., Landi, N., Katz, L., & Mencl, W.E., (2008). An fMRI study of the effects of stimulus difficulty on printed word identification: A comparison of non-impaired and reading disabled adolescent cohorts. *Journal of Cognitive Neuroscience, 20*, 1146-1160.

Rueckl, J.G., & Seidenberg, M.S., (2009). Computational Modeling and the neural bases of reading and reading disorders. In K. Pugh & P.McCardle (Eds.). How Children Learn To Read: Current Issues and New Directions in the Integration of Cognition, Neurobiology and Genetics of Reading and Dyslexia Research and Practice (pp. 101-134). New York: Taylor & Francis.

Frost, S.J., Sandak, R., Mencl, E.W., Landi, N., Rueckl, J.G., Katz, L., & K.R. (2009). Mapping the word reading circuitry in skilled and disabled readers. In K. Pugh & P.McCardle (Eds.). How Children Learn To Read: Current Issues and New Directions in the Integration of Cognition, Neurobiology and Genetics of Reading and Dyslexia Research and Practice (pp. 3-20). New York: Taylor & Francis.

Rueckl, J. G. (2010). Connectionism and the role of morphology in word recognition. *The Mental Lexicon*, *5*, 371-400. DOI: 10.1075/ml.5.3.07rue

Rueckl, J. G. & Rimzhim, A. (2010). On the interaction of letter transpositions and morphemic boundaries. *Language and Cognitive Processes*, First published on:

12 August 2010 DOI: 10.1080/01690965.2010.500020.

Pugh, K.R., Frost, S.F., Sandak, R., Landi, N., Moore, D., Della Porta, G., Rueckl, J. & Mencl, W.E. (2010). Mapping the word reading circuitry in skilled and disabled readers. In P.L. Cornelissen, P.C.Hansen, M.L. Kringelback & K.R. Pugh, (Eds.) The Neural Basis of Reading (pp 281-305): Oxford University Press, UK.

Rueckl, J. G. (2012). The limitations of the reverse-engineering approach to cognitive modelling. *Behavioral and Brain Sciences*, 35(5), pp. 305 – 305. DOI: 10.1017/S0140525X1200026X.

Pugh, K.R., Frost, S.J., Landi, N., Preston, J., Mencl, W.E & Rueckl, J.G. (in press). Neuroimaging Studies of Reading Disabilities. To appear in *Unraveling the Behavioral, Neurobiological, and Genetic Components of Reading Comprehension*. Miller, B., Cutting, L., & McCardle, P. Eds. Baltimore: Paul Brookes Publishing.

Sandak, R., Frost, S.J., Rueckl, J.G., Landi, N., Mencl, W.E., Katz, L., & Pugh, K.R. (2012). How does the brain read words? In M. Spivey, M. Joanisse & K. McRae (Eds.), The Cambridge Handbook of Psycholinguistics. (pp 218:238). New York: Cambridge University Press.

Collison, B., Grela, B., Spaulding, T., Rueckl, J.G., & Magnuson, J.S. (in press) Individual differences in the shape bias in preschool children with specific language impairment and typical language development: Theoretical and clinical implications. *Developmental Science*.

Conference Presentations

Rueckl, J. G. and Oden, G. C. (1983) *The integration of semantic and featural information during word identification*. Midwestern Psychological Association Meeting, Chicago, IL.

Rueckl, J. G. and Oden, G. C. (1985). *A fuzzy propositional model of word identification*. Presented at the Meeting of the Society for Mathematical Psychology, La Jolla, CA.

Rueckl, J. G. (1986). *The locus of the repetition effect in word identification.* Presented at the Meeting of the Midwestern Psychological Association, Chicago, IL.

Oden, G. C., and Rueckl, J. G. (1986). *Taking language by the hand: Reading handwritten words*. Presented at the Meeting of the Psychonomic Society, New Orleans, LA.

Rueckl, J. G. (1988). *The connectionist research program: Something old, something new*. Presented at the Meeting of the Society for Philosophy and Psychology, Chapel Hill, NC.

Rueckl, J. G. (1989). *Repetition priming as perceptual learning*. Presented at the International Conference of Event Perception, Oxford, OH.

Rueckl, J. G. (1989). *Similarity and systematicity in repetition priming.* Presented at the Meeting of the Psychonomic Society, Atlanta, GA.

Rueckl, J. G. (1992). *The effect of orthographic-semantic systematicity on the acquisition of new words*. Presented at the meeting of the International Association for the Study of Attention and Performance, Erice, Italy.

Rueckl, J. G. (1992). *Reducing "catastrophic" interference through weight modulation*. Presented at the Meeting of the Psychonomic Society, St. Louis, MO.

Rueckl, J. G. (1993). *Jumpnet: A multiple-memory systems connectionist archicture.* Presented at the Meeting of the Cognitive Science Society, Boulder, CO.

Rueckl, J. G. (1993). *Interference effects in repetition priming.* Presented at the Meeting of the Psychonomic Society, Washington, D. C..

Rueckl, J. G. (1994). *The role of phonology in repetition priming.* Presented at the Meeting of the Psychonomic Society, St. Louis, MO.

Rueckl, J. G. (1995). *Attractor dynamics and morphological priming*. Presented at the meeting of the Canadian Society for Brain, Behavioral, and Cognitive Science, Halifax, Nova Scotia.

Rueckl, J. G., Raveh, M, Miner, C, & Mikolinski, M. (1995). *Morphological priming in masked fragment completion.* Presented at the Meeting of the Psychonomic Society, Los Angeles, CA..

Brown, J., Fowler, C., & Rueckl, J. (1996). *Voice effects in implicit memory*. Presented at the Meeting of the Eastern Psychological Association, Philadelphia, PA..

Brown, J., Fowler, C., & Rueckl, J. (1996). *Voice effects in implicit memory tasks*. Presented at the Meeting of the Acoustical Society of America, Indianapolis, IN.

Rueckl, J. G., & Miner, C, & Mikolinski, M. (1996). *The representation of visual word form.* Presented at the Meeting of the Psychonomic Society, Los Angeles, CA..

Miner, C., Fowler, C., & Rueckl, J. (1997). *The effect of word-final phonemes on spoken word recognition*. Presented at the Meeting of the Acoustical Society of America.

Rueckl, J. G., & Raveh, M. (1997). *A connectionist account of morphological effects in visual word perception*. Presented at the Meeting of the Psychonomic Society, Philadelphia, PA.

Rueckl, J. G., & Brown, J. M. (1998). *The Dynamics of Visual Word Perception*. Presented at the meeting of the Society for Chaos Theory in Psychology, Boston, MA.

Rueckl, J. G., & Raveh, M. (1998). *A network account of morphological effects in visual word identification*. Presented at the 1st International Conference on the Mental Lexicon, Edmonton, Ontario.

Rueckl, J. G. (1998). *A dynamcal systems approach to word perception and repetition priming*. Presented at the Annual Meeting of the Psychonomic Society, Dallas, TX.

Rueckl, J. G., & Raveh, M. (1999). *The influence of morphological regularities on the dynamics of a connectionist network.* Presented at the Conference on Cross-linguistic Perspectives on Morphological Processing, Aix-en-Provence, France. (June).

Brown, J., Rueckl, J. G., Raveh, M., & Fowler, C. (1999).*The contectual conditioning of perceptual similarity and word frequency effects in implicit and explicit memory*. Presented at the Annual Meeting of the Eastern Psychological Association. (April).

Cassenti, D., & Rueckl, J. G. (1999). *Bowling for words: A dynamic approach to word perception*. Presented at the University of Connecticut Conference on Cognitive Science. (May).

Forouhar, J., & Rueckl, J. G. (1999). *Hysteresis and the dynamics of word perception*. Presented at the University of Connecticut Conference on Cognitive Science. (May).

Galantucci, B., & Rueckl, J. G. (1999). *The timecourse of morphological priming: Perceptual and conceptual components.* Presented at the University of Connecticut Conference on Cognitive Science. (May).

Rueckl, J. G. (1999). *Implicit memory and connectionist networks*. Presented at the University of Connecticut Conference on Cognitive Science. (May).

Yaffee, D., Rueckl, J. G., & Vanhoy, M. (1999). *Bias vs sensititvity in implict memory for words.* Presented at the University of Connecticut Conference on Cognitive Science. (May).

Rueckl, J. G. (1999). *Morphological priming and semantic relatedness: A connectionist account.*. Presented at the Annual Meeting of the Psychonomic Society, Los Angelas, CA. (November).

Rueckl, J. G., & Galantucci, B. (2000). *The time course of morphological priming.* Presented at the Annual Meeting of the Psychonomic Society, New Orleans, LA (November).

Rueckl, J. G., & Galantucci, B. (2000). *Morphological priming: A survival analysis.* Presented at the Workshop on Language and Dynamics, Haskins Laboratories, August 2000.

Rueckl, J. G., & Galantucci, B. (2001). *Long-Term Morphological Priming and the Representation of Word Form.* Presented at The 2nd Conference on Cross-linguistic Perspectives on Morphological Processing, Nijmegan, Holland. (June).

Rueckl, J. G. (2001). *The Dynamics of Visual Word Identification*. Presented at the Eleventh International Conference on Perception and Action, Storrs, CT. (June).

Rueckl, J. G., Yaffee, D.J., Miner, C., & Carello, C. (2001). *Towards a connectionist account of visual word identification in Serbo-Croatian.* Talk presented at the Annual Meeting of the Psychonomic Society, Orlando FLA (November).

Pugh, K., Mencl, W. E., Jenner, A. R., Frost, Rueckl, J. G., & Katz, L. (2002) Effects of stimulus repetition during word reading on cortical activation patterns: an fMRI study.

Poster presented at the Annual Meeting of the Psychonomic Society, Orlando FLA (November).

Mencl, W. E., Pugh, K., Frost, Jenner, A. R., Rueckl, J. G., & Katz, L. (2001). Effects of orthographic and phonologic priming during lexical decision: An fMRI study. Poster presented at the Annual Meeting of the Psychonomic Society, Orlando FLA (November).

Mencl, W. E., Frost, S. J., Sandak, W., Mason, S. A., Lee, J. R., Rueckl, J. G., Constable, T., Katz, L., Pugh, K., & Gore, J. C. (2002). Effects of orthographic and phonologic priming during lexical decision: An fMRI study. Presented at the NeuroImage Human Brain Mapping 2002 Meeting, Japan (June).

Sandak, W., Mencl, W. E., Frost, S. J., Bates, J., Jenner, A. R., Mason, S. A., Rueckl, J. G., Pugh, K., & Katz, L. (2002) Effects of stimulus repetition during word reading on cortical activation patterns: an fMRI study. Presented at the NeuroImage Human Brain Mapping 2002 Meeting, Japan (June).

Sandak, R., Mencl, W. E., Frost, S. J., Rueckl, J. G., Katz, L., & Pugh, K. R. (2002, November). Toward a characterization of how the reading-circuit learns: an fMRI study. Poster presented at the 43rd Annual Meeting of the Psychonomic Society, Kansas City MO.

Rueckl, J. G, & Wright, A. (2002). Grain-size effects in word naming. Paper presented at the 43rd Annual Meeting of the Psychonomic Society, Kansas City MO.

Rueckl, J. (2002, November) Towards the application of nonlinear dynamics in cognitive psychology Presented at the Language Comprehension Across the Life Span: New Methodologies to Study Old Questions mini-conference, Kansas City MO.

Frost, S. J., Mencl., W. E., Sandak, R., Moore, D. L., Mason, S. A., Katz, L., Rueckl, J. G., & Pugh, K. R. (2003, June). Semantic constraints on spelling-to-sound consistency effects. Poster presented at the 9th International Conference on Functional Mapping of the Human Brain, New York.

Frost, S. J., Mencl, W. E., Sandak, R., Moore, D. L., Mason, S. A., Rueckl, J. G., Katz, L., & Pugh, K. R. (2003, November). Semantic constraints on spelling-to-sound consistency effects. Poster presented at the 44th annual meeting of the Psychonomic Society, Vancouver.

Pugh, K. R., Mencl, W. E., Frost, S. J., Sandak, R., & Moore, D. L., & Rueckl, J.G. (2003, November). Neuroimaging studies of word reading: A revised neurobiological theory. Talk presented at the 44 th annual meeting of the Psychonomic Society, Vancouver.

Rueckl, J. G (2003) Morphological structure and the front end of word identification. Presented at The 3rd Conference on Cross-linguistic Perspectives on Morphological Processing, Aix-en-Provence, France. (June).

Rueckl, J. G (2003, November) The effect of case mixing on morphological processing. Talk presented at the 44 th annual meeting of the Psychonomic Society, Vancouver.

Sandak, R., Mencl, W. E., Frost, S. J., Mason, S. A., Rueckl, J. G., Katz, L., Constable, R. T., & Pugh, K. R (2003, June). The neurobiology of adaptive learning in reading: A contrast of different training conditions. Invited talk presented at the 9th International Conference on Functional Mapping of the Human Brain, New York.

Sandak, R., Mencl, W. E., Frost, Rueckl, J. G., Katz, L., Moore, D., Mason, S. J., & Pugh, K. R. (2003, November). How the reading circuit learns: A contrast of different training conditions. Poster presented at the 44 th annual meeting of the Psychonomic Society, Vancouver.

Frost, S. J., Mencl, W. E., Sandak, R., Moore, D. L. Rueckl, J. G., Pugh, K. R. (2004, November). Age-related changes in brain activation patterns for semantics and phonology. Poster presented at the 45th annual meeting of the Psychonomic Society, Minneapolis.

Moore, D. L., Frost, S. J., Mencl, W. E., Snadak, R., Rueckl, J. G., Pugh, K. R. (2004, November). An event-related fMRI study of task comparisons for word identification in reading. Poster presented at the 45th annual meeting of the Psychonomic Society, Minneapolis.

Sandak, R., Mencl, W. E., Frost, S. J., Mason, S. A., Rueckl, J. G., Katz, L., Constable, R. T., Pugh, K. R. (2004, June). How different learning conditions affect the brain's efficiency during word reading. Poster presented at the 10th International Conference on Functional Mapping of the Human Brain, Budapest.

Sandak, R., Mencl, W. E., Frost, S. J., Mason, S. A., Rueckl, J. G., Katz, L., Constable, R. T., Pugh, K. R. (2004, June). How learning conditions affect the way that the brain reads words. Poster presented at the 11th Annual Meeting of the Society for the Scientific Study of Reading.

Sandak, R., Mencl, W. E., Frost, S. J., Moore, D., Rueckl, J. G., & Pugh, K. R. (2004, November). How learning conditions affect the way that the brain reads words. Poster presented at the 45th annual meeting of the Psychonomic Society, Minneapolis.

Mencl, W. E., Frost, S. J., Sandak, R., Fang, S. Y., Della Porta, G., Chen, H., Katz, L., Rueckl, J. G., Pugh, K. R. (2005, June). Individual differences in the cortical circuitry for word identification: Establishing brain/behavior links. Poster presented at the 11th annual meeting of the Organization for Human Brain Mapping, Toronto.

Rueckl, J. G., Frost, S. J., Mencl, W. E., Yaffee, D. J., Sandak, R., and Pugh, K. R. (2005, November) The neural correlates long-term of morphological priming. Paper presented at the 46th annual meeting of the Psychonomic Society, Toronto.

Rueckl, J. G., Mencl, W. E., Frost, S. J., Yaffee, D. J., Sandak, R., and Pugh, K. R. (2005, June) The neural correlates long-term of morphological priming. . Presented at The 4nd Conference on Cross-linguistic Perspectives on Morphological Processing, Cambidge, England. (June).

Sandak, R., Frost, S. J., Mencl, W. E., Rueckl, J. G., Pugh, K. R. (2005, June) Learning to read (alphabetic) words: controlled learning studies in English. Talk presented at the 12th annual meeting of the Society for the Scientific Study of Reading, Toronto.

Sandak, R., Frost, S. J., Mencl, W. E., Rueckl, J. G., Pugh, K. R. (2005, June) Learning to read (alphabetic) words: controlled learning studies in English. Talk presented at the 12th annual meeting of the Society for the Scientific Study of Reading, Toronto.

Rueckl, J. G., Aicher, K., & Yaffee, D. J.. (2006, August) Mouse Tracking and Visual Word Recognition. Paper presented at the University of Connecticut Workshop on Dynamics and Cognition

Rueckl, J. G., Aicher, K., Yaffee, D. J., & Spivey, M.. (2006, November) Visual Word Recognition and the Mouse Tracking Paradigm. Paper presented at the 47th annual meeting of the Psychonomic Society, Houston.

Rueckl, J. G. & Yovanovich, D. (2007, June). Are Brother and Corner Morphologically Structured? Not in the Long Term. Paper presented at the 5th International Workshop on Morphological Processing, Marseilles.

Mencl, E.W., Frost, S.J., Sandak, R., Landi, N., Rueckl, J. & Pugh, K.R. (November 2006). Effects of printed word repetition in good and poor readers: An fMRI study. Poster presented at the annual meeting of the Psychonomic Society, Houston, TX.

Mencl, W.E., Frost, S.F., Fang, S., Landi, N., Chen, H., Katz, L., Rueckl, J., Constable, R.T., & Pugh, K.R. (June, 2007). Titration of stimulus duration: A method for acquiring dynamic information with fMRI. Annual meeting of the Organization for Human Brain Mapping, Chicago, IL.

Chen, H., Mencl, W.E., Frost, S.J., Sandak, R., Landi, N., Katz, L, Rueckl, J, Constable, R.T., & Pugh, K.R. (June, 2006). Effects Of Case Mixing On Functional Connectivity Of Brain Regions. Annual meeting of the Organization for Human Brain Mapping, Florence, Italy.

Mencl, W.E., Frost, S.F., Sandak, R., Landi, N., Chen, H., Katz, L., Rueckl, J., Constable, R.T., Della Porta G., & Pugh, K.R. (June 2006). Effects of Printed Word Repetition on Brain Activation Patterns in Good and Poor Readers. Annual meeting of the Organization for Human Brain Mapping, Florence, Italy.

Fang, S., Mencl, W.E., Frost, S.J., Landi, N., Chen, H., Katz, L., Rueckl, J., Constable, R.T. & Pugh, K.R. (June, 2007). Effects of printed word repetition on functional connectivity in good and poor readers. Annual Meeting of the Organization for Human Brain Mapping, Chicago, IL.

Rueckl, J.G., & Seidenberg, M.S., (July 2007). Computational Modeling and the neural bases of reading and reading disorders. The Dyslexia Foundation Symposium. Campos Do Jordão, Brazil.

Rueckl, J. G., Aicher, K., & Yaffee, D. J.. (2007, August) Don't Stop: Further Explorations of the Mouse Tracking Paradigm. Paper presented at the University of Connecticut Workshop on Dynamics and Cognition.

Rueckl, J.G., Kukona, A., Aicher, K.A., Theophanis, A. & Magnuson, J.S. (August, 2008) Evidence of attractor dynamics from the mouse-tracking paradigm. Paper presented at the 3rd Annual University of Connecticut Workshop on Dynamics and Cognition.

Rueckl, J.G. (2008, October). Morphology and Visual Word Recognition: A Connectionist Perspective. Invited Lecture: *To Store or Not to Store: University of Konstanz Morphology Workshop*. (Invited address)

Rueckl, J.G., Fang, S., Begosh, K., Rimzhim, A., & Tobin, S. (November, 2008). Learned internal representations and letter position information: A connectionist approach. Presented at the annual meeting of the Psychonomic Society, Chicago, IL.

Mencl, W.E., Frost, S.J., Fang, S., Landi, N., Chen, H., Pugh, K.R., & Rueckl, J. (March, 2009). Titration of stimulus duration: A method for acquiring dynamic information with fMRI. Presented at the Sixteenth Annual Meeting of the Cognitive Neuroscience Society, San Francisco, CA.

Zhao, J., Rueckl, J. G., Frost, S.J., Wang, X., Sun, W., Shu, H., Fang, S., Mencl, W.E., & Pugh, K.R. (March, 2009). The Neurobiology of adaptive learning in reading low-frequency Chinese phonograms: A contrast between phonological and semantic training conditions. Presented at the Sixteenth Annual Meeting of the Cognitive Neuroscience Society, San Francisco, CA

Aicher, K.A., Rueckl, J. G., Mencl, W.E., Frost, S.J., Fang, S., & Pugh, K.R. (March, 2009). Effects of multiple repetitions on the functional neurobiology of reading. Presented at the Sixteenth Annual Meeting of the Cognitive Neuroscience Society, San Francisco, CA

Kukona, A., Rueckl, J. G., Aicher, K.A., Theophanis, A. & Magnuson, J.S. (March, 2009). Continuity of hand DOES reveal continuity of mind. Presented at the 22nd Annual CUNY Conference on Human Sentence Processing, Davis, CA.

Mencl, W.E., Frost, S.J., Fang, S., Landi, N., Pugh, K.R., & Rueckl, J. (July, 2009) Investigation of the reading system by parametric manipulation of printed stimulus duration. Presented at the Annual Meeting of the Organization for Human Brain Mapping, San Francisco, CA.

Rueckl, J.G., & Rimzhim, A. (g). (November, 2009). Letter Transposition Effects Across Morpheme Boundaries. Presented at the 50th Annual Meeting of the Psychonomic Society, Boston, MA.

Zhao, J., (g), & Rueckl, J. G. (November, 2009). Repetition Effects on Word and Nonword Reading: An fMRI Study. Presented at the 50th Annual Meeting of the Psychonomic Society, Boston, MA.

Zhao, J., & Rueckl, J. G. (November, 2009). The Roles of Pronounceability and Bigram Frequency in Letter Transposition Effects. Presented at the 50th Annual Meeting of the Psychonomic Society, Boston, MA.

Aicher, K. A., Fang, S., Mencl, W. E., Frost, S. J., Pugh, K. R., & Rueckl, J. G. (2009, November). Repetition effects on word and nonword reading: An fMRI study. Poster presented at the 50th Annual Scientific Meeting of the Psychonomic Society, Boston, MA.

Rueckl, J. G. & Fang, S. The Coding of Letter Order Information in Learned (Hidden) Representations. Invited paper: Symposium: Our Vision for the Word: Models of Orthographic Processing. Presented The 4th Computational Cognitive Neuroscience Conference, Boston, MA.

Aicher, K. A., Collison, B., Arthur, D, Rueckl, J. G. (2010, July). Orthographic and phonologic influences on adult novel word learning. Poster presented at the Seventh International Conference on the Mental Lexicon, Windsor, Ontario.

Aicher, K. A., Collison, B., Arthur, D., Rueckl, J. G. (2010, September). Influences of wordlikeness and learning context in novel word learning. Poster presented at AMLaP 2010: Architectures and Mechanisms for Language Processing, York, UK.

Rueckl, J. G. (2010, November). Are canonical models really canonical? And what if they are not? Pre-Psychonomics Visual Word Recognition Conference, St. Louis, MO.

Rueckl, J. G., & Henry, S. Change you don't believe in: Letter transpositions and the change detection task. Poster presented at the 51st Annual Scientific Meeting of the Psychonomic Society, St. Louis, MO.

Collison, B., Aicher, K. A., Arthur, D., & Rueckl, J. G. (2010, November). The contribution of semantics in a visual word learning study. Poster presented at the 2010 meeting of the American Speech and Hearing Association, Philadelphia, PA.

Rueckl, J. G. (2010, September). Reading acquisition as statistical learning: A framework for studying second-language acquisition. *Donostia Workshop on Neurobilingualism.* Donstria-San Sebastian, Spain.

Aicher, K. A. (Rueckl, J. G. (2011, July). The influence of word form on the acquisition of meaning: An adult word learning study. Eighteenth Annual Meeting Society for the Scientific Study of Reading; St. Petersburg, FL.

Rueckl, J. (2011, June). Getting from Here to There: Limitations of Current Models of Morphological Processes in Word Recognition and Future Directions. 7th International Morphological Processing Conference; Donostia-San Sebastián, Spain.

Rueckl, J. G. & Aicher, K. A. (2011, September). The impact of prior knowledge on word learning. 17th Meeting of the European Society for Cognitive Psychology. Donostia-San Sebastián, Spain

Collison, B.A., Grela, B, Spaulding, T., & Rueckl, J.G. .(2011, June) Visual association, recognition, and learning in preschool children with and without specific language impairment. Symposium in Research on Child Language Disorders.

Rueckl, J. G., Aicher, K., & Austen, A. (2012, May). The role of prior knowledge in word learning. *Second Language Acquisition: from Brain Plasticity to Cognition Scientific Program*. Jersusalem, Israel.

Rueckl, J. G., Zhao, J., & Li, T. (2013, May). Plasticity and the Organization of the Reading System: Variation Between and Within Linguistic Communities. *L1 reading across different languages and L2-literacy acquisition.* Taiwan.

Other Presentations

November, 1986.	Cognitive Science Lecture Series, MIT.
May, 1987.	Vision Group, MIT.
September, 1987.	Boston Society for Cognitive Neuroscience.
February, 1988.	Northeastern University.
March, 1988.	University of Pennsylvania.
September, 1988.	The Wisconsin Psychology Centennial.
December, 1989.	Massachusetts General Hospital.
May, 1990.	Cognitive Science Lecture Series, MIT.
May, 1991.	Tufts University.
April, 1992.	Brigham and Women's Hospital, Boston.
April, 1993	Massachusetts General Hospital
October, 1993	Haskins Laboratories, New Haven
October, 1994	Dartmouth College
October, 1996	Weslayan University
October, 1996	Yale University
May, 1999	Haskins Labs
October, 2003	Boston VA Hospital
April, 2005	Haskins Labs
November, 2007	University of Cincinnati

CURRICULUM VITAE

KENNETH R. PUGH

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CURRENT POSITIONS

President and Director of Research
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Professor
Department of Psychology
University of Connecticut
Storrs, Ct 06269

Associate Professor
Department of Linguistics
Yale University
New Haven, Connecticut

Associate Professor
Department of Diagnostic Radiology
Yale University School of Medicine
New Haven, Connecticut

Education	B.S. (Psychology), summa cum laude, New York Institute of Technology, Spring 1982.
	M.A. (Experimental Psychology), The Ohio State University, 1987
	Ph.D. (Experimental Psychology), The Ohio State University, 1990.

Academic history

Research Assistant, Department of Sensory Biophysics, The Ohio State University: 1983 – 1985.

Teaching Associate, Department of Psychology, The Ohio State University: 1985 – 1987.
Graduate Research Associate, Department of Linguistics, The Ohio State University: 1987.

Instructor, Department of Psychology, Denison University: 1988 – 1989.

Visiting Assistant Professor, Department of Psychology, Holy Cross College: 1989 – 1992.

Visiting Assistant Research Professor, Department of Psychology, University of Connecticut: 1991 – 1993.

Visiting Assistant Professor, Department of Psychology, Dartmouth College, NH: 1992 – 1994.

Senior Scientist, Haskins Laboratories, New Haven, CT: 1990 – 2008

Associate Research Scientist (Assistant Professor level), Department of Pediatrics (Neurology) Yale University School of Medicine: 1994 – May 1996.

Research Scientist (Associate Professor level), Department of Pediatrics (Neurology) Yale University School of Medicine: June 1996 – May 2007

Associate Professor, Department of Pediatrics (Adolescent Medicine) Yale University School of Medicine: June 2007 – 2010.

President and Director of Research, Haskins Laboratories, New Haven, CT: 2008-present

Adjunct Associate Professor, Department of Diagnostic Radiology, Yale University School of Medicine: 2010-present

Adjunct Associate Professor, Department of Linguistics, Yale University: 2010-present

Professor, Department of Psychology University of Connecticut: 2010-present

Professional societies

Psychonomic Society

International Dyslexia Association (Scientific Advisory Board)

Rodin Remediation Academy (Sweden)

American Educational Research Assocation

Service activities

2009-2011: Member of "Committee on the Learning Sciences: Foundations and Applications to Adolescent and Adult Literacy." National Research Council of the National Academies, Washington, D.C.

October 2005-October 2009: Four year standing appointment to the Language an Communication Study Section at the Center for Scientific Review, National Institutes of Health.

2002 – 2003. Member of the Rand Corporation Panel on New Directions for Children's Research and Development Policy.
Co-sponsored/funded by The White House Office of Science and Technology Policy, the National Institutes of Health, and the National Science Foundation.

Corresponding Member of the Rodin Remediation Academy, Stockholm, Sweden (from March, 2003-Present).

Scientific Advisory Board, Elected Member, International Dyslexia Association, Washington DC. 2004-Present.

Organizing committee member for the Plasticity workshop of the 2011 "NICHD's Scientific Vision: The next decade" initiative at the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD).

Ad-hoc reviewer: for numerous journals including Psychological Review, Journal of Experimental Psychology: Human Perception and Performance, Journal of Memory and Language, Perception and Psychophysics, Nature, Brain, Neuroimage, and others.

Awards & honors

Presidential Fellowship, The Ohio State University, 1987 – 1988. Awarded in university-wide dissertation competition; included full stipend

Psychology Award (for highest four-year GPA), New York Institute of Technology, 1982

Professor Carl Atkins (English) Award, New York Institute of Technology, 1982.

Jules Singer Award (for outstanding contribution to the intellectual and cultural climate of the college), New York Institute of Technology, 1982.

Harry Schure Award (presented by faculty for outstanding service and academic achievement), New York Institute of Technology, 1982.

Nu Epsilon Tau Honor Society, New York Institute of Technology, 1981.

Publications

Johnson, N. F., Pugh, K. R., & Blum, A. (1989). More on the way we “see” letters from words within memory. Journal of Memory and Language, 28, 155-163.

Pugh, K., Rexer, K., & Katz, L. (1994). Evidence of flexible coding in visual word recognition. Journal of Experimental Psychology: Human Perception and Performance, 20, 807-825.

Pugh, K., Rexer, K., Peter, M., & Katz, L. (1994). Neighborhood effects in visual word recognition: Effects of letter delay and nonword context difficulty. Journal of Experimental Psychology: Learning, Memory, and Cognition, 20, 639-648.

Johnson, N. F., & Pugh, K. R. (1994). An examination of cohort models of visual word recognition: On the role of letters in word-level processing. Cognitive Psychology, 240-346.

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Representative Invited addresses: Universities

Functional magnetic resonance imaging studies of language processing. Talk given at the University of Connecticut, November, 1993
Flexible coding in visual word recognition. Talk given at the State University of New York (Albany), October, 1993.

Behavioral and functional imaging studies of language processing. Talk given at the University of Southern Maine, May 1993.

Functional imaging studies of language processing: Brain/ behavior relations. Talk given at the Dartmouth College, June 1995.

Functional imaging studies of language processing: Brain/ behavior relations. Talk given at the Wesleyan University, April 1996.

Functional imaging studies of language processing: Brain/ behavior relations. Talk given at the Cognitive Science Institute, University of Pennsylvania, September, 1996.

Functional imaging studies of language processing: Brain/ behavior relations. Talk given at the University of Arizona, May 1997

Functional imaging studies of language processing: Brain/ behavior relations. Talk given at the Hospital for Sick Children, Toronto CA, November, 1997.

Functional imaging studies of language processing:: Implications for the study of dyslexia, Talk given at Wesleyan University, October, 1998.

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Functional imaging studies of language processing:: Establishing Brain/behavior relations in reading and reading disability. Talk given at National Yang-Ming University (Taiwan), March 1999.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Talk given at Northwestern University, April 2000.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Talk given at Massachusetts General Hospital , May 2000.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Talk given at McGill University (Dept. of Communication Disorders) October, 2000.

Functional imaging studies of language processing: Establishing Brain/ behavior relations. Talk given at the Helsinki University of Technology, Helsinki, Finland, February, 2001.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Talk given at Children's Hospital Medical Center, University of Cincinnati; March 2001.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Talk given at Kansas University Medical Center, March 2001.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Talk given at The Kennedy Krieger Institute, Johns Hopkins University, March 2002.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Distinguished Lecture given at the University of Maryland (Dept. of Special Education, sponsor), March, 2003.

Functional imaging studies of language processing:: Establishing Brain/behavior relations in reading and reading disability. Distinguished Lecture Series presentation given at the John F. Kennedy Center for Research on Human Development, Brain Awareness Symposia, Vanderbilt University, March 2003.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Invited talk given at the Cognitive Science Institute, University of Pennsylvania, September, 2003.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Lecture given at Dalhousie University, Halifax, CA, April, 2003.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Invited Lecture given at University of Massachusetts, April, 2004.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Annual Hearst Lecture given at University of Northern Iowa, April, 2004.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Invited lecture given at the Research Laboratory in Electronics (speech group), Massachusetts Institute of Technology, Sept., 2004.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Invited lecture given at the Linguistics Society of America: Summer Institute, Massachusetts Institute of Technology, July, 2005.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Invited lecture given at the University Laboratory of Physiology, Oxford University, England, Oct. 3rd, 2005.

Successful and struggling readers: What's different about what their brains are doing and what can our teaching do? Distinguished Speaker Program, California State University (Northridge), CA, February, 2007.

Reading and the brain: New findings and directions. Invited lecture given at the Waisman Center, University of Wisconsin, October 2007.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Invited lecture given at the City University of New York Graduate Center (Dept. of Linguistics) New York, NY, March 2008.

The neurobiological of reading development and disability: An update on new findings. Keynote lecture given at the Fifth Annual Summer Institute in Cognitive Neuroscience, sponsored by the Institute for Cognitive Neuroscience, National Central University, Taipei, Taiwan, July 2008.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. The Annual MITRE Lecture, given at the University of Minnesota, February, 2009

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Keynote lecture given at the Safra Brain Research Center Inaugural Conference, University of Haifa, Haifa, Israel, June 2009.

Establishing brain/behavior relations. Invited lecture given at the Hebrew University, Jerusalem, Israel, June 2009.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Invited lecture given at the University of Guelph, Guelph Canada, October 2009.

Functional imaging of reading and reading disability. Invited lecture given at Pennsylvania State University, State College, PA, February 2011.

Functional imaging of reading and reading disability: Establishing brain/behavior relations. Invited lecture given at the City University of New York Graduate Center (Dept. of Linguistics) New York, NY, April 2011.

Center for Behavioral Education & Research, 1st Annual CBER Student Research Symposium "Promoting Student Success". Neag School of Education, University of Connecticut, May 2011.

Neurobiological studies of reading. Invited lecture given at Hong Kong University, November 2012.

Neuroimaging studies of reading development: An update on gene-brain-behavior findings. Distinguished scholar lecture given at the Chinese University of Hong Kong, August 2013.

Representative Invited addresses: Conferences

Functional imaging studies of language processing: Establishing Brain/ behavior relations. Talk given at the Presidential Symposium, Annual Meeting of the Otolaryngology Research Organization, St. Petersburg FL, January, 1997

Functional imaging studies of language processing: Establishing Brain/ behavior relations. Talk given at the Annual Meeting of the Learning Disabilities Association of America, Chicago IL, February, 1997

Functional imaging studies of language processing: Establishing Brain/ behavior relations. Plenary lecture given at the International Conference on Mental Retardation: Genes, Brain, and Behavior, at the Institute for Basic Research in Learning Disabilities, Staten Island, NY, July, 1997

Functional imaging studies of reading and reading disability: Talk given at YAI Learning Disabilities Conference, Tarrytown, NY; October, 1998.

Functional imaging studies of language processing: implications for the study of dyslexia. Symposium Talk given at Annual Meeting of the Eastern Psychological Association, April, 1999.

Neuroimaging and intervention studies in reading disability. Talk given at the Second Annual Meeting of the Society for the Scientific Study of Reading, Montreal, CA, April, 1999.

Functional imaging studies of language processing: implications for the study of dyslexia. Address given at the second annual Claremont Conference on Applied Developmental Psychology, May, 1999.

Neuroimaging and intervention studies in reading disability. Talk given at the Annual Meeting of the McDonnell-Pew Program in Cognitive Neuroscience, San Diego, CA, June, 1999.

Functional imaging studies of language processing: Establishing Brain/ behavior relations. Invited lecture given at the International Congress of Psychology 2000; July 26 2000; Stockholm Sweden.

Functional imaging studies of language processing: Establishing Brain/ behavior relations. Invited lecture given at the International Dyslexia Association Meeting, Washington D.C. November, 2000

Functional imaging studies of language processing: Establishing Brain/ behavior relations. Invited lecture given at the American Speech and Hearing Association Convention, Washington D.C. November, 2000.

Functional imaging studies of language processing:: Establishing Brain/behavior relations in reading and reading disability. given at a conference on Mind, Language, and Movement at National Yang-Ming University (Taiwan), December, 2000.

Functional imaging studies of language processing: Establishing Brain/ behavior relations. Invited lecture given at the Finland National Conference on Dyslexia, Jyvaskyla Finland. February, 2001.

Functional imaging studies reading disability. Outcome of a phonological awareness intervention study. Invited lecture given at the International Dyslexia Association Meeting, Albuquerque NM November, 2001.

Functional imaging studies of language processing:: Establishing Brain/behavior relations in reading and reading disability. Invited talk given at Dept. of Education Improving America's Schools Meeting, Reno, NV, November, 2001.

Functional imaging studies of language processing: Establishing Brain/behavior relations in reading and reading disability. Invited talk given at the Annual Meeting of the American Association for the Advancement of Science, Boston MA, 2002.

Functional imaging studies of language processing: Establishing Brain/behavior relations in reading and reading disability. Invited talk given at the Annual Meeting of the Rodin Remediation Academy, Munich Germany, September 2002.

Functional imaging studies of language processing: Establishing Brain/behavior relations in reading and reading disability. Invited talk given at the Max Plank Institute for Psycholinguistics, Nijmegen, Netherlands, September, 2002.

Functional imaging studies of language processing: Establishing Brain/behavior relations in reading and reading disability. Invited Lecture given at the M.I.N.D. Institute Symposium, University of California, Davis, August 2002.

Functional imaging studies of language processing: Establishing Brain/behavior relations in reading and reading disability. Invited talk given at the Organization for Economic Cooperation and Development (OECD)/ CERI meeting on Brain and Literacy, Brockton, MA, February, 2003.

Functional imaging studies of language processing: Establishing Brain/behavior relations in reading and reading disability. Keynote lecture to be given at the 43rd Annual Meeting of the Society for Psychophysiological Research, Chicago, IL, October 2003.

Functional imaging studies of language processing: Establishing Brain/behavior relations in reading and reading disability. Invited talk given at the 30th Annual Conference of the New York Branch of the International Dyslexia Association, New York, March 2003.
Functional imaging studies of language processing: Establishing Brain/behavior relations in reading and reading disability. Invited talk given at the "Learning and the Brain Conference", co-sponsored by the Kosik Lab of Neurobiology at Harvard Medical School and the Boston University School of Education, Boston, MA, April, 2003.

Neuroimaging and reading disability. Invited talk given at "Brain and Plasticity Conference); sponsored by Academia Sinica and National Yang Ming University Taipei, Taiwan, Feb. 2004.

Neuroimaging of reading development and reading disability. Invited talk given at the Dyslexia Foundation Conference, Lake Como, Italy, June 2004.

Neuroimaging and reading disability. Invited talk at the First Oxford/Kobe Dyslexia conference, Kobe, Japan, March, 2004.

Neuroimaging and reading disability. Keynote address at the World Organization of Early Childhood Educators. Madrid, Spain, March 2004.

Neuroimaging and reading disability. Invited talk at Continuing Medical Education conference at Johns Hopkins School of Medicine, Sept, 2004.

Neuroimaging and reading disability. Symposium talk at the American Psychological Association Annual Meeting, Honolulu, HI, July, 2004.

Neuroimaging and reading disability. Invited talk at the International Dyslexia Association Annual Meeting, Philadelphia Penn, Oct, 2004.

Neurology and Education. Invited lecture to over 2000 attendees at the 5th World Conference on Early Childhood Education held in Morelia, Mexico, April, 2005.

Neurology and Language Development. Invited lecture to over 1,500 attendees at the 5th Annual Encounter on Pre-school Education and Child Development, Monterrey Mexico, June, 2005.

Neuroimaging and reading disability. Keynote address at a Continuing Medical Education Conference on Neurodevelopmental Disorders, Hospital for Sick Children, Toronto, CA, June 2005.

Functional imaging and reading in different orthographies. Invited lecture given at an OECD sponsored international conference entitled: “Shallow vs. Non-Shallow Orthographies and Learning to Read”, Cambridge University, Cambridge England, Sept 29, 2005.

Neuroimaging studies of skilled reading and reading disability: New findings and directions. Invited talk given at the International Conference of Cognitive Neuroscience, Academia Sinica, Taipei, Taiwan, December, 2005.

Functional neuroimaging and cognitive development. Invited talk given at “Neuro-mathematics and Education symposium”, co-sponsored by OECD and the National Science Foundation, Copenhagen Denmark, February, 2006.

Neuroimaging and language development. Invited keynote presentation given at Encuentro International De Educadores: La innovacion en la practica pedagogica, Lima Peru, February, 2006.

Neuroimaging and reading disability. Invited talk given at the Council for Exceptional Children Annual Meeting, Salt Lake City, Utah, March 2006.

Neuroimaging and reading disability. Invited talk at the International Reading Association Annual Meeting, Chicago, Il, May 2006.

Neurology and Language Development. Invited lecture given at the 6th Annual Encounter on Pre-school Education and Child Development, Monterrey Mexico, May, 2006.

Neural Basis of developmental learning disabilities. Invited talk given at “The Summer School on Numeracy, Reading, Dyslexia and Dyscalculia: Brain development, culture and remediation”, University of Jyvaskyla, Finland, June 2006.

Neuroimaging and Language development. Invited lecture given at the Rodin Remediation Academy Conference, Georgetown University, Washington, DC, October 2006.

Neuroimaging and Language development. Invited lecture given at the First Conference of Sino-Western Exchanges in Cognitive Neuroscience, October 25-27 2006, in Beijing, China.

Neuroimaging and Language development. Invited lecture given at " Dyslexia as a challenge of science. Review of findings: genetics, neuroscience and psychology of dyslexia." International workshop sponsored by European Union-Neurodys Project, and the Academy of Finland, Helsinki Finland, November, 2006.

Neuroimaging and reading disability: Update and new directions. Invited talk at the International Dyslexia Association Annual Meeting, Indianapolis, Indiana, November, 2006.

Neuroimaging and reading disability: An update and new directions. . Invited talk given at the Second Oxford/Kobe Dyslexia conference, Kobe, Japan, April, 2007.

Neuroimaging of reading development and reading disability. Invited talk to be given at the 10th Extraordinary Brain Symposium sponsored by the Dyslexia Foundation, Campos Dos Jordae, Brazil, June 2007.

Neuroimaging and early brain and language development. Invited keynote presentation given at 2nd Encuentro International De Educadores Lima Peru, February, 2008.

Neuroimaging and language development. Invited lecture given at the Greenland Ministry of Education conference on early childhood education, Nuuk Greenland, November 2007.

How fMRI studies will help us better understand how children learn to read. Literacy, Reading and dyslexia: Address given at conference on Learning Disabilities sponsored by The Dyslexia Foundation; Beth Israel Deaconess Medical Center, Harvard Medical School, Boston MA., October, 2008.

Effects of cognitive, language, and nutritional factors in infants and toddlers on later learning and brain development: Connections to reading acquisition. Invited lecture given at the 8th Annual Encounter on Pre-school Education and Child Development, Monterrey Mexico, October, 2008.

The Neuro-psychological Basis of Learning Disabilities:Exploring Brain/Behavior Relations with Neuroimaging Methods. Keynote address given at the 2008 Learning Disabilities Forum, sponsored by TATA Interactive Systems, Mumbai, India, November 2008.

Early neurocognitive development and readiness to read. Keynote address given at the Second Annual Inter-American Symposium: Policies and strategies for a successful transition to school;. Organized by the Organization of American States, Santiago, Chile, May 2009.

Learning Disabilities:Exploring early predictors of later reading problems. Keynote address given at the 2009 Learning Disabilities Forum, sponsored by TATA Interactive Systems, Mumbai, India, November 2009.

Neuroimaging and the bilingual brain. Invited talk given at the Conference on Cognitive and Neurobiological Foundations of Bilingualism. National Taiwan Normal University, Taiwan, January, 2010.

Neuroimaging of reading development and reading disability Invited talk given World Congress on Neuroeducation, Lima, Perú, August 2010.

Neuroimaging of reading development and reading disability Invited talk given Workshop on Neurobilingualism. at Basque Center on Cognition, Brain and Language, Donostia San Sebastian, Spain, October 2010.

Neuroimaging of reading development and reading disability. Invited talk given at the EBBD (Experience-based Brain and Biological Development) Meeting of The Canadian Institute for Advanced Research (CIFAR), Toronto, Ontario, November 2010.

Neuroimaging of reading development and reading disability. Keynote address for the Martti Takala Studia Generalia lecture series: University of Jyväskylä, Finland, December 2010.

Neuroimaging studies of Reading and Language Development: An update on recent findings. Invited talk at Neuro-cognitive determinants of second language literacy in young adults – A multilingual perspective; National Central University, Taiwan, February 2011.

Neuroimaging studies of Reading and Language Development: An update on recent findings. Invited address given at Lindmood-Bell's 17Th International Conference, The Sensory-Language connection for Learning, San Luis Obispo, CA March 2011.

Neuroimaging studies of Reading and Language Development: An update on recent findings. National Meeting on Early Childhood & Preschool Education, Development strategy for comprehensive early childhood, University of El Salvador, April 2011.

Neuroimaging studies of Reading and Language Development: An update on recent findings. Invited address given at The Developing Brain and Socio-economic Status: Toward an Integrative Perspective Conference; University of Michigan, June 2011.

Neuroimaging studies of Reading and Language Development: An update on recent findings. Invited address given at The 32nd Annual Symposium on Research in Child Language; University of Wisconsin - Madison, June 2011.

Neuroimaging studies of Reading and Language Development: An update on recent findings. Invited address given at the AACAP+CACAP Joint Annual Meeting; Toronto, October 2011.

Neuroimaging studies of Reading and Language Development: An update on recent findings. Invited address given at the 62nd Annual IDA Conference Reading, Literacy & Learning; Chicago, IL, November 2011.

Neuroimaging studies of Reading and Language Development: An update on recent findings. Invited address given at the ASHA Program Committee - Neuroimaging Studies of Typical & Atypical Language & Reading Development; San Diego, November 2011.

Effects of early language experience on later learning and brain development: Connections to reading acquisition. Invited lecture given at the 13th Annual Encounter on Pre-school Education and Child Development, Monterrey Mexico, November 2012.

Neuroimaging studies of Reading and Language Development: An update on recent findings. Invited keynote address given at the Annual Southwest IDA Conference, Albuquerque New Mexico, March 2013.

Neuroimaging and reading disability. Invited talk at the Third Oxford/Kobe Dyslexia conference, Oxford, England, April 2013.

Brain and Reading: An update on recent findings. Invited talk given at the American Educational Research Association Annual Meeting, San Francisco, CA, April 2013.

An update on brain organization for reading across languages : Invited address given at the 2013 Symposium on L1 reading across different languages and L2 literacy acquisition, Laboratory for Cognitive Neuroscience, Taipei, Taiwan, May 2013.

The neurobiology of spoken and written language. Keynote address given at the 5th annual meeting on evolutionary linguistics, Chinese University of Hong Kong, August 2013.

Invited talks at Federal Agencies: National Institutes of Health/ Department of Education

Conditions necessary for the development of tasks for functional neuroimaging studies. Address given at a conference at the National Institutes of Health entitled “Neuroscience and Neurodevelopmental Disorders,” March 22, 1996.

Understanding reading performance and reading disabilities from functional neuroimaging profiles. Address given to the National Advisory Child Health and Human Development Council, June 3, 1996.

Future of Imaging Technologies in MR/DD Research. Talk given at the 31st Annual Gatlinburg Conference, sponsored by NIH; NICHD, Charleston SC March, 1997.

fMRI studies of reading development, Given at an NIH inter-institute pediatric neuroimaging conference “Making the connection: Coordinating neuroimaging and functional paradigms for understanding pediatric neurodevelopment”. Leesburg VA, September 29, 1999.

Functional neuroimaging studies of reading and reading disability: Establishing brain/behavior relationships. Cross-institute address given as part of the NIH Behavioral and Social Sciences Research Lecture Series, Bethesda MD, February 15, 2000.

Functional neuroimaging studies of reading and reading disability: Establishing brain/behavior relationships. Keynote lecture at the NIH /ASHA co-sponsored meeting "Emergent and Early Literacy Workshop; Rockville MD; Sept 21, 2000.

Examining reading development and reading disability in English language learners: Potential contributions from functional neuroimaging. Invited lecture given at the National Symposium on Learning Disabilities in English Language Learners, Washington, D.C., October 14-15, 2003. Co-sponsored by NICHD, and Department of Education.

Functional neuroimaging studies of reading and reading disability: Establishing brain/behavior relationships. Invited lecture given at NABSE (National Alliance for Black School Educators) meeting sponsored by National Institute for Literacy and supported by NICHD, April, 2004, Washington DC.

Examining reading development and reading disability in English language learners: Potential contributions from functional neuroimaging. Improving Academic Performance Among American Indian, Alaska Native, & Native Hawaiian Students: Assessment & Identification of Learning & Learning Disabilities, Invited lecture given at NICHD/DOE sponsored conference, March, 2005, Santa Fe, New Mexico.

Examining reading development and reading disability in English language learners: Potential contributions from functional neuroimaging. Improving Academic Performance Among American Indian, Alaska Native, & Native Hawaiian Students: Assessment & Identification of Learning & Learning Disabilities, Invited lecture given at NICHD/DOE sponsored follow-up conference, August, 2005, Washington DC.

Neuroimaging and reading: What have we learned so far. Invited address at the Institute for Education Sciences. Department of Education, Washington D.C. September 2012.

Ongoing Research

R01 HD 067364 (Pugh) 08/01/11 – 05/31/16
NIH/NICHD
Neurocognitive determinants of second language literacy development in adolescents
This project examines how differences in language characteristics, in conjunction with neurocognitive individual differences, shape the trajectory of acquiring literacy skills in a new language and how those skills, in turn, impact native language performance.
Role:PI

R01 HD 065794 (Pugh) 5/01/11-4/30/16
NIH/NICHD

Neurobiological predictors of spoken and written language learning
The project uses multiple neuroimaging methods to test predictive models of individual differences in learning and consolidation of novel spoken and written words with the overarching goal to develop causal models of the ways in which functional and structural factors might act to impede language and reading-related skill acquisition in RD.
Role: PI
[NL1]
P01 HD 01994 Rueckl/Pugh (co-PI's) 05/01/12-04/30/17
NIH/NICHD
The Nature and Acquisition of the Speech Code and Reading
To better understand the reading process by 1) examining the relation of reading to spoken language and 2) examining the relation between cognitive performance and brain organization.
Role: Investigator

Completed Research

R01 HD 40353 (Shankweiler) 04/01/06-03/31/11

NICHD
Neurobehavioral Mechanisms in Reading Comprehension
This proposal focuses on closing the gap between comprehension of discourse in speech and print that is characteristic of unskilled readers.
Role: Investigator

P50 HD 052121 (Pugh, Subcontract PI) 9/29/06-7/31/11
NIH/NICHD
Reading Disability in Grades 3-8: Neurocognitive Factors
The project aims to enhance our understanding of the substantial degree of behavioral and neurobiological heterogeneity observed among disabled readers by characterizing the neurocognitive development of struggling readers whose reading is or is not at odds with their general cognitive abilities.
Role: Investigator

R01 HD 048830 (Pugh) 08/01/05-05/31/10

NICHD
Neurobiological Foundations of (dis)ability
This study is designed to examine reading development in one normally developing and two reading disabled cohorts at critical points in its establishment with yoked genetics, neurochemistry, neuroimaging, and behavioral measures.
Role: PI

RO1-DA17333 (Jacobsen) 9/30/04 - 8/29/09
NIDA

Brain Functional Correlates of MDMA Use in Adolescents
This study will test for evidence of cognitive deficits and brain functional changes in adolescent MDMA users and determine whether observe changes improve with sustained abstinence from MDMA use.
Role: Investigator

Ph.D. advisees (University of Connecticut)

Anish Kourian, currently in Year 3.

Stephanie Del Tufo currently in Year 2.

Christine Motley, currently in Year 1.

Karen Aicher. Dissertation completed 2012 (Code tradeoffs in visual word recognition)

Jingjing Zhao dissertation completed 2012 (The Influence of Statistical Systematicities on Learning to Read: Studies with Artificial Orthographies)

Stephen Frost, dissertation completed 2001 (Bidirectional consistency effects in visual and spoken word recognition

Karl Rexer. dissertation completed 1994 (Neighborhood effects in visual word recognition)
Einar Mencl (Dartmouth College), dissertation completed 1994 (Connectionist models of music perception)

Emily B. Myers
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EDUCATION

2005 Ph.D., (Cognitive Science), Brown University Dissertation title: "*Neural correlates of phonetic category structure: An fMRI investigation*"
1999 BA with highest distinction, (Spanish and Linguistics), University of Iowa

PROFESSIONAL EXPERIENCE

2012-Present	Research Scientist, Haskins Laboratories
2010-Present	Assistant Professor of Speech, Language, and Hearing Sciences, University of Connecticut
2010-Present	Assistant Professor of Psychology, University of Connecticut (Perception, Action & Cognition Division)
2010-Present	Adjunct Assistant Professor of Research, Cognitive Linguistic and Psychological Sciences, Brown University
2009	Assistant Professor of Research, Brown University, Cognitive & Linguistic Sciences
2006-2008	Postdoctoral Research Assistant, Brown University

GRANT FUNDING

Active Support:

2013	UConn Research Foundation (UCRF) Faculty Large Grant, ($11,779), "Neural systems underlying adaptation to a novel speech pattern: Evidence from aphasia and ERP" (Myers, PI).
2012-2017	NSF Integrative Graduate Education and Research Traineeship grant, "*IGERT: Language plasticity – Genes, Brain, Cognition, and Computation*" (Role: Investigator, James Magnuson, PI)
2012-2017	NIH NICHD, P50 grant, "*Nature and acquisition of the speech code and reading*" (Role: Investigator, Jay Rueckl, PI).

Previous Support:

2008-2011	NIH NIDCD, R03 DC009395 *"The Neural Bases of Statistical and Referential Cues to Phonetic Category Structure"* $300,000, direct costs (Myers, PI) (*no-cost extension to 11/30/13*).
2009-2011	NIH NIDCD P30 DC010751 *"Emergence, structure, and neurological basis of typical and atypical language"* (Role: Co-PI; Diane Lillo-Martin, PI)

2010	UConn VP for Research and Research Advisory Council, "Electrophysiology Shared Resource Laboratory (PSERL)," (Role: Co-PI, Magnuson, PI)
2004-2005	Dana Foundation Fellowship, $5,000 to fund travel and research expenses supporting graduate work in the cognitive neurosciences (Myers, PI)
2003-2005	NIH NIDCD F31 DC006520 "*Neural Bases of Lexical Effects*" National Research Service Award, (Myers, PI)

Mentored Awards:

2013	Summer Undergraduate Research (SURF) Award (undergraduate student Julia Drouin)
2013	Summer Undergraduate Research (SURF) Award (undergraduate student Brittany Ciullo)
2013	Social Sciences, Humanities, and Arts Research Experience (SHARE) Award (undergraduate student Julia Drouin)
2012	Holster Scholar Award (undergraduate student Kaila Manca)
2012	Holster Scholar Award (undergraduate student Kaitrin Acuna)

PUBLICATIONS

**Indicates undergraduate student or Research Assistant working under my supervision
*Indicates graduate student in my lab

Under Review

Myers, E.B., and **Mesite, L. Neural systems underlying perceptual adjustment to non-standard speech tokens.

*Earle, F.S., and **Myers, E.B.** Effects of sleep on speech sound learning.

*Xie, X. and **Myers, E.B.** The Role of Musical and Language Influence in Talker Identification,

2103

Blumstein, S. E., and **Myers, E.B**. Neural Systems Underlying Speech Perception. *Oxford Handbook of Cognitive Neuroscience*

Swan, K.S., **Myers E.B. Category labels induce boundary-dependent perceptual warping in learned speech categories. *Second Language Research, 29(4), 391-411. 10.1177/0267658313491763*

Feldman, Naomi, **Myers, E.B**., White, K.S., Griffiths, T.L., and Morgan, J.L. Word-level information influences phonetic learning in adults and infants. *Cognition, 127(3), 427-38.*

Magnuson, J.S., Mirman, D. and **Myers, E**. Spoken Word Recognition. **In D. Reisberg (Ed.),** *The Oxford Handbook of Cognitive Psychology* (pp 412-441). New York, USA: Oxford University Press

2012

Myers, E.B., and **Swan, K.S. (2012). Effects of category learning on neural sensitivity to non-native phonetic categories. *Journal of Cognitive Neuroscience,* 24(8), 1695-708.

Salvata, C, Blumstein, S.E., **Myers, E. B.** (2012). Speaker Invariance for Phonetic Information: an FMRI Investigation. *Language and Cognitive Processes*, 27(2), 210-230.

2011

Peramunage, D., Blumstein, S. E., **Myers, E. B**., Goldrick, M., & Baese-Berk, M. (2011). Phonological neighborhood effects in spoken word production: an fMRI study. *Journal of Cognitive Neuroscience*, *23*(3), 593-603.

2009

Myers, E. B., Blumstein, S.E. Walsh, E, and Eliassen, J. (2009). Inferior frontal regions underlie the perception of phonetic category invariance. *Psychological Science,* 20(7), 895-903.

Britton, B., Blumstein, S.E., **Myers, E.B**., and Grindrod, C. (2009). The role of spectral and durational properties on hemispheric asymmetries in vowel perception. *Neuropsychologia*, 47(4), 1096-106.

Bielenko, N., Grindrod, C. **Myers, E**., and Blumstein, S. (2009). Neural correlates of semantic competition during processing of ambiguous words. *Journal of Cognitive Neurosceience*, 21(5), 960-75.

2008

Myers, E.B and Blumstein, S.E (2008). The neural bases of the lexical effect: An fMRI investigation. *Cerebral Cortex* 18(2): 278-88.

Grindrod, C., Bilenko, N., **Myers, E**., and Blumstein, S. (2008). The role of the left inferior frontal gyrus in implicit semantic competition and selection: an event-related fMRI study. *Brain Research*, Sep 10; 1229, 167—78.

Ruff, I., Blumstein, S.E., **Myers, E.B**., and Hutchison, E. (2008). Recruitment of anterior and posterior structures in lexical-semantic processing: An fMRI study comparing implicit and explicit tasks. *Brain and Language* 105(1), 41-9.

Hutchison, E., Blumstein, S.E., and **Myers, E.B.** (2008). An event-related fMRI investigation of voice-onset time discrimination. *NeuroImage* 40(1): 342-52.

2007

Myers, E.B. (2007)**.** Dissociable effects of phonetic competition and category typicality in a phonetic categorization task: An fMRI investigation. *Neuropsychologia* 45:1463-1473.

2006

Prabhakaran, R., Blumstein, S.E., **Myers, E.B**., Hutchison, E., and Britton, B. (2006). An event-related fMRI investigation of phonological-lexical competition. *Neuropsychologia* 44(12), 2209-21.

2005

Blumstein, S.E., **Myers, E.B**, and Rissman, J. (2005). The perception of voice-onset time: An fMRI investigation of phonetic category structure. *Journal of Cognitive Neurosicence* 17(9), 1353-66.

Myers, E.B. and Blumstein, S.E. (2005). Selectional restriction and semantic priming effects in normals and Broca's aphasics. *Journal of Neurolinguistics* 18(3), 277-296.

PEER REVIEWED CONFERENCE PROCEEDINGS

Feldman, N, **Myers, E**, White, K, Griffiths, T, and J Morgan (2011). Learners Use Word-Level Statistics in Phonetic Category Acquisition. *Proceedings of the 35th annual Boston University Conference on Language Development,* Cascadilla Press.

Theodore, R. M., **Myers, E. B**., & Lomibao, J. (2013). Listeners' sensitivity to talker differences in voice-onset-time: Phonetic boundaries and internal category structure. *Proceedings of Meetings on Acoustics.*

CONFERENCE PRESENTATIONS

*Mozeiko, J., **Myers, E**., and Coelho, C. (2013) Neurobiological change following intensive therapy for chronic mild aphasia: An fMRI study. Presented at the November 2013 meeting of the Society for the Neurobiology of Language.

Castelluccio, B., Schuh, J., **Myers, E.**, and Eigsti, I-M. (2013) Neural substrates of affective language processing: an event-related fMRI study. Presented at the November 2013 meeting of the Society for the Neurobiology of Language.

Myers, E.B., **Mesite, L., *Johns, A., and Magnuson, J. (2013). How the brain process talker variability: The role of expectation. Presented at the November 2013 meeting of the Society for the Neurobiology of Language.

*Earle, S., and **Myers E.** (2013). The effect of sleep on learned sensitivity to a non-native phonetic contrast. Paper presented at the December 2013 meeting of the Acoustical Society of America.

*Xie, Xin, and **Myers, E.B**. (2013) The role of language and musical experience in talker identification: investigating the language familiarity effect. Presented at the 2013 meeting of AmLAP.

Theodore, R. M., **Myers, E. B**., & Lomibao, J. (2013). Accommodating talker-specific phonetic detail: Influences on internal category structure. Presented at the 35th annual conference of the Cognitive Science Society, Berlin, Germany.

Theodore, R. M., **Myers, E. B**., & Lomibao, J. (2013). Listeners' sensitivity to talker differences in voice-onset-time: Phonetic boundaries and internal category structure. Presented at the 21st International Congress on Acoustics, Montreal, Canada.

Mesite, L, *Del Tufo, S, and **Myers, E, (2013). Neural correlates of intensive non-native phonetic category training. Meeting of the 20th Annual Cognitive Neuroscience Society.

*Del Tufo, S. **Mesite, L, and **Myers, E**. (2013). Structural plasticity resulting from phonetic category training. Meeting of the 20th Annual Cognitive Neuroscience Society.

Myers, E, & **L. Mesite. (2012). Neural systems underlying lexically-biased perceptual learning in speech." Paper presented at the Neurobiology of Language Meeting, San Sebastian, Spain.

*Mozeiko, J.,Coelho, C.A., & **Myers, E.** (June,2011). A comparison of intensity dosage for Constraint Induced Language Therapy. Poster presented at the 42nd Annual Clinical Aphasiology Conference, Fort Lauderdale, FL.

Feldman, N, **Myers, E,** White, K, Griffiths, T, and J. Morgan (2010) Infants and adults use word-level statistics in phonetic category acquisition. *Presented at the Boston University Conference on Language Development, Boston, MA.*

Myers, E.B., and **K. Swan (2010). Emerging categorical perception of non-native speech sounds: Behavioral and neural effects of categorization training. Poster presented at the Neurobiology of Language conference, San Diego, CA.

Myers, E.B. (2009). Statistical Cues to Phonetic Category Structure. *Poster presented at the Cognitive Neuroscience Society meeting, San Francisco, CA.*

Grindrod, C. M., Blumstein, S.E., **Myers, E.B**., & Bilenko, N.Y. (2006). An event-related fMRI study of competition in selecting among semantically ambiguous word meanings. *Poster presented at the Cognitive Neuroscience Society, San Francisco, CA.*

Myers, E.B. and Blumstein, S.E. (2005). Neuroimaging evidence for effects of lexical status on phonetic categorization. *Poster presented at the 12th annual meeting of the Cognitive Neuroscience Society, New York, NY.*

Prabhakaran, R., Blumstein, S.E., **Myers, E.B**., and Hutchison, E. An event-related fMRI investigation of phonological-lexical competition. Brain and Language, 91 (2004) 194-194. *Paper presented at the meeting of the Academy of Aphasia, Chicago, IL.*

Myers, E.B. and Blumstein, S.E. (2004). The Perception of Voice-Onset Time: An fMRI Investigation of Phonetic Category Structure. *Poster presented at the 11th annual meeting of the Cognitive Neuroscience Society, San Francisco, CA.*

Myers, E.B., Zosh, W.D., Eliassen, J.C., & Sanes, J.N. (2003). Cross-modal modulation of human extrastriate visual cortex by concrete words. *Paper presented at the 33rd Annual Meeting of the Society for Neuroscience, New Orleans, LA.*

Teaching and Mentorship Experience

PhD Advisor:

Alexis Johns, Psychology, UConn (admitted, 2010)
Xin Xie, Psychology, UConn (admitted, 2009)
Sayako Earle, Speech, Language and Hearing Sciences, UConn (admitted, 2010)
Iliana Meza-Gonzalez, Psychology, UConn (admitted 2013)

PhD Committee Member:

Stephen Tobin (PSYCH)
Jennifer Mozeiko (SLHS)
Karen Le (SLHS)
Vanessa Harwood (SLHS)
Dana Arthur (SLHS)
Stephanie Del Tufo (PSYCH)
Elizabeth Tyler (SLHS)

Courses Taught:

Undergraduate:

Foundations In Cognitive Science (COGS 2201)
Introduction to Phonetic Principles (CDIS 3247)

Graduate:

Advanced Speech Science II: Speech Perception (CDIS 5362)
Topics in Speech and Hearing Science (CDIS 6367)

Invited Talks

University of Maryland, Linguistics Department Colloquium	10/11/13
Northwestern University, Linguistics Department Colloquium	6/14/13
New York University, Communicative Disorders Colloquium	4/29/11
Columbia University, University Seminar on Language &Cognition	1/20/11
University of Connecticut, Department of Psychology	5/22/09
Indiana University, Speech and Hearing Sciences	4/30/08
Sackler Institute, Weill Medical College of Cornell University	3/27/08
Tufts University, Psychology Department	2/6/08
University of Cincinnati, Communication Sciences	2/4/08
University of Kansas, Speech-Language-Hearing Sciences	1/31/08
Haskins Laboratories	11/8/07
University of Connecticut, Department of Psychology	9/24/07
University of California, San Diego, Department of Linguistics	2/23/07
MIT, Speech Group	11/1/06
Brown University, Cognitive and Linguistic Sciences Colloquium	4/7/03

Professional Affiliations and Service

Academy of Aphasia

Cognitive Neuroscience Society
Society for the Neurobiology of Language

Ad hoc grant reviewer: *NSF Cognitive Neuroscience Program, American Speech and Hearing Foundation*

Ad hoc journal reviewer: *Cerebral Cortex, Neuroscience, Human Brain Mapping, NeuroImage, Journal of Cognitive Neuroscience, Brain and Language, Journal of Speech, Language, and Hearing Research, Frontiers in Perception Science, Cognitive Neuropsychology, American Journal of Speech-Language Pathology, Psychological Science, International Journal of Language and Communication Disorders*

JAMES STEPHEN MAGNUSON

Curriculum Vitae

Department of Psychology
University of Connecticut
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Storrs, CT 06269-1020

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Research interests

Psycholinguistics (word recognition, sentence processing, speech perception), vision (visuo-spatial working memory, eye movements and object recognition), learning, representation (integration of internal representations with environmental context), probability matching, computational modeling.

Teaching interests

Psycholinguistics, cognitive science, sensation and perception, judgment and decision making, connectionist modeling, simulation and modeling, laboratory methods, neurobiology of language, behavior genetics of language

Education and academic positions

2008-present	Associate Professor	University of Connecticut, Department of Psychology
2004-2008	Assistant Professor	University of Connecticut, Department of Psychology
2004-present	Senior Research Scientist	Haskins Laboratories, New Haven, CT
2001-2004	Assistant Professor	Columbia University, Department of Psychology
2001	Ph.D.	University of Rochester, Brain and Cognitive Sciences Advisors: Michael Tanenhaus and Richard Aslin
2000	M.A.	University of Rochester, Brain and Cognitive Sciences
1993-1995	Intern researcher	Advanced Telecommunications Research Human Information Processing Laboratories, Kyoto, Japan
1993	B.A., with honors	University of Chicago, Linguistics
1988	French proficiency certificate	Université de Caen/Centre d'Etudes Franco-Americain, France

Fellowships and grants

2013-2017	National Institute of Child Health and Human Development	*Individual Differences in Learning Potential for Language and Literacy* (Haskins Labs, D. Braze, PI). Role: Subcontract PI. Subcontract total costs: $349,000.
2012-2017	National Science Foundation	*IGERT: Language plasticity – Genes, brain, cognition, and computation.* Role: PI. Total costs: $3,000,000.
2012-2017	National Institute of Child Health and Human Development	*Nature and acquisition of the speech code and reading* (Program Project Grant; J. Rueckl, PI), awarded to Haskins Laboratories. Total costs: $7,230,266. Project Leader, .
2010-2015	National Institute on Deafness & Other Communication Disorders	*Dynamics of Spoken Word Comprehension in Aphasia* (to Moss Rehabilitation Research Institute, D. Mirman, PI). Role: Subcontract PI. Total subcontract costs: $420,000.
2010-2015	National Institute on Deafness & Other Communication Disorders	*Emergence, structure and neurobiological bases of typical and atypical language.* Role: Co-PI (D. Lillo-Martin, PI). Total costs: $1,300,000.
2010	UConn VP for Research and Research Advisory Council	*Equipment for PSERL (Psychology Electrophysiology Shared Resource Laboratory).* $80,305
2010	UConn Research Foundation	*Phoneme Transposition Effects in Spoken Word Perception.* Role: Co-PI (J. Rueckl, PI). $22,800.
2009	UConn Research Foundation	*Evaluating effects of neurofeedback on cognitive processing.* Total costs: $12,647
2008-2013	National Science Foundation	*CAREER: The time course of bottom-up and top-down integration in language understanding.* Total costs: $400,000.
2007-2010	National Science Foundation	*Compensation for coarticulation: Implications for the basis and architecture of speech perception* (PI; co-investigators: C. Fowler, N. Viswanathan). Total costs: $271,779.
2007-2012	National Institute of Child Health and Human Development	*Nature and acquisition of the speech code and reading* (Program Project Grant; C. A. Fowler, PI), awarded to Haskins

		Laboratories. Total costs: $5,000,000. Investigator, 2 projects.
2006-2011	National Institute of Child Health and Human Development	*Neuro-behavioral mechanisms in reading comprehension* (D. Shankweiler, P.I.), awarded to Haskins Laboratories. Total costs: $2,000,000.
2004	UConn Research Foundation	*Is the language processing system interactive? An ERP approach.* Total costs: $12,000
2003	National Institute on Deafness & Other Communication Disorders	Supplement to R01 DC05765 to promote software and database development. Total costs: $50,000
2002-2007	National Institute on Deafness & Other Communication Disorders	R01 DC05765, *The Auditory Lexicon: Similarity, Learning and Processing*. Total costs: $1,185,000.
1998-2000	Sproull Fellowship	University of Rochester
1995-1998	Graduate Research Fellowship	National Science Foundation

Awards

2004	American Psychological Association	Division of Experimental Psychology Young Investigator Award in Experimental Psychology: General (for Magnuson et al., 2003)

Teaching experience

2013	*IGERT Foundations 1: Genes, Brain, and Cognition*
2007, 2010	*Cognition (367)*. Graduate seminar on cognitive psychology
2006, 2009, 2013	*Time course methods*. Graduate seminar on eye tracking and ERP
2006, 2008	*The mental lexicon*. Graduate seminar
2005, 2006, 2009-2011	*Cognitive Psychology, Psychology 2501*
2005-2008	*Principles of Research in Psychology, Psychology 202QW*, U CT, lecture + lab, 3 sections
2004	*Experimental Psychology: Human Behavior*. Undergraduate lab and research methods course, Columbia University
2003	*Dept. of Psychology Honors Seminar*: Columbia seminar for psychology and neuroscience majors, guiding them through 2 years of supervised research and an honors thesis
2001, 2002	*Language & Cognition Seminar*. Graduate seminar, Columbia University
2002, 2003	*Models of Cognition:* Graduate/advanced undergraduate seminar on connectionism and other modeling paradigms, Columbia University
2002	*Cognition*. Large undergraduate lecture course, Columbia University
2002	American Psychological Association Science Directorate Summer Science Institute: Short course on psycholinguistics

Selected external professional activities

2013-2015	College of Reviewers	National Science Foundation (Perception, Action, & Cognition)
2012-2013	Ad-hoc member	NIH Language & Communication study section
2009-2012	Associate Editor	Journal of Memory and Language
2008-2012	Associate Editor	Cognitive Science
2008-present	Editorial board	Cognition
2006-2008	Board of reviewers	Cognitive Science
2007, 2008	Program Committee	Annual Meeting of the Cognitive Science Society
2006	Scientific committee	Architectures and Mechanisms of Language Processing (AMLaP conference)
1998-present	Ad-hoc reviewer	

Funding agencies: *National Science Foundation, National Institutes of Health, Scottish Rite Charitable Foundation, Netherlands Organization for Scientific Research*

Academic journals: *Acta Psychologica, Brain and Language, Behavior Research Methods, Cerebral Cortex,* *Cognition, Cognitive Psychology, Cognitive Science, Connection Science, Discourse Processes, Experimental Brain Research, Journal of the Acoustical Society of America, Journal of Cognitive Neuroscience, Journal of Experimental Psychology: Human Perception and Performance, Journal of Experimental Psychology: Learning, Memory & Cognition, Journal of Memory and Language, Journal of Speech, Language, & Hearing Research, Language & Cognitive Processes, Language & Speech, Memory & Cognition, PLoSONE, Proceedings of the National Academy of Science, Perception & Psychophysics, Quarterly Journal of Experimental Psychology, Social Neuroscience*

Conferences: *Annual Meeting of the Cognitive Science Society, CUNY Sentence Processing Conference, Architectures and Mechanisms of Language Processing*

2000	Co-editor	University of Rochester Working Papers in Language Sciences
1998	Organizing Committee	1st Annual North East Cognitive Science Society meeting

Internal service activities

2008-present	Computer Committee	UConn Department of Psychology
2006-2011	Vision Committee	UConn Department of Psychology
2005-2012	Web committee *(chair)* and webmaster	UConn Psychology
2001-2003	Columbia University Dept. of Psychology	Computer committee Graduate admissions committee Liaison to fMRI center at Columbia Health Sciences Campus
1995-1996	Co-founder, organizing committee	University of Rochester, Brain and Cognitive Sciences weekly lunch talk series

Professional affiliations

Association for Psychological Science
Cognitive Science Society
Psychonomic Society

Dissertation

Magnuson, J. S. (2001). *The Microstructure of Spoken Word Recognition.* Unpublished doctoral thesis, University of Rochester Department of Brain and Cognitive Sciences.

Submitted manuscripts

1. Magnuson, J. S. (under revision). Comment on: "Laminar cortical dynamics of conscious speech perception: Neural model of phonemic restoration using subsequent context in noise" [J. Acoust. Soc. Am. 130, 440-460 (2011)] (L). *Journal of the Acoustical Society of America.*
2. Viswanathan, N., Magnuson, J. S., & Fowler, C. A. (under revision). Information for coarticulation: Static signal properties or formant dynamics?
3. Collisson, B. A., Grela, B., Spaulding, T., Rueckl, J. G., & Magnuson, J. S. (submitted). Individual differences in the shape bias in preschool children with specific language impairment and typical language development: Theoretical and clinical implications.
4. Kornilov, S., Landi, N., Rakhlin, N., Fang, S., Grigorenko, E. L. & Magnuson, J. S. (submitted). Attentional but not pre-attentive neural measures of discrimination are atypical in children with developmental language disorder.
5. Sadat, J., Martin, C. D., Magnuson, J. S., Alario, F.-X. & Costa, A. (submitted). Breaking down the bilingual cost in speech production.

Publications

1. Britt, A. E., Mirman, D., Kornilov, S. A., & Magnuson, J. S. (in press). Effect of repetition proportion on language-driven anticipatory eye movements. *Acta Psychologica.*
2. Scarf, D., Terrace, H., Colombo, M., & Magnuson, J. S. (under revision). Eye movements reveal planning in humans: A comparison with Scarf and Colombo's (2009) monkeys. *Journal of Experimental Psychology: Animal Behavior Processes.*
3. Hannagan, T., Magnuson, J. S. & Grainger, J. (2013). Spoken word recognition without a TRACE. *Frontiers in Psychology, 4:563.* doi:10.3389/fpsyg.2013.00563.
4. Viswanathan, N., Magnuson, J. S., & Fowler, C. A. (2013). Similar response patterns do not imply identical origins: An energetic masking account of nonspeech effects in compensation for coarticulation. *Journal of Experimental Psychology: Human Perception & Performance, 39,* 1181-92. doi: 10.1037/a0030735.
5. Magnuson, J. (2013). Frequency effects in word recognition. In H. Pashler (Ed.), Encyclopedia of the mind. (Vol. 6, pp. 367-369). Thousand Oaks, CA: SAGE Publications, Inc. doi: 10.4135/9781452257044.n135
6. Eigsti, I. M., & Magnuson, J.S. (2013). *Psycholinguistics.* In F. Volkmar (Ed.), Encyclopedia of Autism Spectrum Disorders: Springer Reference (www.springerreference.com). Berlin Heidelberg: Springer-Verlag.
7. Magnuson, J. S., Mirman, D., & Myers, E. (2013). Spoken word recognition. In D. Reisberg (Ed.), *The Oxford Handbook of Cognitive Psychology* (pp. 412-441). New York, USA: Oxford University Press.
8. Magnuson, J. S., Mirman, D., & Harris, H. D. (2012). Computational models of spoken word recognition. In M. Spivey, K. McRae, & M. Joanisse (Eds.), *The Cambridge Handbook of Psycholinguistics* (pp. 76-103). Cambridge University Press.
9. Fowler, C. A., & Magnuson, J. S. (2012). Speech perception. In M. Spivey, K. McRae, & M. Joanisse (Eds.), The

Cambridge Handbook of Psycholinguistics (pp. 3-25). Cambridge University Press.

10. Mirman, D., Yee, E., Blumstein, S., & Magnuson, J.S. (2011). Theories of spoken word recognition deficits in aphasia: Evidence from eye-tracking and computational modeling. *Brain & Language, 117*, 53-68.
11. Katz, L., Brancazio, L, Irwin, J., Katz, S., Magnuson, J., Scarborough, H. & Whalen, D. (2011) What Lexical Decision and Naming Tell Us About Reading. *Reading and Writing, 25*, 1259-1282. *DOI 10.1007/s11145-011-9316-9.*
12. Magnuson, J. S., Kukona, A., Braze, B., Johns. C.L., Van Dyke, J., Tabor, W., Mencl, E., Pugh, K.R., & Shankweiler, D. (2011). Phonological instability in young adult poor readers: Time course measures and computational modeling. In P. McCardle, B. Miller, J.R. Lee, & O. Tseng, *Dyslexia Across Languages: Orthography and the Brain-Gene-Behavior Link*, pp. 184-201. Baltimore: Paul Brookes Publishing.
13. Kukona, A., Fang, S., Aicher, K. A., Chen, H., & Magnuson, J. S. (2011). The time course of anticipatory constraint integration. *Cognition, 119*, 23-42.
14. Braze, D., Mencl, E., Tabor, W., Pugh, K. R., Constable, R. T., Fulbright, R. K., Magnuson, J. S., Van Dyke, J. A., & Shankweiler, D. P. (2011). Unification of sentence processing via ear and eye: An fMRI study. *Cortex, 47*, 416-431.
15. Viswanathan, N., Magnuson, J. S., & Fowler, C. A. (2010). Compensation for coarticulation: Disentangling auditory and gestural theories of perception of coarticulatory effects in speech. *Journal of Experimental Psychology: Human Perception and Performance, 36*, 1005-1015.
16. Mirman, D., Graf Estes, K., & Magnuson, J.S. (2010). Computational modeling of statistical learning: Effects of transitional probability versus frequency and links to word learning. *Infancy, 15*, 471-486.
17. Mirman, D., Strauss, T.J., Dixon, J.A., & Magnuson, J.S. (2010). Effect of representational distance between meanings on recognition of ambiguous spoken words. *Cognitive Science, 34*, 161-173.
18. Stephen, D. G., Mirman, D., Magnuson, J. S., & Dixon, J. A. (2009). Levy-like diffusion in eye movements during spoken-language comprehension. *Physical Review E, 79*, 056114.
19. Stephen, D. G., Boncoddo, R. A., Magnuson, J. S., & Dixon, J. A. (2009). The dynamics of insight: Mathematical discovery as a phase transition. *Memory & Cognition, 37*, 1132-1149.
20. Mirman, D. & Magnuson, J.S. (2009a). The effect of frequency of shared features on judgments of semantic similarity. *Psychonomic Bulletin & Review, 16(4)*, 671-677.
21. Mirman, D. & Magnuson, J.S. (2009b). Dynamics of activation of semantically similar concepts during spoken word recognition. *Memory & Cognition, 37*, 1026-1039.
22. Viswanathan, N., Fowler, C. A., & Magnuson, J. S. (2009). A critical examination of the spectral contrast account of compensation for coarticulation. Psychonomic Bulletin and Review, 16, 74-79.
23. Magnuson, J.S., Tanenhaus, M.K., & Aslin, R.N. (2008). Immediate effects of form-class constraints on spoken word recognition. Cognition, 108(3), 866-873.
24. Mirman, D., Magnuson, J.S., Graf Estes, K., and Dixon, J.A. (2008). The link between statistical segmentation and word learning in adults. Cognition, 108(1), 271-280.
25. Mirman, D., Dixon, J. A., & Magnuson, J. S. (2008). Statistical and computational models of the visual world paradigm: Growth curves and individual differences. Journal of Memory & Language, 59(4), 475-494.
26. Mirman, D., McClelland, J.L., Holt, L.L., and Magnuson, J.S. (2008). Effects of attention on the strength of lexical influences on speech perception: Behavioral experiments and computational mechanisms. Cognitive Science, 32, 398-417.
27. Mirman, D. & Magnuson, J.S. (2008). Attractor dynamics and semantic neighborhood density: Processing is slowed by near neighbors and speeded by distant neighbors. Journal of Experimental Psychology: Learning, Memory & Cognition, 34, 65-79.
28. Magnuson, J. S. (2008). Nondeterminism, pleiotropy, and single word reading: Theoretical and practical concerns. In E. Grigorenko & A. Naples (Eds.), Single Word Reading, pp. 377-404. Mahweh, NJ: Erlbaum.
29. Magnuson, J. S., Dixon, J., Tanenhaus, M. K., & Aslin, R. N. (2007). The dynamics of lexical competition during spoken word recognition. Cognitive Science, 31, 133-156.
30. Magnuson, J. S., & Nusbaum, H. C. (2007). Acoustic differences, listener expectations, and the perceptual accommodation of talker variability. Journal of Experimental Psychology: Human Perception and Performance, 33, 391-409.
31. Strauss, T. J., Harris, H. D., & Magnuson, J. S. (2007). jTRACE : A reimplementation and extension of the TRACE model of speech perception and spoken word recognition. Behavior Research Methods, 39, 19-30.
32. Dahan, D., & Magnuson, J. S. (2006). Spoken-word recognition. In M. J. Traxler & M. A. Gernsbacher (Eds.), Handbook of Psycholinguistics (pp. 249-283). Amsterdam: Academic Press.
33. Magnuson, J. S. (2005). Moving hand reveals dynamics of thought. Proceedings of the National Academy of Sciences (PNAS), 102(29), 9995 - 9996.
34. Chambers, C. G., Tanenhaus, M. K., & Magnuson, J. S. (2004). Actions and affordances in syntactic ambiguity resolution. Journal of Experimental Psychology: Learning, Memory, & Cognition, 30, 687-696.
35. Magnuson, J. S., Tanenhaus, M. K., Aslin, R. N., and Dahan, D. (2003). The time course of spoken word recognition and learning: Studies with artificial lexicons. Journal of Experimental Psychology:General, 132(2), 202-227.
36. Magnuson, J. S., McMurray, B., Tanenhaus, M. K., and Aslin, R. N. (2003). Lexical effects on compensation for coarticulation: A tale of two systems? Cognitive Science, 27, 795-799.
37. Magnuson, J. S., McMurray, B., Tanenhaus, M. K., and Aslin, R. N. (2003). Lexical effects on compensation for coarticulation: The ghost of Christmash past. Cognitive Science, 27, 285-298.
38. Dahan, D., Magnuson, J. S., Tanenhaus, M. K., and Hogan, E. M. (2001). Tracking the time course of subcategorical mismatches: Evidence for lexical competition. Language and Cognitive Processes, 16 (5/6), 507-534.
39. Dahan, D., Magnuson, J. S., and Tanenhaus, M. K. (2001). Time course of frequency effects in spoken-word recognition: Evidence from eye movements. Cognitive Psychology, 42, 317-367.
40. Hayhoe, M., Karn, K., Magnuson, J. & Mruczek, R. (2001). Spatial representations across fixations for saccadic targeting.

Psychologica Belgica, 41, 55-74.
41. Dahan, D., Swingley, D., Tanenhaus, M. K., and Magnuson, J. S. (2000). Linguistic gender and spoken word recognition in French. Journal of Memory and Language, 42, 465-480.
42. Tanenhaus, M. K., Magnuson, J. S., Dahan, D. & Chambers, C. (2000). Eye movements and lexical access in spoken-language comprehension: Evaluating a linking hypothesis between fixations and linguistic processing. Journal of Psycholinguistic Research, 29, 557-580.
43. Tanenhaus, M. K., Magnuson, J. S., McMurray, B., Aslin, R. N. (2000). No compelling evidence against feedback in spoken word recognition. Behavioral and Brain Sciences, 23, 348.
44. Allopenna, P. D., Magnuson, J. S., and Tanenhaus, M. K. (1998). Tracking the time course of spoken word recognition using eye movements: Evidence for continuous mapping models. Journal of Memory and Language, 38, 419-439.
45. Nusbaum, H. C., and Magnuson, J. S. (1997). Talker normalization: Phonetic constancy as a cognitive process. In K. Johnson and J. W. Mullennix (Eds.), Talker Variability in Speech Processing, pp. 109 - 132. Academic Press.

Technical reports and working papers

1. Magnuson, J. S., Dahan, D., & Tanenhaus, M. K. (2001). On the interpretation of computational models: The case of TRACE. In J. S. Magnuson and K.M. Crosswhite (Eds.), *University of Rochester Working Papers in the Language Sciences, 2 (1)*, 71 - 91.

2. Magnuson, J. S., Tanenhaus, M. K., & Aslin, R. N. (2000). Simple recurrent networks and competition effects in spoken word recognition. *University of Rochester Working Papers in the Language Science, 1*, 56-71.

3. Magnuson, J. S. (1995.7.25). Simulating probability matching in groups of foraging animals: A comparison of representational and nonrepresentational models. *ATR Human Information Processing Research Laboratories Technical Report TR-H-160.*

4. Magnuson, J. S., & Yamada, R. A. (1995.7.25). The effects of talker variability on the perception of American English /r/ and /l/ by Japanese listeners, II: Subject differences, acoustic and temporal correlates of talker effects, and some technical considerations. *ATR Human Information Processing Research Laboratories Technical Report TR-H-161.*

5. Magnuson, J. S., Yamada, R. A., & Nusbaum, H. C. (1995.7.20). The effects of talker variability and familiarity on mora perception and talker identification. *ATR Human Information Processing Research Laboratories Technical Report TR-H-158.*

6. Magnuson, J. S., & Yamada, R. A. (1994.12.6). The effects of talker variability on the perception of American English /r/ and /l/ by Japanese listeners. *ATR Human Information Processing Research Laboratories Technical Report TR-H-110.*

Refereed or invited conference proceedings publications

1. Magnuson, J. S. (2011). Individual differences in learning artificial lexicons. Peer-reviewed symposium contribution, *Proceedings of the 17th Meeting of the European Society for Cognitive Psychology*, pp. 43-44.

2. Mirman, D., Magnuson, J.S , Strauss, T.J., & Dixon, J.A. (2008). Effect of global context on homophone ambiguity resolution. In B.C. Love, K. McRae, & V.M. Sloutsky (Eds.), *Proceedings of the 30th Annual Cognitive Science Society Meeting.* (pp. 663-668). Austin, TX: Cognitive Science Society.

3. Viswanathan, N., Magnuson, J. S., & Fowler, C. A. (2008). Compensation for Coarticulation may reflect gestural perception: Evidence from a critical examination of the effects of non-speech contexts on speech categorization. *Proceedings of the Eleventh Conference on Laboratory Phonology (LabPhon)*, Wellington, New Zealand, pp. 147-148.

4. Magnuson, J.S., Mirman, D., Strauss, T., Tabor, W., & Rodny, J. (2007). Why do neighbors speed visual word recognition but slow spoken word recognition? Proceedings of 13th Annual Conference on Architectures and Mechanisms for Language Processing (AMLAP), p. 37. (Talk).

5. Kukona, A., Fang, S. Y., Aicher, K., Chen, H. & Magnuson, J. S. (2007). Predictive constraints on sentence processing: Argument structure and semantic priming. *Proceedings of the 2007 CUNY Human Sentence Processing Conference, p. 27.* March, La Jolla, CA.

6. Magnuson, J. S., & Strauss, T. (2007). Do spoken words tell us how long they will be? *Proceedings of the 2007 CUNY Human Sentence Processing Conference, p. 113.* March, La Jolla, CA.

7. Mirman, D., Strauss, T., Magnuson, J. S., & Dixon, J. A. (2007). Integration of pragmatic context in homophone ambiguity resolution: Time course of activation of context appropriate and context inappropriate meanings5. *Proceedings of the 2007 CUNY Human Sentence Processing Conference, p. 114.* March, La Jolla, CA.

8. Salverda, A. P., Spivey, M. J., Magnuson, J. S., & Tanenhaus, M. K. (2007). Eye movements and hand movements as indices of lexical processing. *Proceedings of the 2007 CUNY Human Sentence Processing Conference, p. 169.* March, La Jolla, CA.

9. Mirman, D. & Magnuson, J. S. (2006). The impact of semantic neighborhood density on semantic access. *Proceedings of the Annual Meeting of the Cognitive Science Society,* 1823-1828.

10. Strauss, T. J., Mirman, D., & Magnuson, J. S. (2006). Speech perception: Linking computational models and human data (half-day tutorial). *Proceedings of the Annual Meeting of the Cognitive Science Society,* 2669.

11. Viswanathan, N., Magnuson, J. S., & Fowler, C. A. (2006). Disentangling gestural and auditory contrast accounts of

compensation for coarticulation. *Proceedings of the Ninth International Conference on Spoken Language Processing* (*Interspeech 2006 - ICSLP*), pp. 861-864.

12. Magnuson, J. S., Strauss, T. J., & Harris, H. D. (2005). Interaction in spoken word recognition models: Feedback helps. *Proceedings of the Annual Meeting of the Cognitive Science Society.*
13. Strauss, T. J., Magnuson, J. S., & Harris, H. D. (2005). JTRACE: A reimplementation and extension of the TRACE model of speech perception and spoken word recognition. *Proceedings of the Annual Meeting of the Cognitive Science Society.*
14. Magnuson, J. S., Strauss, T., & Harris, H. D. (2005). On the role of interaction in models of spoken word recognition: Feedback helps. *Proceedings of the 2005 CUNY Human Sentence Processing Conference*, A-19.
15. Harris, H. D., & Magnuson, J.S. (2004). A cross-disciplinary look at statistics and grounding in human lexical learning. In *Language Learning: An Interdisciplinary Perspective, Papers from the 2004 American Association for Artificial Intelligence Spring Symposium, Technical Report SS-04-05*, 28-31.
16. Magnuson, J.S., Tanenhaus, M. K. & Aslin, R. N. (2002). Immediate integration of syntactic and referential constraints on spoken word recognition. In the *Proceedings of the 24th Meeting of the Cognitive Science Society.*
17. Dahan, D., Magnuson, J. S., Tanenhaus, M. K., & Hogan E. M. (2000). Tracking the time course of subcategorical mismatches on lexical access: Evidence for lexical competition. In A. Cutler, J. M. McQueen, & R., Zondervan (Eds.), *Proceedings of the Workshop on Spoken Word Access Processes*, 67-70.
18. Tanenhaus, M. K., Magnuson, J. S., McMurray, B. M., & Aslin, R. A. (2000). Does lexical knowledge mediate perceptual effects of compensatory coarticulation? Evidence from research with an artificial lexicon. In A. Cutler, J. M. McQueen, & R., Zondervan (Eds.), *Proceedings of the Workshop on Spoken Word Access Processes*, 107-110.
19. Magnuson, J. S., Tanenhaus, M. K., Aslin, R. N., & Dahan, D. (1999). Spoken word recognition in the visual world paradigm reflects the structure of the entire lexicon. In M. Hahn & S. Stoness (Eds.), *Proceedings of the Twenty First Annual Conference of the Cognitive Science Society*, pp. 331-336. Mahwah, NJ: Erlbaum.
20. Magnuson, J. S., Bensinger, D. G, Hayhoe, M., & Ballard, D. (1998). Learning to form visual chunks: On the structure of visuo-spatial working memory. In Gernsbacher, M. A., & Derry, S. J. (Eds.), *Proceedings of the Twentieth Annual Conference of the Cognitive Science Society*, 645-650. Mahwah, NJ: Erlbaum.
21. Magnuson, J. S., Dahan, D., Allopenna, P. D., Tanenhaus, M. K., & Aslin, R. N. (1998). Using an artificial lexicon and eye movements to examine the development and microstructure of lexical dynamics. In Gernsbacher, M. A., & Derry, S. J. (Eds.), *Proceedings of the Twentieth Annual Conference of the Cognitive Science Society*, 651-656. Mahwah, NJ: Erlbaum.
22. Allopenna, P. D., Magnuson, J. S., & Tanenhaus, M. K. (1997a). Tracking the time course of lexical activation in continuous speech. *Proceedings of the Nineteenth Annual Conference of the Cognitive Science Society*, 7 - 12. Mahwah, NJ: Erlbaum.
23. Magnuson, J. S. (1997). Does complex behavior require complex representations? *Proceedings of the Nineteenth Annual Conference of the Cognitive Science Society*, 472 - 477. Mahwah, NJ: Erlbaum.
24. Magnuson, J. S., & Yamada, R. A. (1996). The effects of talker variability on the perception of English /r/ and /l/ by Japanese listeners: Subject differences and acoustic correlates. *Proceedings of the 1996 International Conference on Spoken Language Processing (CD-ROM)*, SuP1P1.17/a022.pdf, 1-4.
25. Tanenhaus, M. K., Spivey-Knowlton, M. K., Eberhard, K. M. & Sedivy, J.C., Allopenna, P. D. & Magnuson, J. S. (l996). Eye-movements and spoken language comprehension. *Proceedings of the 34th Annual Meeting of the Association for Computational Linguistics.*
26. Magnuson, J. S., & Yamada, R. A. (1995). The effects of talker variability on the acquisition of non-native speech contrasts. *Proceedings of the 1995 International Congress of Phonetic Sciences*, 306-309.
27. Magnuson, J. S., Yamada, R. A., & Nusbaum, H. C. (1995). The effects of familiarity with a voice on speech perception. *Proceedings of the 1995 Spring Meeting of the Acoustical Society of Japan*, 391-392.
28. Magnuson, J. S., Yamada, R. A., Tohkura, Y., Bradlow, A., Lively, S., & Pisoni, D. B. (1995). The role of talker variability in non-native phoneme training. *Proceedings of the 1995 Spring Meeting of the Acoustical Society of Japan*, 393-394.
29. Magnuson, J. S. & Nusbaum, H. C. (1994). Some acoustic and non-acoustic conditions that produce talker normalization. *Proceedings of the 1994 Spring Meeting of the Acoustical Society of Japan*, 637-638.
30. Magnuson, J. S. & Yamada, R. A. (1994a). Effect of talker variability on the identification of American English /r/ and /l/ by Japanese listeners. *Proceedings of the 1994 Spring Meeting of the Acoustical Society of Japan*, 357-358.
31. Magnuson, J. S., & Yamada, R. A. (1994b). The effects of talker variability on the perception of American English /r/ and /l/ by Japanese subjects: Normalization or criteria setting? *Proceedings of the 1994 Fall Meeting of the Acoustical Society of Japan*, 413-414.
32. Magnuson, J. S., Yamada, R. A., & Nusbaum, H. C. (1994a). Variability in familiar and novel talkers: Effects on mora

perception and talker identification. *September 1994 meeting of the Acoustical Society of Japan Technical Committee on Psychological and Physiological Acoustics, Kanazawa, Japan, H-94-44*, 1-8.

33. Magnuson, J. S., Yamada, R. A., & Nusbaum, H. C. (1994b). Are representations available for talker identification available for talker normalization? *Proceedings of the 1994 International Conference on Spoken Language Processing*, 1175-1179.

34. Yamada, R. A., Strange, W., Magnuson, J. S., Pruitt, J. S., Clarke, W. D. III. (1994a). The intelligibility of Japanese speakers' productions of American English /r/, /l/ and /w/, as evaluated by native speakers of American English. *Proceedings of the 1994 International Conference on Spoken Language Processing*, 2023-2026.

35. Yamada, R. A., Strange, W., Magnuson, J. S., Pruitt, J. S., Clarke, W. D. III. (1994b). Production and perception of American English /r/, /l/ and /w/ by native speakers of Japanese: The effects of immersion in an American English speaking environment. *Proceedings of the 1994 Fall Meeting of the Acoustical Society of Japan*, 411-412.

Other conference presentations

1. Collison, B., Grela, B., Spaulding, T., Rueckl, J., & Magnuson, J. S. (2013, July). Individual differences in shape bias are predicted by non-linguistic perceptual ability. Proceedings of the 35th Annual Meeting of the Cognitive Science Society, 3910.

2. Johns, A., van der Lely, H., & Manuson, J. S. (2013, July). Early Event-Related Potentials (ERPs) sensitive to animacy expectations in sentence comprehension are not overridden by context. Proceedings of the 35th Annual Meeting of the Cognitive Science Society, 3992.

3. Johns, A., van der Lely, H., & Magnuson, J. S. (2013, April). Structure-driven expectations for animacy drive early left event-related potential negativities that are not overridden by contextual expectations. Poster presented at the 20th Annual Meeting of the Cognitive Neuroscience Society, San Franciso, CA.

4. Sadat, J., Martin, C.D., Magnuson, J., Alario, F.-X., & Costa, A. (2013, March). Breaking down the bilingual cost in speech production. Poster presented at the 11th International Symposium of Psycholinguistics, Tenerife, Canary Island, Spain.

5. Shaw, A., Demos, A. P., Arthur, D., & Magnuson, J. S. (2012, November). Individual differences in lexical quality of newly learned words. Poster presented at the Psychonomic Society, Minneapolis, MN.

6. Kornilov, S., Landi, N., Rakhlin, N., Grigorenko, E. L. & Magnuson, J. S. (2012, November). Atypical simple tone discrimination and processing in children with developmental language impairment. Poster presented at the Society for the Neurobiology of Language, San Sebastian, Spain.

7. Braze, D., Kukona, A., Tabor, W., Magnuson, J. S., Mencl, E., Kornilov, S., Van Dyke, J.A., Johns, C., & SHANKWEILLER, D. (2012, May). Individual differences in speech-drivengaze patterns in the visual world task. The Scandinavian Workshop on Applied Eye Tracking, Karolinska Institutet, Stockholm.

8. Braze, D., Kukona, A., Tabor, W., Magnuson, J. S., Mencl, W. E., Kornilov, S., et al. (2011). Variation in visual world performance is related to both verbal and visual memory. Palo Alto, CA: Poster presented at the 24th CUNY Conference on Human Sentence Processing.

9. Mirman, D., Kornilov, K., & Magnuson, J. S. (2011). Fluent speech, uncertainty, and spoken word recognition. Architectures and Mechanisms of Language Processing (AMLAP) 2011, Paris, France, 1-3 September.

10. Fang, S. (g), Li, J. & Magnuson, J. S. (March, 2010). Reconsidering ERP evidence for early syntactic encapsulation. Talk presented at the 23rd Annual CUNY Conference on Human Sentence Processing, New York, NY.

11. Fang, S. & Magnuson, J.S. (Nov., 2009). An electrophysiological study of temporal order and learning in speech perception. Poster presented at the 50th Annual Meeting of the Psychonomic Society, Boston, MA.

12. Li, J., Fang, S., & Magnuson, J.S. (Nov., 2009). An electrophysiological index of learned anomaly anticipation in reading. Poster presented at the 50th Annual Meeting of the Psychonomic Society, Boston, MA.

13. Viswanathan, N., Magnuson, J. S., & Fowler, C. A. (Nov., 2009). Effects of sine wave contexts on compensation for coarticulation. Poster presented at the 50th Annual Meeting of the Psychonomic Society, Boston, MA.

14. Fang, S. & Magnuson, J.S. (2008). Effects of unrelated distractor frequency in the visual world paradigm. Poster presented at the *49th Annual Meeting of the Psychonomic Society*, Chicago, USA.

15. Magnuson, J.S., Mirman, D., & Dixon, J. (2008). A statistical and computational modeling approach to group and individual differences in the time course of language processing. *Poster presented at the 21st Annual CUNY Conference on Human Sentence Processing*. Chapel Hill, NC.

16. Mirman, D. and Magnuson, J.S. (2008). Dynamics of activation of semantically similar concepts during spoken word recognition. Paper presented at the 49th Annual Meeting of the Psychonomic Society, Chicago, IL.

17. Mirman, D., Yee, E., Magnuson, J.S., & Blumstein, S. (2008). Statistical and computational investigations of the time course of spoken word recognition in aphasia. Poster presented at the *2008 Meeting of the Cognitive Neuroscience Society*, San Francisco, CA.

18. Viswanathan, N., Tobin, S. J., Magnuson, J. S., & Fowler, C. A. (2008). Motor compatibility effects on speech perception.

Poster presented at the 49th Annual meeting of the Psychonomic Society.

19. Kukona, A., Fang, S., Aicher, K., Chen, H., & Magnuson, J. S. (2007). Predictive constraints on sentence processing: Argument structure and semantic priming. Talk delivered at the *20th Annual CUNY Conference on Human Sentence Processing*, La Jolla, CA.
20. Magnuson, J. S., & Strauss, T. (2007). Do spoken words tell us how long they will be? Poster presented at the *20th Annual CUNY Conference on Human Sentence Processing*, La Jolla, CA.
21. Magnuson, J.S. & Mirman, D. (2007). Neighborhood effects in word recognition: It's not where you live, it's how you get home. Paper presented at the *48th Annual Meeting of the Psychonomic Society*, Long Beach, CA.
22. Magnuson, J.S., Mirman, D., & Strauss, T. (August, 2007). Why do neighbors speed visual word recognition but slow spoken word recognition? Paper presented at the 13th Annual Conference on Architectures and Mechanisms for Language Processing, Turku, Finland.
23. Mirman, D. & Magnuson, J.S. (2007). Attractor dynamics and semantic neighborhood density: Processing is slowed by near neighbors and speeded by distant neighbors. Paper presented at the 2nd UConn Workshop on Cognition and Dynamics, Storrs, CT.
24. Mirman, D., Magnuson, J.S., Graf Estes, K., & Dixon, J.A. (2007). Linking statistical learning to language processing. Invited paper presented at the Workshop on Current Issues in Language Acquisition: Artificial Languages and Statistical Learning, Calgary, Alberta, Canada.
25. Mirman, D., Magnuson, J.S., Strauss, T.J., & Dixon, J.A. (2007). The time course of pragmatic context integration in homophone ambiguity resolution. Poster presented at the *48th Annual Meeting of the Psychonomic Society*, Long Beach CA.
26. Mirman, D., Strauss, T., Magnuson, J.S., & Dixon, J.A. (2007). Integration of pragmatic context in homophone ambiguity resolution: Time course of activation of context-appropriate and context-inappropriate meanings. Poster presented at the *20th Annual CUNY Conference on Human Sentence Processing*, La Jolla, CA.
27. Salverda, A. P., Spivey, M., Magnuson, J.S., & Tanenhaus, M. K. (2007). Eye movements and hand movements as indices of lexical processing. Poster presented at the *20th Annual CUNY Conference on Human Sentence Processing*, La Jolla, CA.
28. Viswanathan, N., Magnuson, J.S., & Fowler, C.A. (2007, November). Effects of Nonspeech Contexts on Speech Categorization: A Critical Examination. Poster presented at the *48th Annual meeting of the Psychonomic Society*, Long Beach CA.
29. Dixon, J., & Magnuson, J. S., (2006, August). Growth curve analysis of eye tracking. UConn Workshop on Nonlinear Dynamics and Cognition (small workshop).
30. Magnuson, J. S., (2006, August). Time course measures? Comparing eye tracking, mouse tracking, and ERP. UConn Workshop on Nonlinear Dynamics and Cognition (small workshop).
31. Mirman, D. & Magnuson, J.S. (2006). Location, Location, Location: Contrasting Effects of Near and Distant Semantic Neighbors on Semantic Access. *Poster presented at the 47th Annual Meeting of the Psychonomic Societ*y, Houston, TX.
32. Strauss, T. J., Magnuson, J. S., & Harris, H. D. (2006). jTRACE: A user-friendly reimplementation and extension of the TRACE model of speech perception and spoken word recognition. *Journal of the Acoustical Society of America, 119 (5)*, 3245.
33. Viswanathan, N., Magnuson, J.S., & Fowler, C.A. (2006). Compensation for coarticulation : Three theories compared. *Journal of the Acoustical Society of America, 119 (5)*, 3241.
34. Viswanathan, N., Magnuson, J.S., & Fowler, C.A. (2006, November). Compensation for coarticulation : Comparing Contrast and Gestural theories. Poster presented at the 47th Annual meeting of the Psychonomic Society.
35. Harris, H. D. & Magnuson, J. S. (2004). Proper names, common nouns, and category learning. Poster presented at the Annual Meeting of the Psychonomic Society.
36. Magnuson, J.S., Tanenhaus, M. K. & Aslin, R. N. (2003). The time course of lexical competition in spoken word recognition. Abstracts of the Psychonomic Society: 44th Annual Meeting, 8, 96.
37. Magnuson, J. S., Tanenhaus, M. K., Aslin, R. N., & Dahan, D. (2001). Eye movements and artificial lexicons: A paradigm for measuring real-time language processing and evaluating models. Poster presented at the *14th Annual CUNY Conference on Human Sentence Processing*.
38. McMurray, B., Magnuson, J. S., Tanenhaus, M. K., & Aslin, R. N. (2001). Transitional probabilities and lexical status in spoken word recognition. Poster presented at the *14th Annual CUNY Conference on Human Sentence Processing*.
39. Chambers, C. G., Tanenhaus, M. K., & Magnuson, J. S. (2000). Interaction of referential context and real-world knowledge in syntactic ambiguity resolution. Paper presented at the Annual Meeting of the Linguistic Society of America, Chicago, IL.
40. Dahan, D., Magnuson, J. S., Tanenhaus, M. K., & Hogan E. (2000). Tracking the time course of subcategorical mismatches on lexical access**.** Poster presented at the annual meeting of the Psychonomic Society.

41. Chambers, C. G., Tanenhaus, M. K., & Magnuson, J. S. (1999). Real-world knowledge modulates referential effects on PP-attachment: Evidence from eye movements in spoken language comprehension. Paper presented at the Fifth Conference on Architectures and Mechanisms for Language Comprehension (AMLaP), Edinburgh, UK.
42. Magnuson, J. S., Dahan, D., Tanenhaus, M. K., & Aslin, R. N. (1999). A study of frequency and neighborhood effects on spoken word recognition using an artificial lexicon. Proceedings of the Twelfth Annual CUNY Conference on Human Sentence Processing, 98.
43. Magnuson, J. S., Tanenhaus, M. K., Aslin, R. N., & Dahan, D. (1999). Learning a novel lexicon: Effects of frequency, phonological overlap, and neighborhood density. Paper presented at the First Empire State Speech Conference, Binghamton, NY.
44. Magnuson, J. S., Tanenhaus, M. K., Aslin, R. N., & Dahan, D. (1999). The time course of spoken-word recognition: Measurements and models. Paper presented at the Fifth Conference on Architectures and Mechanisms for Language Comprehension (AMLaP), Edinburgh, UK.
45. Magnuson, J. S., Bensinger, D. G., Hayhoe, M. M., & Ballard (1998). Statistical regularities and task constraints in perceptual learning. *Proceedings of the Association for Research in Vision and Ophthalmology, Investigative Ophthalmology and Visual Science*, 39.
46. Magnuson, J. S., Dahan, D., Allopenna, P. D., Tanenhaus, M. K., & Aslin, R. N. (1998). The development and microstructure of lexical dynamics. Talk presented at the First Annual Meeting of the North East Cognitive Science Society, May, Cornell University, Ithaca, NY.
47. Allopenna, P. D., Magnuson, J. S., & Tanenhaus, M. K. (1997b). Tracking the time course of lexical access in spoken word recognition. Presented at the 38th meeting of the Psychonomic Society, November, 1997.
48. Allopenna, P. D., Magnuson, J. S., & Tanenhaus, M. K. (1997c). Speech in time primes rhymes: Using eye movements to track lexical access in continuous speech. Paper presented at the 10th Annual CUNY Conference on Human Sentence Processing, March 20 - 22, Santa Monica, CA.
49. Allopenna, P. D., Magnuson, J. S., & Tanenhaus, M. K. (1997d). Tracking the time course of lexical access in spoken word recognition. Architectures and Mechanisms for Language Processing (AMLaP), September 11-13, Edinburgh, Scotland.
50. Magnuson, J. S., Sagerer, G., Hayhoe, M. M., & Ballard, D. H. (1997). The role of fixations in task automatization. *Proceedings of the Association for Research in Vision and Ophthalmology, Investigative Ophthalmology and Visual Science*, 38(4), S963.
51. Pruitt, J. S., Magnuson, J. S., & Akahane-Yamada, R. (1997). The effects of "mixed" versus "blocked" talker conditions crosses linguistic and phonetic boundaries. *Proceedings of the 1997 Fall meeting of the Acoustical Society of Japan.*
52. Allopenna, P. D., Magnuson, J. S., & Tanenhaus, M. K. (1996). Watching spoken language perception: Using eye movements to track lexical access. In G. Cottrell (Ed.), Proceedings *of the Eighteenth Annual Conference of the Cognitive Science Society*, 723. Mahwah, NJ: Erlbaum.
53. Magnuson, J. S. (1996). Does probability matching require complex representations? In G. Cottrell (Ed.), Proceedings *of the Eighteenth Annual Conference of the Cognitive Science Society*, 799. Mahwah, NJ: Erlbaum.
54. Magnuson, J. S., Yamada, R. A., Tohkura, Y., & Bradlow, A. R. (1995). Testing the importance of talker variability in non-native speech contrast training. Paper presented at the 129th meeting of the Acoustical Society of America. *Journal of the Acoustical Society, 97(5)*, 3417.
55. Magnuson, J. S., & Yamada, R. A. (1994c). Talker variability and the identification of American English /r/ and /l/ by Japanese listeners. Paper presented at the 127th meeting of the Acoustical Society of America. *Journal of the Acoustical Society of America, 95*, 2872.
56. Magnuson, J. S. & Nusbaum, H. C. (1993). Talker differences and perceptual normalization. Paper presented at the 125th meeting of the Acoustical Society of America. *Journal of the Acoustical Society of America, 93*, 2371.

Invited talks

1. MAGNUSON, J. S. (May 11, 2013). ERP studies of children from a community with very high incidence of developmental language disorder. 2013 Symposium on L1 Reading Across Different Languages & L2 Literacy Acquisition. Zhongli City, Taiwan.
2. Magnuson, J. S. (2012, June). Without a TRACE: A time invariant string kernel model of spoken word recognition. Invited colloquium, University of Geneva, Switzerland.
3. Magnuson, J. S. (May 16, 2012). A new paradigm for studying lexical quality of newly learned words. Invited symposium talk, Second Language Acquisition: from Brain Plasticity to Cognition, Hebrew University, Jerusalem, Israel.
4. Magnuson, J. S. (2011, May). Without a TRACE: A time invariant string kernel model of spoken word recognition. Invited colloquium, University College, London.
5. Magnuson, J. S. (2011, April). Without a TRACE: A time invariant string kernel model of spoken word recognition. Invited colloquium, University of Edinburgh.
6. Magnuson, J. S. (2011, April). Without a TRACE: A time invariant string kernel model of spoken word recognition.

Invited colloquium, Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands.

7. Magnuson, J. S. (2011, November). An overview of current theories of spoken word recognition. Invited lecture, Aix-Marseille University, Marseille, France.
8. Magnuson, J. S. (2011, December). Computational models of spoken word recognition. Invited lecture, Aix-Marseille University, Marseille, France.
9. Magnuson, J. S. (2011, October). Computational implications of priming and expectation in sentence processing. Distinguished Speakers Series Colloquium, Department of Computational Linguistics and Phonetics, Saarland University, Saarbrucken, Germany.
10. Magnuson, J. S. (2011, October). Neighborhood dynamics in spoken word recognition. Department of Computational Linguistics and Phonetics, Saarland University, Saarbrucken, Germany.
11. Magnuson, J. S. (2011, July). Neighborhood density and spoken word recognition: Qué pasa en Español? Basque Center on Cognition, Brain, and Language, San Sebastian/Donostia, Spain.
12. Magnuson, J. S. (2011, July). Anticipation is making me…? Expectations in sentence processing. Basque Center on Cognition, Brain, and Language, San Sebastian/Donostia, Spain.
13. Magnuson, J. S. (2011, March). Expectations, predictions, and priming in sentence processing. Northwestern University Department of Linguistics.
14. Magnuson, J. S. & Allopenna, P. D. (2011, February). Individual differences in lexical learning abilities for speech and print: implications for bilingual research. Neuro-cognitive determinants of second language literacy in young adults: A multilingual perspective, II, Chungli City, Taiwan.
15. Magnuson, J. S. (2011, February). Prediction, priming and computation in language understanding. University of Southern California, Department of Linguistics.
16. Magnuson, J. S. (2011, February). Prediction, priming and computation in language understanding. University of San Diego, Department of Cognitive Science.
17. Magnuson, J.S. (2010, October). Anticipation is making me look: Computational and empirical investigations of anticipation in sentence processing. Laboratoire de Psychologie Cognitive, Centre Nationale du Recherche Scientifique, Universite de Provence-Marseille.
18. Magnuson, J.S. (2010, September). The potential utility of dynamical measures of lexical processing and learning for the study of bilingualism. Workshop on neurobiological and cognitive determinants of second language literacy in young adults, Basque Center on Brain, Cognition, and Language, San Sebastian, Spain.
19. Magnuson, J. S. (2010, May). Phonological stability in poor readers. Talk presented at the Alvin and Isabelle Liberman Memorial Workshop, Storrs, CT.
20. Magnuson, J.S. (2010, March). Models of language comprehension: Opportunities and challenges. Plenary talk given at Cognitive Aging, Atlanta, GA.
21. Magnuson, J.S., Kukona, A., Braze, D., Johns, C. L., Van Dyke, J. A., Tabor, W., Mencl, W. E., Pugh, . K. R., & Shankweiler, D. P. (2010, January). Phonological instability in young adult poor readers: Time course measures and computational modeling. Talk presented at The Dyslexia Foundation Extraordinary Brain Symposium, "Dyslexia across languages: Orthography and the gene-brain-behavior link," Taiwan.
22. Magnuson, J. S. (2010, January). An overview of computational modeling in psycholinguistics. Talk presented at the National Yang Ming University Conference on the Cognitive and Neurobiological Foundations of Bilingualism: Towards Multinational Research on Second Language Acquisition. Taipei, Taiwan.
23. Magnuson, J. S. (2007, June). The use of artificial lexicons to examine typical and atypical language processing and development. Workshop on Current issues in language acquisition: Artificial languages and statistical learning. University of Calgary, June 22-24.
24. Mirman, D., Magnuson, J.S., Graf Estes, K., & Dixon, J.A. (June, 2007). Linking statistical learning to language processing. Workshop on Current issues in language acquisition: Artificial languages and statistical learning. University of Calgary, June 22-24.
25. Magnuson, J. S., (2006, August). Time course measures? Comparing eye tracking, mouse tracking, and ERP. UConn Workshop on Nonlinear Dynamics and Cognition (small workshop).
26. Dixon, J., & Magnuson, J. S., (2006, August). Growth curve analysis of eye tracking. UConn Workshop on Nonlinear Dynamics and Cognition (small workshop).
27. Magnuson, J. S. (2006, June). Artificial language studies and the distinction between statistical and linguistic knowledge. Invited participant in a "fishbowl" session on statistical learning, International Society for Infant Studies, Kyoto, Japan (large international conference).
28. Magnuson, J. S., (2006, April). Dynamics of spoken word recognition. Colloquium, NYU Department of Psychology.
29. Magnuson, J. S., (2006, April). Bottom-up and top-down constraints on ambiguity. Invited talk, USC Department of Linguistics Workshop on Ambiguity. (Small workshop with 6 speakers from across the nation.)

30. Magnuson, J. S., (2006, April). Dynamics of spoken word learning and recognition. Brown University Department of Linguistic and Cognitive Sciences.
31. Magnuson, J. S., (2006, February). Similarity of spoken words: From signal to semantics. Invited talk, LOVE Conference, Niagara Falls, Ontario. (Regional conference [Northeastern USA, Southeastern Canada], 1 of 6 speakers.)
32. Magnuson, J. S., (2006, February). Dynamics of spoken word recognition. Colloquium, University of Western Ontario, Department of Psychology.
33. Magnuson, J. S., (2005, March). It's about time: Spoken word similarity is dynamic. Blumstein lab, Department of Linguistic and Cognitive Sciences, Brown University, Providence, RI.
34. Magnuson, J. S., (2005, April). The static lexicon? Talk given as part of a workshop on the Dynamics of the Lexicon, Center for the Ecological Study of Perception and Action, University of Connecticut, Storrs.
35. Magnuson, J. S. (2004, March). University of California, Berkeley, Department of Linguistics.
36. Magnuson, J. S. (2004, March). University at Buffalo, Department of Psychology.
37. Magnuson, J. S. (2004, March). University of Toronto-Mississaugua, Psychology, 29 January, 2004
38. Magnuson, J. S. (2004, January). Carnegie Mellon University, Department of Psychology.
39. Magnuson, J. S. (2004, January). Carnegie Mellon University, Cognitive Area.
40. Magnuson, J. S. (2004, January). University of Denver, Department of Psychology.
41. Magnuson, J. S. (2001, February). Annual meeting of the American Association for the Advancement of Science (AAAS), Symposium on "Eye Movements: Eye Movements and Spoken Language." "Time, eye movements, and computational models of spoken language understanding."
42. Magnuson, J. S. (2001, December). Sackler Center for Developmental Psychobiology, Cornell University Medical Center, New York City. "The Structure and Development of Spoken Word Recognition."
43. Magnuson, J. S. (2001, June). Canadian Society for Brain, Behavior, and Cognitive Science (symposium on "Computational Models of Memory and Language"). "Modeling the time course of spoken word recognition."
44. Magnuson, J. S. (1997, September). University of New Mexico, Department of Linguistics. "Using eye movements to track the time course of lexical access in continuous speech."
45. Magnuson, J. S. (1997, September). University of Glasgow, Department of Psychology. "Eye movements and competition effects in spoken-word recognition."

References

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EDUCATION

2001 Dual Ph.D. (Clinical Psychology and Brain and Cognitive Sciences), University of Rochester
Dissertation committee: Loisa Bennetto, Elissa Newport, Richard Aslin, Dante Cicchetti

2000 M.A. (Clinical Psychology), University of Rochester

1999 M.A. (Brain and Cognitive Sciences), University of Rochester

1993 A.B *cum laude* (Linguistics), University of Chicago

PROFESSIONAL EXPERIENCE

2011-present Associate Professor, Psychology, University of Connecticut (Clinical Division)

2004-2011 Assistant Professor, Psychology, University of Connecticut (Clinical Division)

2001- 2004 Post-doctoral Research Fellow in Pediatric Neuroimaging, Sackler Institute for Developmental Psychobiology, Columbia University

2000-2001 Clinical Psychology Internship (APA accredited), Department of Psychiatry (Child and Adolescent Division), University of Rochester School of Medicine

AFFILIATIONS

2013- Faculty Affiliate, Center on Postsecondary Education and Disability, Neag School of Education
2009- Research Scientist, Haskins Laboratories

AWARDS AND HONORS

2011 Fulbright Research Scholar Award, "*Embodied cognition: Insights from autism*."

Language Learning Dissertation Award, "*Word learning and memory functions in young children with autism*," April, 2000.

Society for a Science of Clinical Psychology Dissertation Award, "*Word learning and memory functions in autism*," December, 1999.

PUBLICATIONS (* indicates publications with graduate students)

1. IOrinstein, A., Helt, M., Troyb, E., Tyson, K. E., Barton, M. L., **Eigsti, I. M.,** . . . Fein, D. A. (revisions). Intervention history of children and adolescents with high-functioning autism and optimal outcomes. *Journal of Developmental and Behavioral Pediatrics*.
2. *Troyb, E., Rosenthal, M., **Eigsti, I. M**., Kelley, E., Tyson, K., Orinstein, A., . . . Fein, D. A. (in press). Executive functioning in children with ASDs who have achieved optimal outcomes. *Child Neuropsychology*.
3. **Eigsti, I. M.,** Rosset, D., Col Cozzari, G., Da Fonseca, D., & Deruelle, C. (revisions). Motor effects on affect and ideation in high-functioning autism and typical development. *Developmental Science*.
4. *Tyson, K. E., Kelley, E., Fein, D. A., Orinstein, A., Troyb, E., Barton, M., **Eigsti, I.M**., . . . Rosenthal, M. (revisions). Language and verbal memory in individuals with a history of ASD who achieve optimal outcomes. *Journal of Autism and Developmental Disorders*.
5. *Schuh, J. M., Mirman, D., & **Eigsti, I. M**. (under review). Finding common ground: Developmental aspects of working memory influence perspective taking in children and adults. *Developmental Psychology*.
6. *Suh, J., **Eigsti, I. M.**, Naigles, L. R., M., B., Kelley, E., & Fein, D. A. (in press). Narrative abilities of optimal outcome children and adolescents with a previous history of an Autism Spectrum Disorder (ASD). *Journal of Autism and Developmental Disorders*.
7. *Troyb, E., Orinstein, A., Tyson, K., Helt, M., **Eigsti, I.M**., Stevens, M.L., & Fein, D.A. (in press). Academic abilities in children and adolescents with a history of Autism Spectrum Disorders who have achieved optimal outcomes. *Autism*.

8. **Eigsti, I. M.,** & Fein, D.A. (revisions). Dual task performance in children with high functioning autism. *Cognitive Neuropsychology*.
9. *Tyson, K. E., Kelley, E., Fein, D., Orinstein, A., Troyb, E., Barton, M., **Eigsti, I.M**., et al. (in press). Language and verbal memory in individuals with a history of ASD who achieve optimal outcomes. *Journal of Autism and Developmental Disorders*.
10. **Eigsti, I.M.,** & Fein, D.A. (2013). More is less: Pitch discrimination and language delays in children with optimal outcomes from autism. *Autism Research*. E-pub ahead of print.
11. **Eigsti, I. M.** (2013). A review of embodiment in autism spectrum disorders. *Frontiers in Psychology, 4* (Special topic: The role of body and environment in cognition). Retrieved from doi:doi: 10.3389/fpsyg.2013.00224
12. *Mayo, J., Chlebowski, C., Fein, D.A., & **Eigsti, I. M.** (2013). Age of first words predicts cognitive ability and adaptive skills in children with ASD. *Journal of Autism and Developmental Disorders, 43*(2), 253-264. doi: 10.1007/s10803-012-1558-0
13. Fein, D.A., Barton, M., **Eigsti, I. M.,** Kelley, E., Naigles, L.R., Schultz, R.T., . . . Tyson, K. (2013). Optimal outcome in individuals with a history of autism. *Journal of Child Psychiatry and Psychology, 52*(2), 195-205. doi: 10.1111/jcpp.12037.
14. *Schuh, J.M., & **Eigsti, I. M.** (2012). Working memory, language skills, and autism symptomatology. *Behavioral Sciences, 2*, 207-218. Retrieved from doi:10.3390/bs2040207
15. *Mayo, J., & **Eigsti, I.M**. (2012). A comparison of statistical learning in school-aged children with high functioning autism and typically developing peers *Journal of Autism and Developmental Disorders, 42*, 2476-85.
16. *Bean, J. L., & **Eigsti, I. M.** (2012). Assessment of joint attention in school-age children and adolescents. *Research in Autism Spectrum Disorders, 6*, 1304-1310. doi: 10.1016/j.rasd.2012.04.003
17. ***Eigsti, I.M.**, Schuh, J.M., Mencl, E., Schultz, R.T., & Paul, R. (2012). The neural underpinnings of prosody in autism. *Child Neuropsychology, 18*, 600-17.
18. Masino, S.M., Kawamura, M., Jr., Plotkin, L.M., Svedova, J., DiMario, F.J., Jr., & **Eigsti, I.M.** (2011). The relationship between the neuromodulator adenosine and behavioral symptoms of autism. *Neuroscience Letters, 500*(1), 1-5. doi: 10.1016/j.neulet.2011.06.007
19. ***Eigsti, I. M.,** Weitzman, C., Schuh, J. M., de Marchena, A., & Casey, B. J. (2011). Language and cognitive outcomes in internationally adopted children. *Development and Psychopathology, 23*, 629-646.
20. *de Marchena, A., **Eigsti, I. M**., Worek, A., Ono, K. E., & Snedeker, J. (2011). Mutual exclusivity in autism spectrum disorders: Testing the pragmatic hypothesis. *Cognition. 119*, 96-113.
21. ***Eigsti, I. M.,** de Marchena, A. B., Schuh, J. M., & Kelley, E. (2011). Language acquisition in autism spectrum disorders: A developmental review. *Research in Autism Spectrum Disorders, 5*, 681-691.
22. *Helt, M. S., **Eigsti, I. M.**, Snyder, P. J., & Fein, D. A. (2010). Contagious yawning in autistic and typical development. *Child Development, 81*(5), 1620-1631.
23. Tottenham, N., Hare, T. A., Quinn, B. T., McCarry, T. W., Nurse, M., Gilhooly, T., Milner, A., Galvan, A. Davidson, M. C., **Eigsti, I. M**., Thomas, K. M., Freed, P. J., Booma, E. S., Gunnar, M. R., Altemus, M., Aronson, J., Casey, B. J. (2010). Prolonged institutional rearing is associated with atypically larger amygdala volume and difficulties in emotion regulation. *Developmental Science*, 13(1), 46-61.
24. *Brynskov, C., & **Eigsti, I. M**. (2010). Det tidlige sprog hos børn med autisme – en udviklingsmæssigt afgørende faktor [The critical influence of early language abilities in autism on longterm outcomes]. *Psyke & Logos, 31*, 443-460.
25. *de Marchena, A., & **Eigsti, I. M**. (2010). Conversational gestures in autism spectrum disorders: Asynchrony but not decreased frequency. *Autism Research, 3*, 311-322.
26. Fifer, W. P., Byrd, D. L., Kaku, M., **Eigsti, I. M.,** Isler, J. R., Grose-Fifer, J., et al. (2010). Newborn infants learn during sleep. *Proceedings of the National Academy of Sciences of the United States of America, 107*, 10320-10323.
27. **Eigsti, I. M.,** & Bennetto, L. (2009). Grammaticality judgments in autism spectrum disorders: Deviance or delay. *Journal of Child Language, 19*, 1-23.
28. ***Eigsti, I. M.,** & Schuh, J. M. (2008). Neurobiological underpinnings of language in autism spectrum disorders. *Annual Review of Applied Linguistics, 28*, 128-149.
29. **Eigsti, I. M.,** Bennetto, L., & Dadlani, M. B. (2007). Beyond pragmatics: Morphosyntactic development in autism. *Journal of Autism and Developmental Disorders, 37*(6), 1007-1023.
30. **Eigsti, I. M.,** Zayas, V., Mischel, W., Shoda, Y., Ayduk, O., Dadlani, M. B., et al. (2006). Predicting cognitive control from preschool to late adolescence and young adulthood. *Psychological Science, 17*(6), 478-484.
31. **Eigsti, I. M**., & Cicchetti, D. (2004). The impact of child maltreatment on expressive syntax at 60 months. *Developmental Science, 7*(1), 88-102.
32. **Eigsti, I. M.,** & Shapiro, T. (2003). A systems neuroscience approach to autism: Biological, cognitive and clinical perspectives. *Mental Retardation and Developmental Disabilities Research Reviews, 9*, 205-215.
33. Durston, S., Tottenham, N. T., Thomas, K. M., Davidson, M. C., **Eigsti, I. M.,** Yang, Y., et al. (2003). Differential patterns of striatal activation in young children with or without ADHD. *Biological Psychiatry, 53*, 871-878.
34. Hudson, C. L., & **Eigsti, I. M.** (2003). Lexical competency, the overt expression of grammatical structure, and contrasts between pidgins and creoles. *Journal of Pidgin and Creole Languages 18*(1), 1-79.

35. Vatikiotis-Bateson, E., **Eigsti, I. M.,** Yano, S., & Munhall, K. G. (1998). Eye movements during audiovisual speech perception. *Perception and Psychophysics, 60*(6), 926-940.

CHAPTERS AND BOOKS (* indicates publications with graduate students)

1. Masino, S.A., Svedova, J., Kawamura, M., Jr., Jonas, D., DiMario, Jr., F.D., & **Eigsti, I.M**. (in press). Adenosine and autism. In *Autism, Book 2*, ISBN 978-953-307-493-1. InTech Open Access Publishing.
2. **Eigsti, I.M**. (2013). Theories of Language Development. In F. Volkmar (Ed.), Encyclopedia of Autism Spectrum Disorders: SpringerReference (www.springerreference.com). Berlin Heidelberg: Springer-Verlag. doi: DOI: 10.1007/SpringerReference_334364 2012-12-12 14:37:57 UTC.
3. **Eigsti, I. M.** (2013). Peabody Picture Vocabulary Test. In F. Volkmar (Ed.), *Encyclopedia of Autism Spectrum Disorders: SpringerReference (www.springerreference.com).* Berlin Heidelberg: Springer-Verlag. doi: DOI: 10.1007/SpringerReference_334358 2012-12-12 14:37:52 UTC
4. **Eigsti, I. M.,** & Magnuson, J.S. (2013). Psycholinguistics. In F. Volkmar (Ed.), *Encyclopedia of Autism Spectrum Disorders: SpringerReference (www.springerreference.com)*. Berlin Heidelberg: Springer-Verlag. doi: DOI: 10.1007/SpringerReference_344131 2013-03-12 15:00:22 UTC
5. Svedova, J., **Eigsti, I. M.,** & Masino, S. M. (2012). Adenosine and autism: Physiological symptoms and metabolic opportunities. In S. M. Masino & D. Boison (Eds.), *Adenosine: A key link between metabolism and central nervous system activity* (Chap. 24). New York: Springer.
6. **Eigsti, I.M.** (2011). Executive functions. In D. Fein (Ed.), *Neuropsychology of Autism* (pp. 185-204). New York: Oxford University Press.
7. ***Eigsti, I.M.**, & Mayo, J. (2011). Implicit learning in ASD. In D. Fein (Ed.), *Neuropsychology of Autism* (pp. 267-80). New York: Oxford University Press.
8. **Eigsti, I. M**. (2009)**.** *Syntax and working memory in preschool children with autism***.** Köln, Germany: Lambert Academic Publishing (92 pgs).
9. Casey, B.J., Durston, S., Tottenham, N., Spicer, J, **Eigsti, I. M**., Galvan, A., (2008). Disruption of frontostriatal circuitry, dopamine and cognitive control in ADHD. In D. M. Barch (Ed.), *Handbook of Cognitive and Affective Neuroscience of Psychopathology*: Oxford University Press.
10. **Eigsti, I.M.** (2006). Child Maltreatment: Effects on Grammatical and Lexical Aspects of Language Acquisition. In S.M. Sturt (Ed.), *New Developments in Child Abuse Research* (pp. 1-19). Haupage, NY: Nova Science Publishers.

CURRENT GRANTS

2012-2017 National Science Foundation (1144399), "*IGERT: Language plasticity Genes, Brain, Cognition and Computation*." Role: Investigator (J. Magnuson, PI). Total Direct Costs: $3,000,000.

2010-2012 National Institute on Deafness and Other Communication Disorders (ARRA P30 DC010751-01), "*Emergence, structure and neurobiological bases of typical and atypical language*." Role: Investigator (D. Lillo-Martin, PI). Total Direct Costs: $999,211

(under review) *"Sexual literacy and behavior change in young adults with developmental disability."*

(To be resubmitted, February 2014) National Institute on Deafness and Other Communication Disorders (1R01DC012337-01), *"Impact of gestures on cognition and communication in autism spectrum disorders."*

PREVIOUS GRANTS

2010 UConn VP for Research and Research Advisory Council, "*Electrophysiology Share Resource Laboratory*." Role: Co-I (J. Magnuson, PI). Total Direct Costs: $80,305

2006-2010 National Institute on Deafness and Other Communication Disorders (R01 MH076189-01A1), "*Language Functioning in Optimal Outcome Children with a History of Autism*." Role: Co-I (D. Fein, PI). Total Direct Costs: $1,506,782

2006-2010 National Institutes of Mental Health (Program Project HD003008-38), "*Autism and related disorders: Development and outcome*." Project 3, "*Social Communication*." Role: Co-I (F. Volkmar, PI; R Paul, Project 3 PI). Total Direct Costs (UConn Subcontract): $106,353

2009 UConn Research Foundation (458938), "*A gesture towards learning: Communicative gesture and mental representation in autism*." Role: PI. $22,651

2007 UConn Research Foundation (449255), "*Drenched in love: International adoption and language development*." Role: PI. $18,000

2005 UConn Research Foundation (449446762255), "*Syntactic development and implicit learning in autism spectrum disorder*s." Role: PI. $23,000

2003-2005 National Alliance for Research on Schizophrenia and Depression Young Investigator Award, "*Joint attention and core attentional mechanisms in ASD*. " Role: PI. Total Costs: $120,000

2003-2004 National Institutes of Mental Health Small Business Initiatives Research (R03 N43MH32087), "*CaseIQ-ASD: Ratings Scale Toolkit for ASD Clinical Research*." Role: Consultant (25% time). Total Costs: $100,000

2003-2008 National Institutes of Mental Health Postdoctoral research training grant (T32 MH018264), "*Training for MD and PhDs in Psychobiology*." Role: Fellow. Direct Costs for Project: $250,000

2000-2001 National Institutes of Mental Health Dissertation Research Grant in Developmental Psychopathology (R03 MH61032), "*Word learning and memory functions in young children with autism*." Role: PI. Total Costs: $21,892

GRADUATE STUDENT GRANTS/FELLOWSHIPS SPONSORED

2012 University of Connecticut Outstanding Scholars Program Fellowship, awarded to Brian Castelluccio, B.A. Role: Advisor. Three years of graduate support.

2010 Council for International Exchange of Scholars U.S. Student Fulbright Award, "*Implicit perspective taking in children with autism spectrum disorders*." Awarded to Ashley de Marchena, M.A. Role: Advisor. $37,000

2010 Millon Dissertation Scholarship, "*Executive and communicative contributions to pragmatic language in autism spectrum disorder*." Awarded to Ashley de Marchena, M.A. $1500

2009 Millon Dissertation Scholarship, "*Pragmatic language: Working memory influences on mutual information in autism spectrum disorders*." Awarded to Jillian Schuh, M.A. $1500

RESEARCH INTERESTS

Psycholinguistics in autism spectrum disorders (acquisition of language, conversational gestures, discourse and executive processes, prosody, implicit learning, optimal outcomes in ASD), psycholinguistics in international adoption, functional magnetic resonance imaging (MRI)

TEACHING INTERESTS

Language acquisition, autism, cognitive neuroscience, developmental psychopathology

TEACHING EXPERIENCE (UNIVERSITY OF CONNECTICUT)

2004-2012 *Abnormal Psychology*. Large (250 enrollments) undergraduate lecture course

2008, 2009, 2011, 2013 *Autism and Developmental Disorders*. Small advanced undergraduate seminar incorporating both didactic and clinical components

2007, 2010 *Language Acquisition and Cognitive Development in Language Pathologies*, co-taught with L. Naigles. Graduate seminar on atypical language acquisition

2010, 2012, 2013 *Cognitive Assessment*. Graduate practicum course including supervised assessment experiences

2005, 2007 *Child Psychopathology*. Graduate seminar on developmental psychopathology

PROFESSIONAL SERVICE

2012- Editorial Board Member, *Development and Psychopathology*
2007-2012 Consulting Editor, *Neuropsychology*

2010, 2013 Ad-hoc panel member *National Institutes of Health Study Section, Child Psychopathology and Development Disabilities*

1999-present Ad Hoc Reviewer
Funding agencies: *Autism Speaks-UK*; *National Science Foundation; National Institutes of Mental Health America Recovery and Reinvestment Act; Research Grant Council of Hong Kong; Swiss National Science Foundation; Netherlands Organisation for Scientific Research, Division of Social Sciences*

Academic journals: *Autism; Cerebral Cortex; Child Development; Cortex; Development and Psychopathology; Developmental Psychobiology; Developmental Science; International Journal of Language and Communication Research; Journal of Autism and Developmental Disorders; Journal of Child Psychology and Psychiatry; Journal of Neurodevelopmental Disorders; Pediatric Research; Proceedings of the National Academy of Sciences*.

Conferences: *Society for Research in Child Development, Boston University Conference on Language Development, Cognitive Science Society, International Meeting for Autism Research*

PROFESSIONAL AFFILIATIONS

Elected member, *Psychonomics Society*
Member, *American Psychological Association; Association for Psychological Science; Cognitive Science Society; International Society for Autism Research; Society for Research in Child Development*

UNIVERSITY SERVICE

2013	Member, Clinical Division Faculty Search Committee
2013	Member, CLAS Academic Planning Committee
2012	Member, fMRI Acquisition Committee
2012	Member, Cognitive Science Faculty Search Committee (3 positions)
2011	Member, Clinical Neuropsychology Faculty Search Committee
2005-present	Organizer, *Graduate Seminar in Clinical Research*, professional development and visiting speaker presentation series
2007-present	Cognitive Science Steering Committee. Organizer: Colloquium Series.
2005-2010	Faculty Advisor, Mortarboard Honor Society
2005-2006	Departmental Web Committee

REFEREED OR INVITED CONFERENCE PROCEEDINGS PUBLICATIONS (* indicates publications with graduate students)

1. Schuh, J. M., **Eigsti, I. M.,** Evans, J., Pollak, S. D., & Miller, J. F. (2008). *Is exposure enough? Narrative development in internationally adopted children.* Proceedings of the *Boston University Conference on Language Development, 2*, 438-449.
1. Vatikiotis-Bateson, E., Munhall, K. G., Garcia, F., & **Eigsti, I. M.** (1996). Characterizing audiovisual information during speech. *Proceedings of the International Conference on Spoken Language Processing, 1*, 175-177.
2. Vatikiotis-Bateson, E., **Eigsti, I. M.,** & Yano, S. (1994). Listener eye movement behavior during audiovisual perception. *Proceedings of the International Conference on Spoken Language Processing, 2*, 527-530.
3. **Eigsti, I. M.,** Vatikiotis-Bateson, E., & Yano, S. (1994). Contrasts in listener eye movements during audiovisual perception with stimuli differing in size. *Proceedings of the Acoustical Society of Japan, October*, 481-482.

OTHER CONFERENCE PRESENTATIONS (* indicates presentations with graduate students)

1. Bean, J., Casares, J., & Eigsti, I.M. (2010, May). *A novel measure of joint attention for use with older children and adolescents: evidence for clinical utility and external validity*. Paper presented at the International Meeting for Autism Research (IMFAR-10).
2. Bean, J., & Eigsti, I.M. (2009, May). *Validity and reliability of a new measure of joint attention in school-age children and adolescents*. Paper presented at the International Meeting for Autism Research (IMFAR-09).
3. Bean, J., & Eigsti, I.M. (2010, June). *Joint attention and ToM*. Paper presented at the American Academy of Clinical Neuropsychology.
4. Bean, J.L., & Eigsti, I.M. (2008, August). *Differential influences of specific aspects of institutional life on cognitive and language development: A study of international adoption*. Paper presented at the American Academy of Clinical Neuropsychology.
5. de Marchena, A., & Eigsti, I.M. (2008, May). *Timing and communicative quality of gestures in adolescents with high-functioning autism*. Paper presented at the International Meeting for Autism Research (IMFAR-08).
6. de Marchena, A., & Eigsti, I.M. (2009, April). *Speech and gestures in autism: Quantifying asynchrony*. Paper presented at

the Society for Research in Child Development.
7. de Marchena, A., & Eigsti, I.M. (2009, May). *Relative contributions of speech and gesture on the ADOS "demonstration task" in adolescents with high-functioning autism*. Paper presented at the International Meeting for Autism Research (IMFAR-09).
8. de Marchena, A., & Eigsti, I.M. (2010, May). *Adolescents with ASD and TD show equivalent patterns of gesture use during lexical retrieval*. Paper presented at the International Meeting for Autism Research (IMFAR-10).
9. de Marchena, A., Worek, A., Ono, K., Eigsti, I.M., & Snedeker, J. (2008, November). *Mutual exclusivity in autism spectrum disorders: Testing the pragmatic hypothesis*. Paper presented at the Boston University Conference on Language Development.
10. de Marchena, A., Worek, A., Ono, K., Eigsti, I.M., & Snedeker, J. (2009, April). *Mutual exclusivity in autism spectrum disorders*. Paper presented at the Society for Research in Child Development.
11. Dombrowski, C.V., de Marchena, A.B., & Eigsti, I.M. (2010, May). *Gesture as a methodological tool? Adolescents with ASD use their hands to explain balance*. Paper presented at the International Meeting for Autism Research (IMFAR-10).
12. Eigsti, I.M. (1995, January). *Listener eye movements in multimodal communication*. Paper presented at the ATR International Symposium on Face and Object Recognition '95.
13. Eigsti, I.M. (2007, April). *Symposium chair: Longitudinal and Cross-Domain Studies of Executive Function*. Paper presented at the Society for Research in Child Development.
14. Eigsti, I.M. (2009, April). *Symposium Chair: Making the mental visible: Co-Speech gestures in autism spectrum disorders*. Paper presented at the Society for Research in Child Development.
15. Eigsti, I.M. (2010, January). *Symposium chair, "From genes to brains to language: Verbal and non-verbal communication in autism"*. Paper presented at the Winter Conference on Developmental Psychobiology.
16. Eigsti, I.M., & Bennetto, L. (2001, April). *Working memory and distraction in young children with autism*. Paper presented at the Society for Research in Child Development.
17. Eigsti, I.M., & Bennetto, L. (2001, November). *Syntactic and memory functions in young children with autism*. Paper presented at the International Society for Developmental Psychobiology.
18. Eigsti, I.M., & Cicchetti, D. (1999, April). *Language development in maltreated children*. Paper presented at the Society for Research in Child Development.
19. Eigsti, I.M., Dixon, J., de Marchena, A., Helt, M., & Sullivan, R. (2010, May). *Dynamical systems analysis of hand movement organization in autism: Movement structure is associated with problem-solving and symptom severity*. Paper presented at the International Meeting for Autism Research (IMFAR-10).
20. Eigsti, I.M., & Fang, S.Y. (2006, August). *Implicit learning and lexical development*. Paper presented at the Cognitive Science Society.
21. Eigsti, I.M., & Hudson, C. (1999, April). *Short-term language creation: Interdependence of grammatical structure and the lexicon*. Paper presented at the Society for Research in Child Development.
22. Eigsti, I.M., Markoff, K.S., Rosenthal, M., Helt, M.S., & Fein, D. (2008, May). *Dual task performance in children and adults with autism*. Paper presented at the International Meeting for Autism Research (IMFAR-08).
23. Eigsti, I.M., Munhall, K.G., Yano, S., & Vatikiotis-Bateson, E. (1995, August). *Effects of listener expectation on eye movement behavior during audiovisual perception*. Paper presented at the International Congress of Phonetic Sciences.
24. Eigsti, I.M., Munson, S.F., Tottenham, N., Thomas, K.M., Durston, S., & Casey, B.J. (2002, March). *Neural and behavioral correlates of institutionalization*. Paper presented at the Cognitive Neuroscience Society.
25. Eigsti, I.M., Newport, E.L., Aslin, R.N., Nordeen, E., Williams, H., & Nordeen, K. (1998, November). *Creolization in zebra finch song: Improving on the input?* Paper presented at the Boston University Conference on Language Development.
26. Eigsti, I.M., Schuh, J.M., Mencl, E., Schulz, R., & Paul, R. (2009, May). *Neural underpinnings of prosody processing in autism*. Paper presented at the International Meeting for Autism Research (IMFAR-09).
27. Eigsti, I.M., Tottenham, N., Davidson, M.L., Galvan, A., Hare, T., & Casey, B.J. (2004, June). *Joint attention and core attentional mechanisms in autism spectrum disorders*. Paper presented at the Human Brain Mapping.
28. Eigsti, I.M., Tyson, K., Troyb, E., Rosenthal, M., Helt, M., & Fein, D. (2009, May). *Tone discrimination in adolescents who have lost their autism diagnosis: Low-level auditory perceptual abilities*. Paper presented at the International Meeting for Autism Research (IMFAR-09).
29. Eigsti, I.M., Weitzman, C., & Mayo, J. (2009, March). *Language acquisition in international adoptees: Influences of explicit but not implicit learning* Paper presented at the Georgetown University Roundtable (GURT).
30. Eigsti, I.M., Zayas, V., Mischel, W., Shoda, Y., & Casey, B.J. (2006, November). *Delay of gratification and cognitive control*. Paper presented at the Psychonomics Society.
31. Fein, D., Barton, M., Eigsti, I.M., Naigles, L., Rosenthal, M., Tyson, K., et al. (2009, May). *Cognitive and behavioral profiles of children who recover from autism (oral presentation)*. Paper presented at the International Meeting for Autism Research (IMFAR-09).
32. Helt, M.S., Eigsti, I.M., Dumont-Mathieu, T., Barton, M.L., Troyb, E., Tyson, K., et al. (2010, May). *Differences in early symptom presentation between children with a history of autism who achieve an "optimal outcome," and children*

with persisting autism. Paper presented at the International Meeting for Autism Research (IMFAR-10).

33. Helt, M.S., Markoff, K.S., Eigsti, I.M., Snyder, P.J., & Fein, D.A. (2008, February). *Are children with autism susceptible to contagious yawning?* Paper presented at the International Neuropsychological Society.
34. Hudson, C.L., & Eigsti, I.M. (2001, January). *Lexical fluency, the overt expression of grammatical structure, and the differences between pidgins and creoles*. Paper presented at the Society for Pidgin and Creole Linguistics.
35. Masino, S.M., Kawamura, M., Jr., Svedova, J., Plotkin, L.M., DiMario, F.J., Jr., & Eigsti, I.M. (2010, May). *Exploring the relationship between the neuromodulator adenosine and behavioral symptoms of autism*. Paper presented at the International Meeting for Autism Research (IMFAR-10).
36. Mayo, J., & Eigsti, I.M. (2010, May). *Statistical word learning in children with ASD*. Paper presented at the International Meeting for Autism Research (IMFAR-10).
37. McCullough, K.E., Pedelty, L., & Eigsti, I.M. (1993, May). *Left hemisphere phenomena in language and gesture*. Paper presented at the Theoretical and Experimental Neuropsychology.
38. Mossler, D., Britner, P.A., Eigsti, I.M., Joseph, T., & Weitzman, C.C. (2008, March). *Disturbances in attachment in a sample of internationally adopted children*. Paper presented at the Eastern Psychological Association.
39. Mossler, D., Eigsti, I.M., Britner, P.A., Joseph, T., & Weitzman, C.C. (2008, May). *Severity of deprivation predicts developmental outcomes in internationally adopted children*. Paper presented at the Association for Psychological Science.
40. Naigles, L., Helt, M., Rosenthal, M., Troyb, E., Tyson, K., Eigsti, I.M., et al. (2009, May). *Defining category abilities and challenges in adolescents with autism vs. those with optimal outcomes*. Paper presented at the International Meeting for Autism Research (IMFAR-09).
41. Orinstein, A., Tyson, K., Troyb, E., Rosenthal, M., Helt, M., Eigsti, I.M., et al. (2010, May). *Sensory reactions in optimal outcome children with a history of autism spectrum disorders*. Paper presented at the International Meeting for Autism Research (IMFAR-10).
42. Pedelty, L., McCullough, K.E., & Eigsti, I.M. (1993, May). *Spatial characteristics of gesture in right hemisphere damaged speakers*. Paper presented at the Theoretical and Experimental Neuropsychology.
43. Rosenthal, M.A., Troyb, E., Helt, M., Tyson, K., Eigsti, I.M., & Fein, D. (2008, May). *Executive functioning in optimal outcome children*. Paper presented at the International Meeting For Autism Research (IMFAR-08).
44. Schuh, J.M., Eigsti, I.M., Evans, J., Pollak, S.D., & Miller, J.F. (2008). Is exposure enough? Narrative development in internationally adopted children. *Proceedings of the Boston University Conference on Language Development, 2*, 438-49.
45. Schuh, J.M., Eigsti, I.M., Evans, J., Pollak, S.D., & Miller, J.F. (2008, November). *Language in international adoption: exposure and individual differences.* Paper presented at the Boston University Conference on Language Development, Boston, MA.
46. Schuh, J.M., Eigsti, I.M., Mirman, D., & Gustafson, T. (2009, April). *Do you see what I see? The influence of working memory on shared knowledge in children and adults*. Paper presented at the Society for Research in Child Development.
47. Schuh, J.M., Mirman, D., & Eigsti, I.M. (2010, May). *Perspective taking abilities in children with autism: The influence of working memory and theory of mind on shared knowledge (oral presentation)*. Paper presented at the International Meeting for Autism Research (IMFAR-10).
48. Schuh, J.M., Mirman, D., Gustafson, T., & Eigsti, I.M. (2009, May). *Do you see what I see? The influence of working memory on shared knowledge in children with autism and typical development*. Paper presented at the International Meeting for Autism Research (IMFAR-09).
49. Schuh, J.M., Riegler, S., & Eigsti, I.M. (2008, August). *Narrative development in international adoption: Exposure and individual differences*. Paper presented at the American Academy of Clinical Neuropsychology.
50. Troyb, E., Rosenthal, M., Tyson, K., Helt, M., Naigles, L., Eigsti, I.M., et al. (2009, May). *Executive functioning in children with ASDs who have achieved optimal outcomes*. Paper presented at the International Meeting for Autism Research (IMFAR-09).
51. Troyb, E., Tyson, K., Rosenthal, M., Herlihy, L., Helt, M., Orinstein, A., et al. (2010, May). *Academic functioning in children with ASDs who have achieved optimal outcomes*. Paper presented at the International Meeting for Autism Research (IMFAR-10).
52. Tyson, K., Rosenthal, M.A., Helt, M., Troyb, E., Eigsti, I.M., Naigles, L., et al. (2008, May). *Do optimal outcome children exhibit residual language deficits?* Paper presented at the American Academy of Clinical Neuropsychology.
53. Tyson, K., Rosenthal, M.A., Helt, M., Troyb, E., Eigsti, I.M., Naigles, L., et al. (2008, May). *Verbal learning in optimal outcome children*. Paper presented at the International Meeting For Autism Research (IMFAR-08).
54. Tyson, K., Troyb, E., Rosenthal, M., Helt, M., Eigsti, I.M., Barton, M.L., et al. (2010, May). *Psychiatric Symptoms and Comorbidities in Children with a History of Autism who Achieve an "Optimal Outcome"*. Paper presented at the International Meeting for Autism Research (IMFAR-10).
55. Tyson, K., Troyb, E., Rosenthal, M., Helt, M., Eigsti, I.M., Naigles, L., et al. (2009, May). *Psychiatric disorders in optimal outcome children with a history of autism spectrum disorders*. Paper presented at the International Meeting for Autism Research (IMFAR-09).

INVITED TALKS

1. August, 2013. Language and Mind in Autism. *Society for Research in Child Language Disorders*. Keynote. Madison, WI.
2. July, 2013. Language and Mind in Autism. *International Congress of Linguists*. Geneva, Switzerland.
3. November, 2012. Implicit learning in autism: Implications for language acquisition. *American Speech Hearing and Language Association Annual Convention*. Atlanta, Georgia.
4. October, 2012. Understanding the cognitive and neural basis of developmental trajectories in delay of gratification. *Oesterreichische Forschungsgemeinschaft ceremony to honor Walter Mischel, Austrian Research Asssociation*. Vienna, Austria.
5. July, 2012. Language in autism spectrum disorders: From low-level discrimination high-level impairment. *Birkbeck College, University of London*, London, England.
6. June, 2012. Autism and language acquisition. *Basque Center on Cognition, Brain and Language*. San Sebastian, Spain.
7. May, 2012. Language in autism spectrum disorders: From low-level auditory discrimination and prosody to high-level gesture and embodiment. *City University Autism Lectures, City University London*, London, England.
8. October, 2011. Neural underpinnings of language in autism: Prosody, gesture, and embodiment. Colloquium presentation, *Laboratoire de Psychologie Cognitive, CNRS, Université de Provence*. Marseille, France.
9. March, 2011. Outgrowing Autism. *Spectrum of Developmental Disabilities Course, Johns Hopkins University*. Baltimore, Maryland.
10. May, 2010. Functional MRI of prosody in autism spectrum disorders. Colloquium, *Department of Psychology, Connecticut College*. New London, Connecticut.
11. May, 2010. Staying in the academic pipeline: Growing professionally in an economic drought. Paper presented at the *American Psychological Society*. Boston, MA.
12. January, 2010. Symposium chair: From genes to brains to language: Verbal and non-verbal communication in autism. Session presented at the *Winter Conference on Developmental Psychobiology*. Manzanillo, Mexico.
13. January, 2010. Functional brain imaging of prosody comprehension in autism. Paper presented at the *Winter Conference on Developmental Psychobiology*. Manzanillo, Mexico.
14. May, 2009. Staying in the academic pipeline: Growing professionally in an economic drought. Papesr presented at the *Psychonomics Society*. Boston, MA.
15. July, 2009. Dynamical contributions to conceptual change in autism: Gestures promote knowledge. Paper presented at the *Cognition & Dynamics IV*. Storrs, CT.
16. June, 2009. Theoretical perspectives on impairments in spoken language processing. Paper presented at the *Cognitive Science Society*. Amsterdam, The Netherlands.
17. May, 2009. Interactions among syntactic processes and implicit learning skills in ASD. Paper presented at *Innovative Research In Autism*. Tours, France.
18. May, 2008. Conversational gestures in autism spectrum disorders. Human Development, Brown University.
19. June, 2008. Brain and Language in Autism. *Psi Chi Induction Ceremony*, University of Connecticut.
20. May, 2007. What do teachers need to know about autism? A Symposium for Educators and Administrators, Leadership Greater Hartford.
21. May, 2006. International adoption: Language acquisition, learning mechanisms, and stress. Department of Psychology, Yale University.
22. April, 2005. International adoption: Language acquisition, learning mechanisms, and stress. Sackler Institute for Developmental Psychobiology, New York, NY.
23. May, 2004 . Overview of Autism Spectrum Disorders: Phenomenology, cognitive features, neuroanatomical, neurochemical, neurophysiological findings, theories, and clinical issues. Invited talk at *National Students of Speech, Language, Hearing Association*, Boston University.
24. June, 2004 . Brain imaging in ASD. ATR Human Information Sciences Laboratory. Kyoto, Japan.
25. February, 2003. Language acquisition and neurocognitive development. Colloquium, Columbia University, Department of Psychology.
26. 2003. University of California – Berkeley, Department of Psychology.
27. 2003. University of Denver, Department of Psychology.
28. 2003. Penn State University, Department of Psychology.
29. 2003. McGill University, Department of Educational and Counselling Psychology.
30. 2003. Queen's University, Department of Psychology.
31. 2003. Brooklyn College, Department of Psychology.
32. 2003. University of Connecticut, Department of Psychology.
33. 2003. University of Madison-Wisconsin. Department of Psychology, Department of Communication Disorders.
34. 2003. Barnard College, Department of Psychology.
35. 2002. New York University, Department of Psychology.

GRADUATE STUDENTS

Jillian Marie (DeGroot) Schuh, Ph.D. (matriculated 2005)
Dissertation (2010): Pragmatic Language: Working Memory Influences On Mutual Information In Autism Spectrum Disorders
M.A. Research (2008): Narrative Development In Internationally Adopted Children
Current position (through June 2011): Clinical Psychology Internship in Child Psychology (APA accredited), Department of Psychiatry, University of Chicago School of Medicine.
Anticipated position (July, 2011): Clinical and Research Post-Doctoral Fellow, Medical College of Wisconsin.

Ashley de Marchena, M.A. (matriculated 2006)
M.A. Research (2009): Quality and Integration of Gesture and Speech in Adolescents with High- Functioning Autism Spectrum Disorders
Dissertation: Executive Contributions to Pragmatic Language and Gestures in Autism Spectrum Disorder

Jessica Bean, M.A. (matriculated 2007)
M.A. Research (2010): A New Measure of Joint Attention: Validity and Reliability in School-Age Children and Adolescents with Autism
Dissertation: Core Attentional Processes and Joint Attention In Autism Spectrum Disorders

Jessica Mayo, M.A. (matriculated 2008)
M.A. Research (2010): Implicit Learning and Language Skills in Autism Spectrum Disorders

Christine Irvine, B.A. (matriculated 2010)
M.A. Research: Theory of Mind, Executive Functioning, and Language

Brian Castelluccio, B.A. (matriculated 2012). Outstanding Scholar Fellow; IGERT Fellow.
Allison Canfield, B.A. (matriculated 2012).
Joshua Green, B.A. (matriculated 2013). IGERT Fellow.

INTERNATIONAL GRADUATE STUDENTS HOSTED

Marthe Höppener, Radboud University, Nijmegen, the Netherlands. "The influence of mimicry on likeability of autistic children." February-March 2013.
Katherine Mumford, University of Birmingham, UK. "Investigating the links between gesture and language in early childhood." October-November 2012.
Cecilia Brynskov, Aarhus University, Denmark. "Language acquisition in Danish children with autism." July-September 2010.

UNDERGRADUATE STUDENT THESES/FELLOWSHIPS SPONSORED

Catherine Piotrowski
Honors thesis (2014): *Gestures in autism.*

Emily Thompson
Honors thesis (2014): *Talker identification in autism*.
Social Science, Humanities, and Arts Research Experience (SHARE) award (2013): *Talker identification in autism*.

Allison Fitch
Social Science, Humanities, and Arts Research Experience (SHARE) award (2012): *I vs. Me: Pronoun Use in the Development of Theory of Mind in Autism*.
Current position: Ph.D. Student in Developmental Cognitive Neuroscience, Boston University

Danielle Daley
University Honors Scholar Thesis (2011): *Language about people and objects: Adolescents with autism.*

Kaitlin de Yoe
Student Undergraduate Research Fellowship, 2010 ($2,500).
University Honors Scholar Thesis (2011): *Pragmatic language in adolescents who have recovered from a diagnosis of autism*.

Caitlin Dombrowski, B.A.
University Honors Scholar Thesis (2010): *Gestures support conceptual change in adolescents with autism*.
Current position: Ph.D. Student in Clinical Psychology, University of Connecticut

Juliana Hartley, B.S.
University Honors Scholar Thesis (2010): *Interactions between gestures and speech in adolescents with autism*.
Current position: Teaching Fellow, Teach For America

Kimberly Markoff, B.A.
University Honors Scholar Thesis (2008): *Multi-tasking in Autism*.
Student Undergraduate Research Fellowship, 2008 ($2,500).
Current position: Ph.D. Student in School Psychology, Indiana University

PROFESSIONAL LICENSURE

2003-2005	Licensed Psychologist, State of New York (#15383)
2006-present	Licensed Psychologist, State of Connecticut (#2675)

Nicole Landi

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Department of Psychology
406 Babbidge Road, Unit 1020
Storrs, CT 06269-1020
Nicole.landi@Uconn.edu
203-988-8963

POSITIONS

Assistant Professor, Department of Psychology — Aug 2013- Present
University of Connecticut

Adjunct Assistant Professor — Aug 2013- Present
Child Study Center, Yale University

Research Scientist (Associate Professor of Research) — June 2012- Aug 2013
Child Study Center, Yale University

Associate Research Scientist (Assistant Professor of Research) — June 2009 – May 2012
Child Study Center, Yale University

Director of EEG Research — June 2009 - present
Haskins Laboratories

Senior Scientist — January 2008 – present
Haskins Laboratories

Assistant Professor, Educational Psychology & Psychology: Learning and Cognition & Minnesota Interdisciplinary Training in Educational Research (MITER) Program (IES Funded center grant) — January 2008 - June 2009
University of Minnesota, Minneapolis Minnesota

ADDITIONAL POSITIONS AND AFFILIATIONS

IGERT Faculty, University of Connecticut — May 2013- present

Faculty Member, Cognitive Science program**,** University of Connecticut — May 2013- Present

Executive Board, New England Research on Dyslexia (NERDY) Society, Harvard University (founders: Al Galaburda,; Nadine Gaab) — July 2012- present

Affiliate Member, Center for Cognitive Sciences, University of Minnesota — January 2008- present

Faculty Affiliate, Center for Neurobehavioral Development, University of Minnesota — January 2008- present

POST-DOCTORAL EXPERIENCE

Postdoctoral Fellow — August 2005 - August 2007
Haskins Laboratories
Mentor: Ken Pugh

Postdoc
Yale Child Study Center — August 2007- December 2007
Mentor: Linda C. Mayes

EDUCATION

Ph.D., Cognitive Psychology & Cognitive Neuroscience — August 2000- August 2005
University of Pittsburgh & Carnegie Mellon joint program, Center for the Neural Basis of Cognition (CNBC)
Advisor: Charles Perfetti
Dissertation committee: Charles Perfetti; Julie Fiez; Eric Reichle; Isabelle Beck; Cameron Carter

B.A., Psychology
Summa cum laude
University at Albany (SUNY) & The University of Hull, UK (study abroad) — August 1996 - December 1999
Research Mentors: Jim Neely & Jeanette Altarriba

ACADEMIC AWARDS, HONORS, AND FELLOWSHIPS

President's Distinguished Faculty Mentor, University of Minnesota	January 2009
NIH Clinical Research Loan Repayment Award, Competitive Renewal	2010-2011
NIH Clinical Research Loan Repayment Award, Competitive Renewal	2008-2009
NIH Clinical Research Loan Repayment Award	2006-2008
NIH National Research Service Award (NRSA- F32 Postdoctoral fellowship) *Declined due to job acceptance at the University of Minnesota	2007
NIH National Research Service Award (NRSA- T32 Postdoctoral fellowship	2005-2007
NSF Integrated Graduate Education Research and Training (IGERT) Fellowship	2002-2004
NIH National Research Service Award (NRSA- T32 Predoctoral fellowship) *Declined due to IGERT fellowship acceptance	2002
Phi Beta Kappa, University at Albany	1998
Deans list 6/6 semesters attended, University at Albany	1996-1998
Psi Chi, Outstanding Member, University at Albany	1997

PROFESSIONAL AFFILIATIONS

Cognitive Neuroscience Society
Society for the Scientific Study of Reading (Voting Member)
International Dyslexia Association
Organization for Human Brain Mapping
Association for Psychological Science

PROFESSIONAL SERVICE

JOURNAL REVIEW

1) Psychological Science; 2) Psychonomic Bulletin & Review; 3) Cortex; 4) Journa
Neuroscience; 5) Neuroscience Letters; 6) Journal of Experimental Psychology: Le
Cognition; 7) 8) Child Development; 9) Cognitive Science: 10) Journal of Experin
11) Brain and Language; 12) Behavior Genetics; 13) Human Brain Mapping; 14) Jo
Developmental Disorders; 15) NeuroImage; 16) Scientific Studies of Reading; 17)
Mental Retardation; 18) Learning and Individual Differences; 19) Journal of Resear
Journal of Neurolinguistics; 21) Reading & Writing; 22) Journal of Fluency Disord
language; 24) Developmental Neuropsychology; 25) Cerebral Cortex; 26) Develop
Psychopathology; 27) Developmental Science.

GRANT REVIEW

Austrian Science Foundation (ASF); National Science Foundation (NSF), Linguistics Panel; NSF, Cognitive Neuroscience Panel; National Institutes of Health (NIH), Sensorimotor Integration (SMI) Panel; National Institutes of Health (NIH), Communication Disorders Review Committee (CDRC); MRC (Medical Research Council, UK).

PUBLICATIONS

JOURNAL ARTICLES

* Indicates \student or postdoctoral fellow co-author (at the time of publication)

*Peter W. Hashim, Roberto Travieso, John A. Persing, *Marika Coffman, *Cora Mukerji,, *Adam Naples, *Rachael M. Tillman, Jordan Terner, MD, **Nicole Landi**, Anup Patel, Derek Steinbacher, Linda Mayes, James McPartland, (in press). Brain electrophysiology reveals intact processing of speech sounds in deformational plagiocephaly. *Plastic and Reconstructive Surgery.*

Preston, J.L, Molfese, P., Mencl, W.E., Frost, S.J., Hoeft, F. Fullbright, R.K, **Landi, N**. Grigorenko, *E.L., Seki, A., Felsenfeld, S. Pugh, K.R (in press) Structural brain differences in school-age children with residual speech sound errors. *Brain and Language. PMCID in process.*

Preston, J. L., *Brick, N., & **Landi, N.** (2013). Ultrasound biofeedback treatment for persisting childhood apraxia of speech. *American Journal of Speech-Language Pathology, 22*(4), 627-643. doi: 10.1044/1058-0360(2013/12-0139). *PMCID- In process.*

Pugh, K.R., **Landi, N.,** Preston, J.L., Mencl, W.E., *Austin, A., *Sibley, D., Fulbright, R.K., Seidenberg, M.S. Grigorenko, E., Constable, R.T., *Molfese, P., Frost, S.J. (2013). The relationship between phonological and sensorimotor processing skills and the neurocircuitry for reading in emergent readers. *Brain and Language, 25, 173-183.* PMC3655431

Landi, N., Frost, S.J., Mencl, W.E, Sandak, R. & Pugh, K.R. (2013). Neurobiological bases of reading comprehension: Insights from neuroimaging studies of word level and text level processing in skilled and impaired readers. *Reading and Writing Quarterly, 29, 145-167.* PMC3646421

Landi, N. *Montoya, J., Kober, H., *Rutherford, HJV, Mencl, W.E., *Worhunsky, P. D., Potenza, M. N., & Mayes, L.C., (2013) Correction to "Maternal neural responses to infant cries and faces: relationships with substance use. *Frontiers in Child and Neurodevelopmental Psychiatry.* doi: 10.3389/fpsyt.2012.00115. *PMCID- In process.*

Landi, N., Frost, S.F., Mencl, W.E., Preston, J.L., Jacobsen, L.K., *Lee, M., *Yrigollen, C., Pugh, K.R. & Grigorenko, E.L. (2013). *The COMT* Val/Met polymorphism is associated with reading related skills and consistent patterns of functional neural activation. *Developmental Science, 16, 13- 23.* PMC3655431

Preston, J.L., Felsenfeld, S.F., Frost, S.J., Mencl, W.E, Fulbright, R.K., Grigorenko, E. **Landi, N.** & Pugh, K.R. (2012). Functional brain activation differences in school-age children with speech Sound Errors: Speech and print processing. *Journal of Speech Language and Hearing Research, 55, 1068- 1082.* PMC3427927

*Montoya, J.L., **Landi, N.,** Kober, H., *Worhunsky, P.D., *Rutherford, H.J.V, Mencl, W.E., Mayes, L.C., & Potenza, M.N. (2012). Regional brain responses in nulliparous women to emotional infant stimuli. *PlosOne.* 7(5): e36270. doi:10.1371/journal.pone.0036270. PMC3349667

* Ercan-Sencicek, *A.G., Davis *Wright, N.R., Frost, S.J., Fulbright, R.K., Felsenfeld, S., *Hart, L., **Landi, N.,** Mencl,W.E., *Sanders,S.J., Pugh, K.R., State, M.W. & Grigorenko, E. (2012). Searching for Potocki-Lupski syndrome phenotype: A Patient with Language Impairment and no autism. *Brain and Development.* 34, 700-

703. *PMCID- In process.*

Landi, N., Crowley, M.J., *Wu, J., *Bailey, C. & Mayes, L.C. (2011). Deviant ERP response to spoken non-words among adolescents exposed to cocaine in utero. *Brain and Language. 120, 209- 216.* PMC3633521

Landi, N., *Montoya, J., Kober, H., *Rutherford, H. J.V., Mencl ,W.E., *Worhunsky, P.D., Potenza, M.N. & Mayes, L.C. (2011). Maternal neural responses to infant cries and faces: relationships with substance use. *Frontiers in Child and Neurodevelopmental Psychiatry, 2, 1-13. * please see correction published in 2013.* PMC3118477

*Palejev, D., *Hwang, W., **Landi, N**., *Eastman, M., Frost, S., Fullbright, R., Kidd, J. R., Kidd, K. R., Mencl, W.E., *Yrigollen, C., Pugh, K.R., & Grogorenko, E. (2011). An application of the elastic net for an endophenotype analysis. *Behavior Genetics*, *41*, 6-30. PMC3613288

*Skiba, T., **Landi, N.** Wagner, R. & Grogorenko, E. (2011) In search for the perfect phenotype: An analysis of linkage and association studies of reading and reading-related processes. *Behavior Genetics, 41,* 120-124. PMC3056345

*Preston, J.L., Frost, S., Mencl, W.E., Fulbright, R.K., **Landi, N**., Grigorenko, E., Jacobsen, L.& Pugh, K.R (2010). Early and late talkers: School-age language, literacy and neurolinguistic differences. *Brain. 133, 2185-2195.* PMC3139938

Landi, N. Mencl, W.E., Frost, S.J., Sandak, R., *Chen, H. & Pugh, K.R. (2010). An fMRI study of multimodal semantic and phonological processing in reading disabled adolescents. *Annals of Dyslexia, 60, 102-121.* PMC3148012

Landi, N. (2010). An examination of the relationship between reading comprehension, higher-level and lower-level reading sub-skills in adults. *Reading and Writing, 23, 701- 717.* PMC3117585

Frost, S., **Landi, N**., Mencl,W. E., Sandak, R. Fullbright, R.K., Jacobsen, L., Grigorenko, E., Constable, R.T. & Pugh, K. (2009). Phonological awareness predicts cortical activation patterns for print and speech. *Annals of Dyslexia, 59,* 78-97. PMC2720826

Bauer, L. M., *Olheiser, E. L., Altarriba, J., & **Landi, N.** (2009). Word type effects in false recall: Concrete, abstract, and emotion word critical lures. *American Journal of Psychology, 122, 469-481. PMCID- In process.*

Pugh K.R., Frost, S.J., Sandak, R., **Landi, N**. Rueckl, J.,G., Constable, R.T., Seidenberg, M., Fullbright, R., Katz, L., & Mencl, W.E. (2008). Effects of stimulus difficulty and repetition on printed word identification: An fMRI comparison of nonimpaired and reading-disabled adolescent cohorts. *Journal of Cognitive Neuroscience*, *20*, 1146-1160. PMC3152957

***Landi, N**. & Perfetti, C.A. (2007). An electrophysiological investigation of semantic and phonological processing in skilled and less skilled comprehenders. *Brain and Language, 102, 30-45.*

***Landi, N.**, Perfetti, C.A., *Bolger, D.J., *Dunlap, S. & Foorman, B.R. (2006). The role of discourse context in developing word representations: A paradoxical relation between reading and learning. *Journal of Experimental Child Psychology, 94,* 114-133.

BOOK CHAPTERS

Pugh, K.R., Frost, S.J., **Landi, N**., Preston, J., Mencl, W.E & Rueckl, J.G. (2013) In *Unraveling the Behavioral, Neurobiological, and Genetic Components of Reading Comprehension*. Miller, B., Cutting, L., & McCardle,

P. Eds. Baltimore: Paul Brookes Publishing.

Landi, N. (2013). Learning to read words: Understanding the relationship between reading ability, lexical quality, and reading context. (pp. 17- 33). In M.A. Britt, S.R. Goldman & J-F Rouet (Eds.), Reading: From Words to Multiple Texts. Routledge : Taylor & Francis Group.

Sandak, R., Frost, S.J., Rueckl, J.G., **Landi, N.**, Mencl, W.E., Katz, L., & Pugh, K.R. (2012). How does the brain read words? In M. Spivey, M. Joanisse & K. McRae (Eds.), *The Cambridge Handbook of Psycholinguistics*. New York: Cambridge University Press.

Pugh, K.R., Frost, S.F., Sandak, R., **Landi, N.,** Moore, D., *Della Porta, G., Rueckl, J. & Mencl, W.E. (2010). Mapping the word reading circuitry in skilled and disabled readers. In P.L. Cornelissen, P.C. Hansen, M.L. Kringelback & K.R. Pugh, (Eds.) *The Neural Basis of Reading* (pp 281-305): Oxford University Press, UK.

McCardle, P., **Landi, N**. & Pugh, K. (2009). An introduction to the volume: How children learn To read: Current issues and new directions in the integration of cognition, neurobiology and genetics of reading and dyslexia research and practice. In P. McCardle & K.R. Pugh (Eds.), *How Children Learn To Read: Current Issues and New Directions in the Integration of Cognition, Neurobiology and Genetics of Reading and Dyslexia Research and Practice*. New York: Taylor-Francis.

Frost, S., Sandak, R., Mencl, W.E., **Landi, N.**, Rueckl, J.G., Katz, L. & Pugh, K.R. (2009). Mapping the word reading circuitry in skilled and disabled readers. In P. McCardle & K.R. Pugh (Eds.), *How Children Learn To Read: Current Issues and New Directions in the Integration of Cognition, Neurobiology and Genetics of Reading and Dyslexia Research and Practice*. New York: Taylor-Francis.

Frost, S. J., Sandak, R., Mencl, W. E., **Landi, N**., Moore, D., *Della Porta, G., Rueckl, J. G., Katz, L., & Pugh, K. R. (2008). Neurobiological and behavioral studies of skilled and impaired word reading. In E. Grigorenko & A. Naples (Eds.), *Single-Word Reading: Biological and Behavioral Perspectives*. Mahwah: Erlbaum.

Perfetti, C.A., ***Landi, N.**, & Oakhill, J.V. (2005). The acquisition of reading comprehension skill. In M.J. Snowling & C. Hume (Eds.), *The Science of Reading: Handbook of Reading Research*. Oxford: Blackwell.

OTHER PUBLICATIONS

Landi, N. (2009). Alexia/Dyslexia; Cloze Procedure & Decoding. (definitions of). In Matsumoto, D. (Ed.). *The Cambridge Dictionary of Psychology*. New York, NY: Cambridge University Press.

MANUSCRIPTS SUBMITTED & UNDER REVISION

Landi, N. Mollfese, P., Frost, S.J, Mencl, W.E., Grigorenko, E. & Pugh, K.R (submitted). The COMT Val/Met polymorphism is associated with structural changes in brain that support reading. *J.Neurosci*

Pugh, K. R., Frost, S.J., Rothman, D.L., Mason, G.M., J. NeurosciDel Tufo, S., Molfese, P.J., Mencl, W. E., Grigorenko, E., **Landi, N.,** Preston, J.L., Jacobsen, L., Hoeft, F., Seidenberg, M., & Fulbright, R.K., (under revision). The neurochemistry of reading development: An MRS study of typically and atypically developing beginning readers *J.Neurosci*

Kornilov, S.A., **Landi, N.,** Rakhlin, N., Fang, S.-Y., Grigorenko, E.L., & Magnuson, J.S. (Under revision) Attentional but not Pre-Attentive Neural Measures of Discrimination are Atypical in Children with Developmenal Language Disorder. *Brain and Language*.

Schleisman, K. **Landi, N.,** & Marsolek, C. (under revision). Long-term cross-modal repetition priming is accompanied by antipriming: Post-visual word representations may be superimposed and modified with usage. *Journal of Experimental Psychology: Learning, Memory & Cognition.*

POPULAR MEDIA

Landi, N. & Skiba, T. (January, 2011). Dan Malloy, Dyslexia & Neuroscience, Colin McEnroe Show, National Public Radio (NPR), Hartford, CT. http://www.yourpublicmedia.org/node/9381

Landi, N. (March, 2011). Neurobiological bases of reading disability: Panel convened at the CT film festival, Danbury CT.

MANUSCRIPTS IN PREPARATION

Landi, Kornilov & Grigorenko (in prep). Haplotype analyses of *COMT* and *BDN*F reveal strong associations between these genes, phonological awareness and oral language skills.

Kornilov, S.A., **Landi, N.,** Rakhlin, N., Grigorenko, E.L., & Magnuson, J.S. (in prep) ERP Indices of Lexical Semantic Processing in Children with Developmenal Language Disorder.

Landi, N., Frost, S.F., Mencl, W.E., Preston, J.L & Pugh, K.R. (in prep). Do children with IQ discrepant reading disability have distinct behavioral and neurobiological profiles?

Landi, N., Kurian, A., Lepannen, P., Hamalainen, J., Molfese, P. Preston, J., Frost, S., Mencl, W.E., Lee, J.R., Chen, Y., Guttorm, T., Lyytinen, H. & Pugh, K.R. (in prep). Difficult but not easier deviant CV phoneme contrasts are associated with deviant MMN response in poor readers.

Landi, N., Nation, K., Pugh, K.R., Frost, S.F., Preston, J.L. & Mencl, W.E. (in prep). Neural profiles of printed and spoken word processing in children with specific comprehension impairment.

Schleisman, K. **Landi, N.,** Chesley, P. & Marsolek, C., (in prep). Cross-modal repetition priming is accompanied by antipriming: ERP evidence.

PRESENTATIONS

SYMPOSIA ORGANIZED

New Directions in Cognitive Neuroscience Research on Dyslexia (November, 2013). **Nicole Landi,** Chair Presented at the 2013 annual meeting of the International Dyslexia Association, New Orleans, LA.

Neuroimaging studies of reading ability: Functional and structural measures of neural plasticity in learning and development (June, 2009). **Nicole Landi,** Chair. Presented at the sixteenth annual meeting of the society for the scientific study of reading, Boston, MA.

INVITED TALKS & PRESENTATIONS (SELECTED)

Landi, N. (September, 2014). Genes brain and behavior in both known an idiopathic cases of language impairment may cross inform the broader impact of language impairment. To be presented at the Boston University Developmental and Cognitive lecture series (invited by Sudha Arunachalam).

Landi, N. (July, 2014). Common but impactful genetic polymorphisms in COMT & BDNF are associated strongly with reading and related skills and associated patterns of neural activity. To be presented at the twenty-first annual meeting of the society for the scientific study of reading (SSSR); Symposium organized by Marc Joanisse.

Landi, N. (August, 2013). Reading and language impairments, behavioral, neuroimaging and genetic perspectives. presented at the International Dyslexia Association, CT Branch. Southern Connecticut State University, New Haven CT.

Landi, N. (April, 2013) Reading and language impairments, behavioral, neuroimaging and genetic perspectives.

Presented to the University of Massachusetts, Amherst Cognitive and Developmental faculty, UMass Amherst, Amherst, MA.

Landi, N. (November, 2012). Studies of reading and language impairment, from low-level to high-level deficits. Loraine Obler Lab, City University of New York (CUNY) Graduate Center, New York, NY.

Landi, N. (October, 2012). Landi lab research. The first Annual Conference of the New England Dyslexia Research Group. Harvard University, Boston, MA.

Landi N. (May 2012). Difficult to discriminate, but not easy to discriminate deviant MMN response predicts reading performance in young children. The Sixth Annual Conference on Mismatch Negativity (MMN) and its Clinical and Scientific Application. City University of New York (CUNY), NY.

Landi, N. (March, 2012). Studies of reading and language impairment, from low-level to high-level deficits. Developmental Psychology Speaker Series, University of Massachusetts at Amherst, Amherst, MA.

Landi, N. (March, 2012) Studies of reading and language impairment, from low-level to high-level deficits. Haskins Next Generations Speaker Series, New Haven CT.

Landi, N. (July, 2011). Learning to read words: Understanding the relationship between reading ability, lexical quality, and reading context. Society for Text and Discourse, Poitiers, France.

Landi, N. (March, 2011). Using cognitive neuroscience methods to uncover language and reading anomaly. University of Connecticut Annual Language Festival, Storrs, CT.

Landi, N. (March, 2009) Using fMRI to investigate specific reading disability in adolescents. University of Minnesota, Center for Cognitive Sciences Colloquium. Minneapolis, MN.

PEER REVIEWED PRESENTATIONS (SELECTED)

Sorcinelli, A. Irwin, J., Gumbkowski, N. Broncazio, L., Preston, J. & **Landi, N.** (May, 2013). Diminished Audiovisual Speech Integration for Children with Autism Spectrum Disorders. Poster to be presented at the at the 25th APS Annual Convention, May 23-26, 2013 at the Washington Marriott Wardman Park in Washington, D.C., USA.

Hashim, P. Cofman, N., Mukerji, R., Tillman, D., Perszyk, Terner, J.S., Travesio, R., **Landi, N**., Mayes, L.C., Persing, J.A. & McPartlan, J.C. (May, 2013) Specificity of Atypical Neural Development for Language in Infants At Risk for ASD. Poster to be presented at the IMFAR meting, San Sebastian, Spain.

Kornilov, S., **Landi, N**., Rakhlin, N., Grigorenko, E., & Magnuson, J. (October, 2012). Atypical Simple Tone Discrimination and Processing in Children with Developmental Language Impairment. Paper presented at the Neurobiology of Language Conference, San Sebastian, Spain.

Landi, N. (July, 2012), *COMT* Val/Met polymorphism is associated with reading related skills and related patterns of functional neural activation. Talk presented at the 19th Annual Meeting of The society for the Scientific Study of Reading, Montreal Canada.

Irwin, J., **Landi, N**., Brancazio, L., Kennedy, A. & Grohman, E. (July, 2011). An ERP investigation of auditory and audiovisual speech in children with autism spectrum disorders. Talk presented at the Conference of the International Association for Child Language, Montreal, Canada.

Seipel, B., Clinton, V.E., van den Broek, P., O'Brien, E., & **Landi, N.** (August, 2010). *Examination of global text and local text coherence utilizing EEG.* Poster presented at the 20th Annual Meeting of the Society of Text and Discourse in Chicago, IL.

Landi, N., Mencl, W. E., Worhunsky, P. Jiansong, X., Erbe, J., Irwin, J. R., Topf, J., Potenza, M.N., & Mayes, L.C. (October, 2009). *fMRI and EEG measures of adult processing of infant emotion*. Poster presented at the annual meeting of the Society for Neuroscience, Chicago, IL.

Seipel, B., Clinton, V., van den Broek, P., Olman, C., O'Brien, E. & **Landi, N**. (June, 2009). *Monitoring global coherence using fMRI*. Poster presented at the sixteenth annual meeting of the Society for the Scientific Study of Reading, Boston, MA.

Landi, N., Frost,S.J.,. Mencl, W. E Sandak, R. & Pugh, K.R. (June, 2009). *An fMRI comparison of reading disabled adolescents with and without general cognitive difficulty*. Poster presented at the sixteenth annual meeting of the society for the scientific study of reading, Boston, MA.

Landi, N., Mencl, W.E., Erbe, J., Potenza, M.N., Irwin, J.R., Topf, J., & Mayes, L.C. (March, 2009*). Functional Cortical Activation Associated with Processing of Infant Emotional State*. Poster presented at the sixteenth annual meeting of the cognitive neuroscience society, San Francisco, CA.

Schleisman, K., Olson, Matthew, Ahneman, K. Ryan, R., **Landi, N**. & Marsolek, C. (March, 2009). Does long term semantic priming actually reflect antipriming? Poster presented at the sixteenth annual meeting of the cognitive neuroscience society, San Francisco, CA.

Erbe, J**., Landi, N**., Irwin,J., Mencl, E., Topf,J., Potenza, M. & Mayes, L. (March, 2009*). EEG Measures of Adult Response to Infant Emotion*. Poster presented at the sixteenth annual meeting of the cognitive neuroscience society, San Francisco, CA.

Stephen Frost, W. Einar Mencl; Rebecca Sandak; **Nicole Landi**; Robert Fulbright; Leslie Jacobsen; Elena Grigorenko; R. Todd Constable; Kenneth Pugh (June, 2008). *Relating Phonological Awareness to Brain Activation Patterns for Reading.* Talk presented at the fifteenth annual meeting of the society for the scientific study of reading, Ashville, NC.

Frost, S.J., Mencl, W.E., Sandak, R., **Landi, N.,** Chen, H. & Pugh, K.R. (June, 2007). *Relating Phonological awareness to modality lexicality and pronounceability effects in beginning readers: An fMRI study.* Poster presented at the annual meeting of the Organization for Human Brain Mapping, Chicago, IL.

Landi, N., Mencl, E.W., Frost, S.J., Sandak, R., Chen, H., & Pugh, K.R. (June, 2007). *fMRI comparisons of multimodal semantic and phonological processing in reading disabled and non-impaired adolescent readers.* Poster presented at the annual meeting of the Organization for Human Brain Mapping, Chicago, IL.

Landi, N. W., Mencl, E.W., Frost, S.J., Sandak, R., Chen, H., & Pugh, K.R. (November, 2006). *fMRI comparisons of multimodal semantic and phonological processing in reading disabled and non-impaired adolescent readers.* Poster presented at the annual meeting of the Psychonomic Society, Houston, TX.

Landi, N. (June, 2006). *Behavioral and electrophysiological investigations of semantic processing in skilled and less-skilled comprehenders*. Paper presented at the annual meeting of the Society for the Scientific Study of Reading, Vancouver, BC.

Landi, N., & Perfetti, C.A. (April, 2004). *The role of phonology in accessing meaning: An ERP investigation.* Poster presented at the annual meeting of the Cognitive Neuroscience Society, San Francisco, CA.

Landi, N. (June, 2003). *Phonological activation and skill differences in reading.* Poster presented at the annual meeting of the Society for the Scientific Study of Reading, Boulder, CO.

Landi, N., VanDyke, J., Perfetti, C.A., & Foorman, B. (June, 2002). *The causes and consequences of predictability.* Poster presented at the annual meeting of the Society for the Scientific Study of Reading, Chicago, IL.

FUNDING

INTERNAL

University of Minnesota, College of Education and Human Development, Dept. of Ed. Psych. Indirect Cost recovery mini-grant, $2,000
May 2008

University of Minnesota, College of Education and Human Development, Faculty Research Award, $5,000
May 2008

EXTERNAL

P01 HD070837-01
Neurocognitive bases of treatment resistance in developmental dyslexia
Role: *Investigator, Neuroimaging Core Co-director*
PI: Robin D. Morris
August 2013- July 2018

P01 HD001994-46
Nature and acquisition of the speech code and reading
Role: *Project Leader*; Project IV: Examinations of skilled and impaired spoken and written comprehension processes.
PI: Jay Rueckl
August 2012- July 2017

R21 DA030665
Neurobiology of language function in adolescents exposed to cocaine in utero
Role: *Principle Investigator*
November 2011- September 2013

R21 DC011342
Neurobiological signatures of audiovisual speech perception in children in ASD
Role: *Investigator*
PI: Julia Irwin
July 2011- June 2013

Childhood Apraxia of Speech Association of north America (CASANA) Treatment Award
Biofeedback training for children with persisting CAS: Articulatory and neural changes
Role: *Co-Investigator*
PI: Jonathan Preston
August 2011 – August 2012

R01 HD 06736
Neurocognitive determinants of second language literacy development in adolescents
Role: *Investigator*
PI: Kenneth R. Pugh
June 2011- May 2016

R01 HD065794
Neurobiological predictors of spoken and written language learning
Role: *Investigator*
PI: Kenneth R. Pugh
April 2011- May 2016

R01 DA026437
Maternal Brain and Behavioral Responses to Infant Cues in Cocaine Exposed Mothers
This study explores the impact of maternal drug use on maternal sensitivity to infant cries and facial expressions.
Role: *Investigator*
PI: Lane Strathern
04/15/2010 - 03/31/2015

COMPLETED

P01 DA022446
Neural circuitry of parent attachment in substance abuse - Project 3
Role: *Investigator*
PI: Josephine Johns
Project PL: Linda Mayes

R03 HD053409
Neurocognitive development in RD children with/without general cognitive deficits
Role: *Principle Investigator*
October 2008 – September 2010

P41 RR008079
Investigating Global coherence in narrative text with fMRI methodology
Role: *Principle Investigator*
January 2009 – August 2009

NIH P50 HD052120
Behavioral Characterization and Genetic Bases of Profoundly Impaired SRD
Role: *Investigator and Co Mentor to Thomas Skiba* (diversity supplement)
PI: Richard Wagner; Elena Grigorenko, Project Leader and CSC subcontract PI
07/01/2006 – 12/31/2011

P01 HD 01994
Nature and acquisition of the speech code and reading
Role: *Investigator*
PI: Carol Fowler
May 2007- April 2012

GRADUATE STUDENTS

Katrina Schleisman - Archambaultd, University of Minnesota, Dept. of Psychology, MITER & Cognitive Sciences (Co- advised by C. Marsolek)	Ph.D. expected 2014
Sarita Austin, Autism Science Foundation Predoc Fellow, Yale Child Study Center and doctoral Student, CUNY Dept. of Speech Language and Hearing Sciences (CUNY advisor, Dr. Valery Shafer)	Ph.D. expected 2013
Benjamin Seipel, University of Minnesota Dept. of Ed. Psych, MITER & Cognitive Sciences (Currently: Assistant Professor of Education, California State University at Chico)	Ph.D. August 2011

Virginia Clinton, University of Minnesota Dept. of Ed. Psych, MITER & Cognitive Sciences (Currently: Postdoctoral Fellow, University of Wisconsin at Madison, Dept of Psychology, Advisor: Martha Alibali) — Ph.D. August 2011

CURRENT POSTDOCTORAL FELOWS/ASSOCIATES

Kaja Jasinska, Haskins Laboratories — September 2013- Present

PAST POSTDOCTORAL FELOWS/ASSOCIATES

Jia Wu, Yale Child Study Center — November 2012- June 1 2013
Currently: Associate Research Scientist (Assistant Research Faculty), Yale CSC)

ADDITIONAL, POSTDOCTORAL, DOCTORAL, POSTBACALLEAUREAT AND UNDERGRADUATE TRAINING

Vanessa Harwood, Graduate Student, University of Connecticut (B. Grela, primary advisor)	Fall 2012- present
Sergey Kornilov, Graduate Student, University of Connecticut; Research Affiliate, Yale Child Study Center (J. Magnuson, primary advisor)	Fall 2011-present
Nina Gumkowsky, Post Baccalaureate Associate, Haskins Labs BA: Mount Holyoke College	Fall 2012- present
Andrea Sorcinelli, Undergraduate Intern, Haskins Laboratories	Summer- 2012- present
Dianna Gal, Post Baccalaureate Associate, Yale Child Study Center BA: College of William and Mary	Summer 2012- present
Anna Carr Faurot, Yale CSC Summer Intern Sophomore, Sewanee, The University of the South	Summer 2012 B.A Expected, 2015
Allison Waggoner, Post Baccalaureate Intern, Haskins Laboratories; BA, University of Pittsburgh (Currently: Medical Student at Lincoln-Memorial University- Debusk College of Osteopathic Medicine)	Summers, 2009-2012 D.O expected 2014
Emily Phillips, Undergraduate Intern, Haskins Laboratories; BA: Southern Connecticut State University, Department of Communication Disorders (Currently: Masters Student, SCSU Department of communication Disorders)	Fall, 2011- Summer 2012 M.S. expected 2014
Allie Ellman, Undergraduate Intern, Haskins Laboratories Junior, University of Pennsylvania, Cognitive Sciences Program	Summer 2011 B.S. expected 2014
Vaughn Steele, Graduate Student, University of Minnesota, Dept. of Psychology (Primary Advisor: C. Marsolek), (Currently: Postdoc, University of New Mexico, Dept. of Psychology, Advisor: Kent Kiel)	Ph.D. August 2011
Miriam Lauter, Undergraduate Intern, Haskins Laboratories Sophomore, Yale College, Cognitive Sciences Program	Summer 2011 B.S. expected 2014
Katherine Meltzoff, Undergraduate Intern, Haskins Laboratories;	July 2008- August

BA: Trinity College, Department of Psychology (Currently: Doctoral Student, UCSD, Deptartment of Psychology)	2009 Ph.D. expected 2014
Jeff Erbe, MA student in Psychoanalytic Developmental Neuroscience, Yale Child Study Center & Anna Freud Center London, UK (Primary Advisor L.C. Mayes) (Currently: Doctoral student, CUNY, Dept. of Psychology)	Sept 2007-August 2009 Ph.D. expected 2014
Thomas Skiba, NIH Postbaccaloreate Training Fellow, Yale Child Study Center, (NIH funded Disability Supplement, Co- Advisor, E. Grigorenko) (Currently: Doctoral Student, Florida Institute of Technology, Dept. of Psychology)	June 2009- Jan 2011 Ph.D. expected 2016
Daniella Duran, Recipient, Presidents Distinguished Faculty Mentee, University of Minnesota, College of Liberal Arts	January 2009- May 2009
Annie Bartels, Undergraduate Research Opportunity Fellow (UROP), University of Minnesota, Dept. of Psychology	January 2009- May 2009
Christina Overfors, Undergraduate Research Opportunity Fellow (UROP), University of Minnesota, Dept. of Psychology	January 2009- May 2009
Martin Odima, Undergraduate Research Opportunity Fellow (UROP), University of Minnesota, Dept. of Psychology	Sept 2008- December 2008

TEACHING EXPERIENCE

GRADUATE COURSES

Team- Instructor, Individual Differences, University of Connecticut (J. Rueckl, Instructor of record)

Instructor, Writing Empirical Papers and Grants, University of Minnesota

Instructor, Psychology and Cognitive Neuroscience of Language, University of Minnesota

Instructor, Advanced Experimental Methods, University of Minnesota

UNDERGRADUATE COURSES

Instructor, Cognition, Southern Connecticut State University

Instructor, Experimental Methods, University of Pittsburgh

INDEPENDENT STUDY

EEG studies of Language Processing University of Minnesota, Dept. of Ed. Psych/ Cognitive Sciences (multiple students)

Directed Research Study in Cognitive Neuroscience, University of Pittsburgh (multiple students) Fa

UNIVERSITY SERVICE

Yale Child Study Center, Postdoctoral T32, Advisory Committee	2012-2013
University of Minnesota, Center for Cognitive Sciences, Predoctoral T32 Advisory Committee	2009
University of Minnesota, Minnesota Interdisciplinary Training in Educational Research: MITER (IES funded graduate training program), Steering Committee	2008-2009

University of Minnesota, Department of Ed. Psych., Steering Committee	2008-2009
University of Minnesota, Department of Ed Psych. Graduate Curriculum Development Committee	2008-2009
University of Minnesota, Learning and Cognition Job Search Committee (Faculty Hired: Dr. Sashank Varma)	2007
Haskins laboratories, Chair, SSSR Rebecca Sandak Young Investigator Award Committee	2006- 2008
The Dyslexia Foundation, Organizer, Extraordinary Brain Symposium, Sao Paulo, Brazil	2007
Haskins Laboratories, Organizer, Reading Seminar	2006-2007
University of Pittsburgh, Cognitive Psychology Job Search Committee, Graduate Student Representative (Faculty hired: Dr. Tessa Warren)	2003
University of Pittsburgh, Organizer, Weekly Seminar in Cognition	2004
Center for the Neural Basis of Cognition, Organizer, Annual Retreat Committee	2003
University of Pittsburgh/Carnegie Mellon University, Organizer, 19th & 20th Annual Pitt-CMU Psychology Conference	2001-2002

The following are job descriptions for four MRI Center positions: Director, Associate Director, Physicist, and Technician. None are yet hired.

DIRECTOR

Responsibilities

The role of the Director is to provide scientific leadership and administrative oversight. The Director will:

- Develop and implement a strategic plan to establish a broad portfolio of scientific research and ensure that the Center is financially self-sustaining within five years.
- Broaden the base of successful users by the direct or indirect mentoring of new users, offering or organizing classes, workshops, and symposia on imaging methodology and advanced techniques, establishing partnerships with local and regional organizations, and ensuring that scientists have access to the technical and scientific expertise needed to advance their research.
- Support revenue generation by seeking external funding for imaging research, as well as aiding other users in their grant initiatives and organizing larger grant activities (e.g., center grants). The Director will also work with the UConn Foundation in support of fund-raising activities.
- Align the function of the Center with other academic and strategic initiatives of the University in support of its scientific, educational, and service missions.
- Reach out to the broader research community, locally, regionally, and nationally to positively represent the Center, to forge new collaborations, and to augment Center activity.
- Provide financial and administrative oversight of the Center.

Qualifications

- Ph.D. in field relevant to imaging such as Physics or Psychology OR an M.D. with a relevant specialty such as psychiatry or radiology.
- Scientific and leadership experience relevant to the MRI Center's mission.
- Significant professional experience as a PI, mPI or co-PI in research studies relevant to MRI.
- Knowledge of the variety of utilizations for MRI and related analyses.
- Familiarity with research intensive institutions and a variety of federal and/or non-federal sponsored programs

ASSOCIATE DIRECTOR

Responsibilities

The Associate Director (AD) will oversee, coordinate, and manage all aspects of the MRI imaging functions of the center, including data acquisition, processing and analysis. The AD will provide scientific expertise to scientists affiliated with the Center and is responsible for the day-to-day operation of the Center. The AD will:

- Provide expertise in experimental design and data analysis. Consult with faculty and researchers to design and implement structural, functional, and diffusion weighted neuroimaging experimental protocols and scanning sequences and to analyze the resulting data. Evaluate and approve scanning protocols.
- Together with the staff physicist, establish and maintain procedures related to data quality assurance (e.g., gradient heating, amplifier stability, ghosting, higher-order shimming, susceptibility artifacts, reconstruction). Oversee the management of imaging hardware (scanner, console, software) and peripheral devices (response boxes, physiological recording equipment, eye tracker, etc.)
- Establish and maintain operational policies and procedures. Ensure and maintain required documentation for compliance with safety, environmental and infection control standards, and with local, state, and federal regulations. Monitor compliance with standards, identify variances or inabilities to meet established targets and implement action to ensure that targets are met.
- Design, establish, and maintain data storage and analysis facilities
- Organize and direct the maintenance of facilities, equipment, supplies and materials.
- Through courses and workshops, help train researchers on acquisition, data analysis, and safety procedures.
- Support manuscript and grant-writing efforts. Maintain careful records of all work performed.
- Have the opportunity to advance his or her own program of research and author manuscripts and presentations describing accomplished research.
- Hire, train, and supervise technical and administrative staff. Ensure that all personnel are properly trained on equipment and competent in its use.
- Work with the Director to reduce costs, enhance revenues, and achieve effective use of imaging services.

Qualifications:

- Position Qualifications Include: Ph.D. or M.D. in cognitive science, neuroscience, biomedical engineering, medical physics, physics or related field.

- Significant prior functional MRI experience, with expertise in neuroimaging with MRI and modalities such as functional MRI, diffusion imaging, volumetry, susceptibility-weighted imaging, MR relaxometry.
- Demonstrated skills in MRI pulse sequence programming and image analysis algorithm development.
- Strong skills in using of one or more common functional neuroimaging packages (e.g., AFNI, FSL, or SPM).
- The successful candidate should have the flexibility and expertise to (1) support research across a variety of content areas and (2) implement advances and new approaches in neuroimaging data collection.
- Previous laboratory management experience

PHYSICIST (part time)

Responsibilities

The Center Physicist will provide physics support for both brain and whole-body MRI. Together with the Associate Director, the Physicist is responsible for ensuring smooth day-to-day operation of the scanner and will establish and maintain procedures related to data quality assurance (e.g., gradient heating, amplifier stability, ghosting, higher-order shimming, susceptibility artifacts, reconstruction). The Physicist will:

- Provide support for the optimization and implementation of MRI-based research protocols.
- Work with scientists to optimize and maintain the quality of MRI imaging.
- Educate scientists and staff on the technical aspects of the MRI system.
- Keep up to date with innovations in MR technology and medical applications in area of clinical expertise via scientific literature, symposia and international conferences
- Develop new pulse sequences and hardware to support neuroimaging and whole-body research conducted on the scanner.
- Have the opportunity to advance his or her own program of research and is expected to author manuscripts and presentations describing accomplished research

Position Qualifications

- Education Requirements: Ph.D. degree in physics, chemistry, biomedical engineering or other relevant technical background OR M.Sc. degree in above area(s) with a minimum of 5 years of relevant experience OR Doctoral thesis or series of scientific publications on MR-related topics. ….

- Solid knowledge of NMR/MRI physics and signal processing as well as a track-record of MRI pulse sequence development are essential.
- Skills in mathematics, scientific computing, and programming in the Unix-like environment are desirable.
- Experiences in imaging are preferable but not necessary.
- A strong track record of publications in internationally recognized journals.

TECHNICIAN

Responsibilities

The staff Technician will be involved in data acquisition and analysis, operational training of other researchers, and various other support services. The Technician will:

- Collaborate on research projects by acquiring data and analyzing imaging data.
- Provide expertise to faculty and academic staff researchers regarding acquisition, scan duration, use of MR equipment, and safety screening procedures.
- Perform regular quality assurance procedures on the scanner, data acquisition and archiving of imaging data; ensure that MR imaging and behavioral and data collected are of the highest quality.
- Maintain detailed records for MRI scans including imaging protocols and scan logs. Archive data.
- Perform general lab functions, including maintaining supplies, updating records, and keeping MRI area organized and clean, and the recruitment of volunteers
- Ensure that all experiments conducted are in compliance with applicable NIH standards and regulations. Act as a patient/volunteer advocate for patient safety and comfort.

Qualifications:

- Bachelor's degree required; degree in a scientific area such as computer science or engineering preferred.
- Basic computer skills and knowledge of Unix and Linux systems.
- Knowledge and/or certification in a radio-technologist program desirable.
- Experience in conducting and participating in research studies.
- Previous laboratory management experience
- Experience of analytic techniques for neuroimaging data
- Experience of technical and scripting programming languages/formats
- Experience of a broad array of software for neuroimaging analysis

APPENDIX D:
NON-PROFIT STATUS

STATE OF CONNECTICUT

DEPARTMENT OF REVENUE SERVICES

Brian Vail
University of Connecticut
Mansfield Rd. U-2074
Storrs, CT 06269

Dear Colleague:

I am pleased to provide your agency with a Connecticut State Agency Tax Exemption Number. This certificate issued by the Department of Revenue Services (DRS) will serve as evidence that your agency is exempt from Connecticut sales and use taxes on the purchase or lease of tangible personal property and services, except for meals and lodging. Qualifying state agencies still must get advance DRS approval for sales and use tax exemptions for meals and lodging.

Tax Exemption Numbers are issued only to Connecticut state agencies. DRS does not assign tax exempt numbers to agencies of the United States government or to municipalities or their agencies.

DRS issues Tax Exemption Numbers to state government agencies to verify the agency's tax-exempt status when making purchases. Use your Tax Exemption Number when completing **CERT-134**, *Exempt Purchases by Qualifying Governmental Agencies.*

For information on the Tax Exemption Number policy, please see **Policy Statement 2006(4)**, *Tax Exemption Purchases by Connecticut State Agencies*, on the DRS web site at **www.ct.gov/DRS** or call the DRS Taxpayer Services Division at 860-297-5962. As always, I welcome your comments and suggestions. Feel free to e-mail DRS at drs@po.state.ct.us

Sincerely,

Pam Law

Pam Law, Commissioner

OR-295 (Rev. 2/06)

OR-295 (Rev. 2/06)
NOT TRANSFERABLE or ASSIGNABLE

STATE OF CONNECTICUT
DEPARTMENT OF REVENUE SERVICES
25 Sigourney Street, Hartford CT 06106-5032

Connecticut State Agency
Tax Exemption Number

06-0772160 UOC67000
Tax Exemption Number

April 12, 2006
Date Issued

Pam Law
Commissioner

Brian Vail
University of Connecticut
Mansfield Rd. U-2074
Storrs, CT 06269

QUI TRANSTULIT SUSTINET

The Connecticut State Agency named on this certificate is exempt from Connecticut sales and use taxes on the purchase or lease of tangible personal property and services, except for meals and lodging. This permit is issued pursuant to Conn. Gen. Stat. §12-412(1)(A).

APPENDIX E:
DPH LICENSES

State of Connecticut

Department of Public Health

410 Capitol Avenue, Hartford, CT 06134
(860) 509-8045

In Accordance with Connecticut General Statutes 19a-77 to 19a-87 inclusive, the Department of Public Health issues this license, which is non-transferable, to:

UCONN SCHOOL OF FAMILY STUDIES
843 BOLTON RD U-1117 HUMAN DEV CTR
STORRS, CT 06269-0001

to operate a

Child Day Care Center

at

UCONN CHILD DEVELOPMENT LABORATORIES
843 BOLTON RD- U-1117 HUMAN DEV CTR
MANSFIELD, CT 06269

License Number: **DCCC.13495**
Expiration Date: **11/30/2016**
Approved for the Following Services:

Children Under 3 Yrs; Pre-School; School Age

Maximum Children at One Time: **100**
Children Under 3 Years of Age: **46**

Jewel Mullen, MD, MPH, MPA
Commissioner

STATE OF CONNECTICUT

Department of Public Health

LICENSE

LICENSE NO. 0051

Infirmary Operated by an Educational Institution

In accordance with the provisions of the General Statutes of Connecticut Section 19a-493:

University of Connecticut of Storrs CT d/b/a University of Connecticut Hilda Williams Student Health Center is hereby licensed to maintain and operate an Infirmary Operated by an Educational Institution.

This license authorizes the named facility to provide overnight accommodations for short-term care and treatment, beyond first aid, by a practitioner of the healing arts of students, faculty and employees, for those emergencies and other medical conditions including injuries which do not required the skill and equipment of a hospital.

University of Connecticut Hilda Williams Student Health Center Infirmary is located at Unit 2011, 234 Glenbrook Road, Storrs, CT 06269.

8 Licensed Beds

This license expires **June 30, 2014** and may be revoked for cause at any time.

Dated at Hartford, Connecticut, July 1, 2012

Jewel Mullen, MD, MPH, MPA
Commissioner

APPENDIX F: AUDITED FINANCIAL STATEMENTS

University of Connecticut

Financial Report

For the Year Ended June 30, 2012

Message from the Executive Vice President for Administration and Chief Financial Officer

Founded in 1881, the University of Connecticut (University) serves as the State of Connecticut's (State) flagship institution for higher education, meeting the educational needs of undergraduate, graduate, professional, and continuing education students through the integration of teaching, research, service and outreach. The University of Connecticut is a comprehensive institution of higher education which includes the University of Connecticut Health Center (Health Center). Although governed by a single Board of Trustees, the University and its Health Center maintain separate budgets and are by statute separate entities for purposes of maintaining operating funds and State appropriations. The Health Center also has a Board of Directors to whom the Board of Trustees has delegated certain responsibility and authority.

This financial report for the fiscal year ended June 30, 2012 represents the transactions and balances of the University, herein defined as all programs except the Health Center. This includes Storrs-based undergraduate and graduate programs, the regional campuses, the School of Law and the School of Social Work. The University's enrollment in fiscal year 2012 was 29,994 students, taught by 1,330 full-time faculty members and an additional 735 part-time faculty and adjuncts. In total, the University employs 4,510 full and part-time faculty and staff (excluding adjuncts).

The University's Board of Trustees is vested by law with fiscal oversight of the University. The operational authority granted to the University builds upon the successful implementation of legislation known as the Flexibility Acts enacted in the early 1990s. These statutory changes enabled the University to become responsible and accountable for its operational decisions independent of many of the previously imposed regulatory requirements. The University is responsible for the budgetary allocation of its State appropriation, check-writing authority, human resource control, and purchasing authority and, with the advent of the UCONN 2000 building program in 1995, management of capital projects.

While the University's operational flexibility and capacity has grown, all of these activities also take place within a context of continuing vigilance. The financial statements contained in this report reflect budget execution results consistent with spending plans and operating and capital budgets approved by the University's Board of Trustees. The Board of Trustees, through its Joint Audit and Compliance Committee, exercises oversight of the integrity of the University's financial statements and internal control systems, as well as direct engagement in the approval of independent auditing services to augment the University's internal audit capacity and the work performed by the Auditors of Public Accounts. An important component of external oversight, the Auditors of Public Accounts issue an Independent Auditors' Report on the financial statements of the University. They are responsible for auditing its financial operations and their audit opinion appears in this report.

The fiscal operations of the University are not an end in themselves—rather, the maintenance of fiscal health and stability serves the ultimate goal of enabling the University to achieve its teaching, research, service and outreach mission. Over the past decade, the growth and diversification of the University's funding streams, combined with the continuing physical transformation through UCONN 2000, have led the University to record enrollments, research success, and significant contributions to the economy of the State.

The financial condition of the University is closely tied to the State's economic condition. There are significant financial and economic challenges facing the state and the nation. Over the past several years, the University has experienced reductions in the State appropriation in addition to mandatory transfers to the State from the University's unrestricted net assets. Furthermore, decreases in State funding are also anticipated for fiscal year 2013. Despite the reality of declining State support, the University is committed to continuing its high standard of service to its students and the citizens of the State.

The University continues to seek immediate and long-term efficiencies where possible while focusing on three key goals: assuring access to educational excellence, enabling the University to be a key resource for Connecticut's economic growth, and outreach to Connecticut's people. The fiscal year 2012 financial statements reflect enhanced revenues where possible and reduced expenditures through the following actions: a stringent approval process for all hires and rehires, reductions for non-personnel expenditures, and review of procurement contracts for savings opportunities.

The University enjoys strong support across the State, is attracting greater numbers of highly qualified applicants than ever before, and maintains solid national rankings in virtually all relevant areas. Among its many accomplishments, the University continues to be the top public university in New England and is among the top public universities in the nation in the annual *U.S. News and World Report (2012 America's Best Colleges)* rankings. The University is also 25th on *Kiplinger's Personal Finance's* list of 100 Best Values in Public Colleges which ranks schools that combine outstanding education with economic value.

- Undergraduate enrollment is at an all-time high, while the quality and diversity of students choosing the University has shown a documented rise every year since the mid-1990s. Compared to fall of 1995, fall 2011 freshman enrollment at the main campus was up 65%, minority freshman enrollment was up 171%, and since 1996, average SAT scores were up 103 points. 43% of these students ranked in the top 10% of their high school class.
- The University's freshman-to-sophomore retention rate at the main campus is 93% and is substantially higher than the 82% average for 383 colleges and universities in the national Consortium for Student Retention Data Exchange. The 6-year graduation rate is 83% and the average time to graduate is 4.2 years among students completing Bachelor's within six years.
- Approximately 7,640 degrees were conferred in the 2011-12 school year for the completion of undergraduate, graduate and professional programs at the Storrs and regional campuses.
- Research awards for the Storrs-based program grew from $55.9 million in fiscal year 1996 to $122.5 million in fiscal year 2012.
- The endowment for both the University and the Health Center is valued at $329.1 million and is maintained by the University, The University of Connecticut Foundation, and The University of Connecticut Law School Foundation. The support provided to or on behalf of the University and the Health Center from both foundations totaled $31.3 million in 2012 for scholarships, faculty, programs and facilities.
- By the end of fiscal year 2012, the UCONN 2000 program has led to the authorization of 108 major projects totaling $2.1 billion in bond proceeds.

Respectfully Submitted,

Lysa D. Teal

Richard D. Gray
Executive Vice President for Administration
and Chief Financial Officer

Lysa D. Teal
Associate Vice President of Finance
and Budget

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STATE OF CONNECTICUT

AUDITORS OF PUBLIC ACCOUNTS
STATE CAPITOL
210 CAPITOL AVENUE
HARTFORD, CONNECTICUT 06106-1559

JOHN C. GERAGOSIAN

ROBERT M. WARD

INDEPENDENT AUDITORS' REPORT

The Board of Trustees of the
University of Connecticut

We have audited the accompanying statements of net assets of the University of Connecticut (University) as of June 30, 2012 and 2011, and the related statements of revenues, expenses and changes in net assets and statements of cash flows for the years then ended. The University is a component unit of the University of Connecticut system, which includes the University of Connecticut, the University of Connecticut Health Center and the University of Connecticut Foundation, Inc. These financial statements are the responsibility of the University's management. Our responsibility is to express an opinion on these financial statements based on our audits. We did not audit the financial statements of the University of Connecticut Law School Foundation, Inc., a discretely presented component unit, which represented .59 and .61 percent of the assets of the University as of June 30, 2012 and 2011, respectively. The University of Connecticut Law School Foundation, Inc. represented .21 and .34 percent of the combined revenues and other additions for the years ended June 30, 2012 and 2011, respectively. Those financial statements were audited by other auditors whose reports thereon have been furnished to us, and our opinion, insofar as it relates to the amounts included for the University of Connecticut Law School Foundation, Inc., is based solely on the reports of the other auditors. The audits of the University of Connecticut Law School Foundation, Inc. were conducted in accordance with auditing standards generally accepted in the United States of America.

We conducted our audits in accordance with auditing standards generally accepted in the United States of America. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes consideration of internal control over financial reporting as a basis for designing audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the University's internal control over financial reporting. Accordingly, we express no such opinion. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation. We believe that our audits and the reports of the other auditors provide a reasonable basis for our opinion.

In our opinion, based upon our audits and the reports of the other auditors, the financial statements referred to above present fairly, in all material respects, the financial position of the University, as of June 30, 2012 and 2011, and the changes in net assets and its cash flows for the years then ended, in conformity with accounting principles generally accepted in the United States of America.

The Management Discussion and Analysis on pages 2 through 15 is not a required part of the basic financial statements of the University, but is supplementary information required by the Governmental Accounting Standards Board. We have applied certain limited procedures, which consisted principally of inquiries of management regarding the methods of measurement and presentation of the required supplementary information. However, we did not audit the information and express no opinion on it. The introductory section has not been subjected to the auditing procedures applied in the audit of the basic financial statements and, accordingly, we express no opinion on it.

Sincerely,

John C. Geragosian
Auditor of Public Accounts

Robert M. Ward
Auditor of Public Accounts

January 4, 2013
State Capitol
Hartford, Connecticut

MANAGEMENT'S DISCUSSION AND ANALYSIS

Management's Discussion and Analysis

INTRODUCTION

The following Management's Discussion and Analysis (MD&A) is required supplemental information. Its purpose is to provide users of the basic financial statements with a narrative introduction, overview, and analysis of those statements. The MD&A, which is unaudited, includes an analysis of the financial position and results of activities of the University of Connecticut (University, as defined below) for the fiscal year ended June 30, 2012, based on currently known facts, decisions, or conditions. It also includes selected comparative information for the years ended June 30, 2011 and 2010, and certain amounts previously reported have been reclassified in order to conform to the current year presentation. As the MD&A presentation includes highly summarized information, it should be read in conjunction with the accompanying financial statements and related notes to the financial statements. The financial statements, notes to the financial statements, and this MD&A are the responsibility of management.

Founded in 1881, the University of Connecticut serves as the State of Connecticut's (State) flagship for higher education, meeting the educational needs of undergraduate, graduate, professional, and continuing education students through the integration of teaching, research, service and outreach. The University of Connecticut is a comprehensive institution of higher education, which includes the University of Connecticut Health Center (Health Center). Although governed by a single Board of Trustees, the University and the Health Center maintain separate budgets and are, by statute, separate entities for purposes of maintaining operating funds and State appropriations. The Health Center also has a Board of Directors to whom the Board of Trustees has delegated certain responsibility and authority.

This financial report for the fiscal year ended June 30, 2012 represents the transactions and balances of the University, herein defined as all programs except the Health Center. This includes Storrs-based undergraduate and graduate programs, the regional campuses, the School of Law and the School of Social Work.

During the year ended June 30, 2004, the University adopted Governmental Accounting Standards Board (GASB) Statement No. 39, *Determining Whether Certain Organizations Are Component Units,* which amends GASB Statement No. 14, *The Financial Reporting Entity*. As a result, The University of Connecticut Law School Foundation, Inc. (Law School Foundation) is included as a component unit with the University (see Note 1). A related, but independent, corporate entity, The University of Connecticut Foundation, Inc. (Foundation), operates exclusively for charitable and educational purposes, raising funds to promote, encourage, and assist education and research at the University and the Health Center (see Note 12). The Foundation solicits and accepts donations of properties, monies, and securities and invests and administers these gifts. The Foundation materially supports the mission of both the University and the Health Center which are separately audited, producing their own financial statements. Displaying the Foundation's financial statements as a component unit of either the University or the Health Center would distort its actual contribution or economic benefit to that entity, and therefore the Foundation is not included as a component unit in the accompanying financial statements.

The University's Board of Trustees is vested by law with fiscal oversight of the University. The operational authority granted to the University builds upon the successful implementation of several pieces of legislation known as the Flexibility Acts, enacted in the early 1990s. These statutory changes enabled the University to become responsible and accountable for its operational decisions independent of many of the previously imposed regulatory requirements. The University is now responsible for the budgetary allocation of its State appropriation, check-writing authority, human resource control, purchasing authority and, with the advent of UCONN 2000 in 1995, management of capital projects.

While the University's operational flexibility and capacity has grown, all of these activities also take place within a context of continuing external review. The financial statements contained in this report reflect budget execution results consistent with spending plans and operating and capital budgets approved by the University's Board of Trustees. The Auditors of Public Accounts issue an Independent Auditors' Report on the financial statements of the University. They are responsible for auditing its financial operations and their opinion appears on page 1.

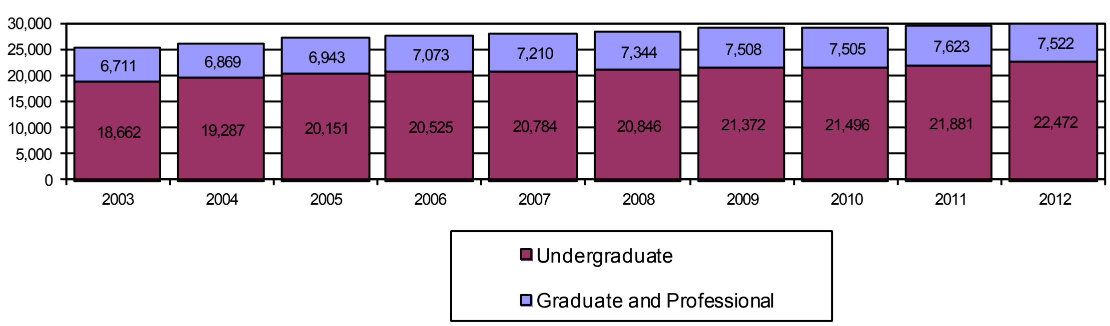
FINANCIAL HIGHLIGHTS AND ECONOMIC OUTLOOK

The University submits a separate biennial operating budget request to the Governor through the Secretary of the Office of Policy and Management (the Governor's fiscal office). The General Assembly appropriates funds upon passage of the annual appropriations bill. In general, the Governor may reduce State agency allotments by not more than 5%, although in recent years the General Assembly has afforded the Governor certain specified additional reduction authority.

The financial statements contained herein show an operating loss of $340.5 million for the year ended June 30, 2012 (fiscal year 2012) as compared to $376.9 million for the year ended June 30, 2011 (fiscal year 2011), and $363.2 million for the year ended June 30, 2010 (fiscal year 2010). The decrease in operating loss in fiscal year 2012 from fiscal year 2011 was due to an increase in total operating revenues of 2.8%, primarily attributed to an increase in undergraduate enrollment, tuition and fees, and board and room fees. There was also a 2.0% decrease in total operating expenses, as result of cost saving measures implemented during the year. The increase in operating loss in fiscal year 2011 from fiscal year 2010 was due to an increase in total operating expenses of 5.9%, primarily caused by a 6.4% increase in salaries as a result of a 3.3% increase in full-time equivalent staff and negotiated raises. For public institutions, the measure more indicative of normal and recurring activities is income or loss before other changes in net assets, which includes revenue from the State appropriation. The University experienced a loss before other changes in net assets of $41.9 million in fiscal year 2012 as compared to $49.9 million and $38.3 million for fiscal years 2011 and 2010, respectively. Total operating revenues grew $16.7 million in fiscal year 2012 and $40.8 million in fiscal year 2011. At the same time, operating expenses decreased $19.6 million in fiscal year 2012 as compared to an increase in fiscal year 2011 of $54.4 million over fiscal year 2010. Investment income decreased $0.1 million in fiscal year 2012, $0.3 million in fiscal year 2011 and $3.0 million in fiscal year 2010.

Sources of recurring revenues continued to exhibit strength. The University's total enrollment in fiscal year 2003 topped 25,000 students and grew to 29,994 students in fiscal year 2012. These students are taught by 1,330 full-time faculty members (an increase of 26 faculty over the prior year) and an additional 735 part-time faculty and adjuncts. Undergraduate enrollment at the University reached 22,472 students in fiscal year 2012, 2.7% more than fiscal year 2011 (1.8% more students in fiscal year 2011 over 2010). At the same time, an in-state tuition and mandatory fee increase of 2.4% and an out-of-state increase of 2.6% were approved for fiscal year 2012. Graduate and professional enrollment decreased by 1.3% with an in-state tuition and mandatory fee increase of 2.6% and an out-of-state increase of 2.5%. The net increase in overall enrollment, when combined with the tuition and mandatory fee increases, resulted in an increase in tuition and fee revenue, before scholarship allowances, of $19.2 million (5.6%) as compared to a $23.9 million (7.5%) increase in fiscal year 2011. Sales and services of auxiliary enterprises, before scholarship allowances, increased $3.3 million (1.8%), primarily as a result of an overall increase in room and board fees of 2.5% for undergraduate and graduate students and an increase in room occupancy of 1.6% over fiscal year 2011. In fiscal year 2011, sales and services of auxiliary enterprises, before scholarship allowances, increased $11.8 million (6.9%), primarily as a result of an overall increase in room and board fees of 6.5% for undergraduate students and 6.6% for graduate students and an increase in room occupancy of 1.2% over fiscal year 2010. Grant and contract revenues decreased $4.9 million (3.0%) in fiscal year 2012 as compared to an increase of $17.4 million (11.8%) fiscal year 2011 over 2010.

HEADCOUNT ENROLLMENT IN FALL OF EACH FISCAL YEAR
TEN YEAR COMPARISON



The 21st Century UConn program, also known as Phase III of UCONN 2000, began in fiscal year 2005 and was amended in fiscal years 2008, 2010 and 2011. As amended, it represents a $1.82 billion, 13-year extension of the original UCONN 2000 program (see Note 5), and provided $1.0 billion for facilities improvements at Storrs, the regional campuses, the School of Law and the School of Social Work. It also provided for $775.3 million for improvements at the Health Center. The total estimated cost for the UCONN 2000 program, including Phases I, II and III, is $3.1 billion. This commitment from the State provides long-term funds for capital enhancement and preservation and will allow the University to provide quality facilities commensurate with the enrollment growth experienced in recent years.

The financial condition of the University is closely tied to the State's economy. There are significant financial and economic challenges facing the State and the nation. In fiscal year 2012, the University experienced a reduction of approximately $39.4 million in appropriation and payments for fringe benefits as a result of the State's economic initiatives. In fiscal years 2011 and 2010, the University transferred $15.0 million and $8.0 million, respectively, from unrestricted net assets to the State's General Fund as a result of a deficit mitigation plan implemented by the State. These funds have not been restored to the University's appropriation and further reductions in State support of approximately $15.0 million are anticipated in fiscal year 2013 due to the widening State deficit. In response to these measures, the University continues to seek immediate and long-term efficiencies where possible while focusing on three key goals: assuring access to educational excellence, enabling the University to be a key resource for Connecticut's economic growth, and outreach to Connecticut's people. The fiscal year 2012 financial statements reflect enhanced revenues where possible and reduced expenditures through the following actions: a stringent approval process for all hires and rehires, reductions for non-personnel expenditures, and review of procurement contracts for savings opportunities. Despite the reality of declining State support, the University is committed to continue its high standard of service to its students and the citizens of the State.

FINANCIAL STATEMENTS

Effective July 1, 2001, the University adopted GASB Statement No. 35, *Basic Financial Statements - and Management's Discussion and Analysis - for Public Colleges and Universities*, as amended by GASB Statement Nos. 37 and 38. GASB Statement No. 35 establishes standards for financial reporting for public colleges and universities. The University's financial report includes three basic financial statements: Statements of Net Assets; Statements of Revenues, Expenses, and Changes in Net Assets; and Statements of Cash Flows. In addition, the following elements are included with these general-purpose financial statements: Management's Discussion and Analysis and Notes to the Financial Statements. GASB Statement No. 35 focuses on the University as a whole rather than on accountability by individual fund groups and provides accounting and financial reporting guidelines, enhancing the usefulness and comprehension of financial reports by external users. The adoption of these standards resulted in the conversion from fund accounting statements to statements presented in a single-column format.

The financial statements reflect budget execution results consistent with operating budgets and spending plans approved by the University's Board of Trustees. The University prepares and presents its Operating Budget requests and annual Spending Plan in a current funds format.

STATEMENTS OF NET ASSETS

The Statements of Net Assets present the assets, liabilities, and net assets of the University as of the end of the fiscal year, June 30. The Statements of Net Assets are a point in time financial statement – a snapshot – and a measure of the financial condition of the University. These statements present end-of-year data concerning assets, classified as current (those available for use within one year) and noncurrent (those available beyond one year), liabilities, categorized as current (those maturing and due within one year) and noncurrent (those maturing and due after one year), and net assets that represent the difference between total assets and total liabilities. Assets represent what is owned by or what is owed to the University, including payments made to others before a service was received. Assets are recorded at their current value, except for property and equipment which are recorded at historical cost, net of accumulated depreciation and amortization. Liabilities represent what is owed to others or what has been received from others prior to services being provided by the University.

Readers of the Statements of Net Assets are able to determine the assets available to continue the operations of the University. The net asset value of the University is the residual interest or equity in the University's assets after liabilities are deducted. Over time, an increase in net assets is an indicator of the University's improving financial strength.

The following table shows condensed Statements of Net Assets at June 30 (in millions):

	2012	2011	2010
Current assets	$ 612.3	$ 500.6	$ 584.6
Noncurrent assets			
State debt service commitment	828.8	735.0	804.3
Investments	10.3	10.7	9.8
Property and equipment, net	1,422.8	1,399.3	1,397.5
Other	19.8	19.3	19.5
Total assets	$2,894.0	$2,664.9	$2,815.7
Current liabilities	$ 302.7	$ 268.3	$ 294.5
Noncurrent liabilities			
Long-term debt and bonds payable	1,082.4	978.1	1,058.7
Other	19.8	23.2	18.2
Total liabilities	$1,404.9	$1,269.6	$1,371.4
Invested in capital assets, net	$1,155.6	$1,144.9	$1,131.9
Restricted	162.3	75.0	149.6
Unrestricted	171.2	175.4	162.8
Total net assets	$1,489.1	$1,395.3	$1,444.3

The total assets increased $229.1 million in fiscal year 2012 over 2011 as compared to a decrease of $150.8 million in fiscal year 2011 over 2010. The increase in fiscal year 2012 was primarily attributed to the net effect of the following increases and decreases: a $9.7 million decrease ($9.5 million increase in fiscal year 2011) in cash and cash equivalents, a $8.0 million increase in due from State of Connecticut ($0.5 million decrease in fiscal year 2011), a $106.8 million increase in deposit with bond trustee ($92.6 million decrease in fiscal year 2011), a $101.0 million increase in the State debt service commitment ($73.6 million decrease in fiscal year 2011), and a net increase of $23.5 million to property and equipment ($1.7 million in fiscal year 2011).

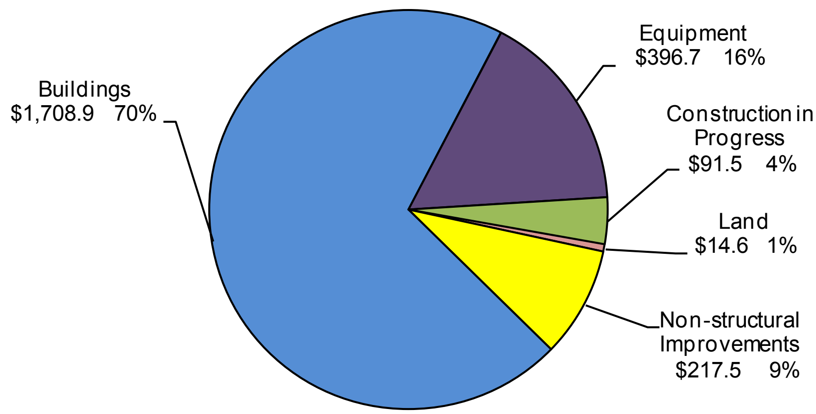
The total liabilities for fiscal year 2012 increased $135.3 million ($101.8 million decrease in fiscal year 2011) primarily due to newly acquired debt through the sale of general obligation bonds and bond refundings of $236.3 million ($0 in fiscal year 2011), which was offset by the retirement and refundings of debt on existing bonds and loans of $126.1 million in fiscal year 2012 ($84.5 million in fiscal year 2011), a decrease in wages payable of $15.3 million ($5.5 million increase in fiscal year 2011), and an increase in due to affiliate of $41.5 million in fiscal year 2012 ($24.0 million decrease in fiscal year 2011). The combination of the increase in total assets of $229.1 million ($150.8 million decrease for fiscal year 2011) and total liabilities of $135.3 million ($101.8 million decrease for fiscal year 2011) yields an increase in total net assets of $93.8 million ($49.0 million decrease in fiscal year 2011).

Capital and Debt Activities

During fiscal year 2012, the University recorded additions to property and equipment totaling $112.7 million ($93.1 million and $75.7 million in fiscal years 2011 and 2010, respectively) of which $83.2 million related to buildings and construction in progress ($69.2 million and $51.8 million in fiscal years 2011 and 2010, respectively). The growth of the University's property and equipment is a direct result of the successful UCONN 2000 program. The third phase of the program, also known as 21st Century UConn, expands and builds on the success of UCONN 2000 with an additional $1.82 billion for improvements to facilities at the University and the Health Center (see Note 5).

The following pie chart presents the total property and equipment at cost:

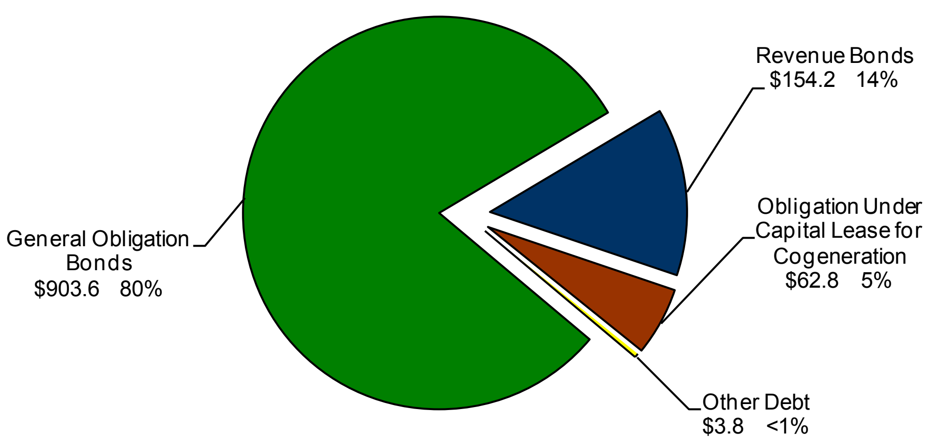
TOTAL PROPERTY AND EQUIPMENT AT COST AT JUNE 30, 2012
($ in Millions) Total $2,429.2



In fiscal year 2012, the University issued UCONN 2000 general obligation bonds with a face value of $179.7 million ($0 in fiscal year 2011) of which $62.5 million was committed to the Health Center for its UCONN 2000 projects (see Note 5). The State has made a commitment to fund the University for all principal and interest payments due on UCONN 2000 general obligation debt, inclusive of 21st Century UConn. As the general obligation debt is incurred, the commitment from the State is recorded as a current and noncurrent receivable (State debt service commitment in the accompanying Statements of Net Assets). When bonds are issued, the amount of the commitment for the Health Center is reflected as a liability by the University. Subsequent to the year ended June 30, 2012, the University issued $88.0 million in special obligation student fee revenue bonds, with a closing date of December 13, 2012, to refund outstanding balances of previously issued bonds (see Note 5).

The following chart illustrates the categories of debt as of June 30, 2012, exclusive of premiums, discounts and debt differences due to refunding:

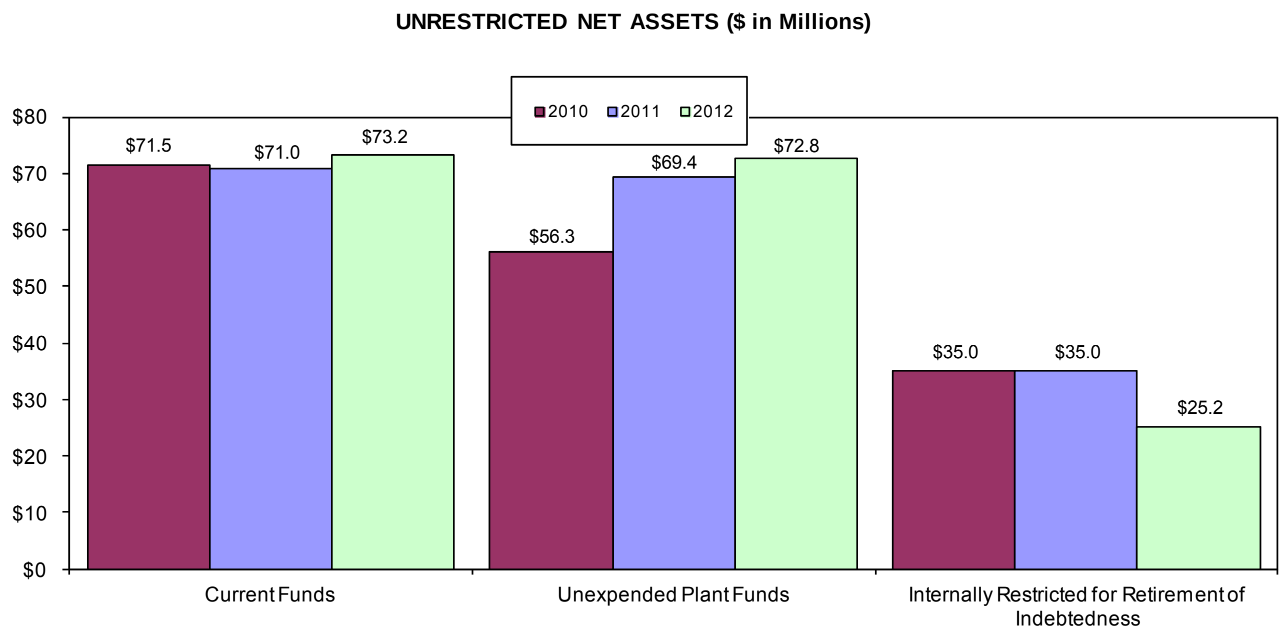
CATEGORIES OF DEBT AT JUNE 30, 2012
($ in Millions) Total $1,124.4



See Notes 4 and 5 of the financial statements for further information on capital and debt activities.

Net Assets

Net assets are divided into three major categories. The first category, invested in capital assets, net of related debt, represents the University's equity in property and equipment. The restricted net assets category is subdivided into nonexpendable and expendable. The corpus of restricted nonexpendable resources is only available for investment purposes, and in the University's Statements of Net Assets this amount represents endowment assets. Expendable restricted net assets are available for expenditure by the institution, but must be spent for purposes determined by donors and/or external entities that have placed time or purpose restrictions on the use of the assets. The final category is unrestricted net assets. Unrestricted net assets are defined by GASB Statement No. 35 to include funds not restricted by third-parties, including all unrestricted funds formerly (prior to fiscal year 2002) included in the balances of unrestricted current funds, retirement of indebtedness funds, and plant funds on the Statement of Net Assets. Unrestricted net assets may be designated for specific purposes by action of management or the Board of Trustees or may otherwise be limited by contractual agreements with outside parties. GASB prohibits a breakout of designated unrestricted funds on the face of the Statements of Net Assets. Unrestricted net assets are available to the University for any lawful purpose of the institution. The following shows a comparison between fiscal years by category of unrestricted net assets:



For the most part all unrestricted net assets are internally designated for academic and research programs, capital programs, retirement of debt, and auxiliary enterprise activities.

STATEMENTS OF REVENUES, EXPENSES, AND CHANGES IN NET ASSETS

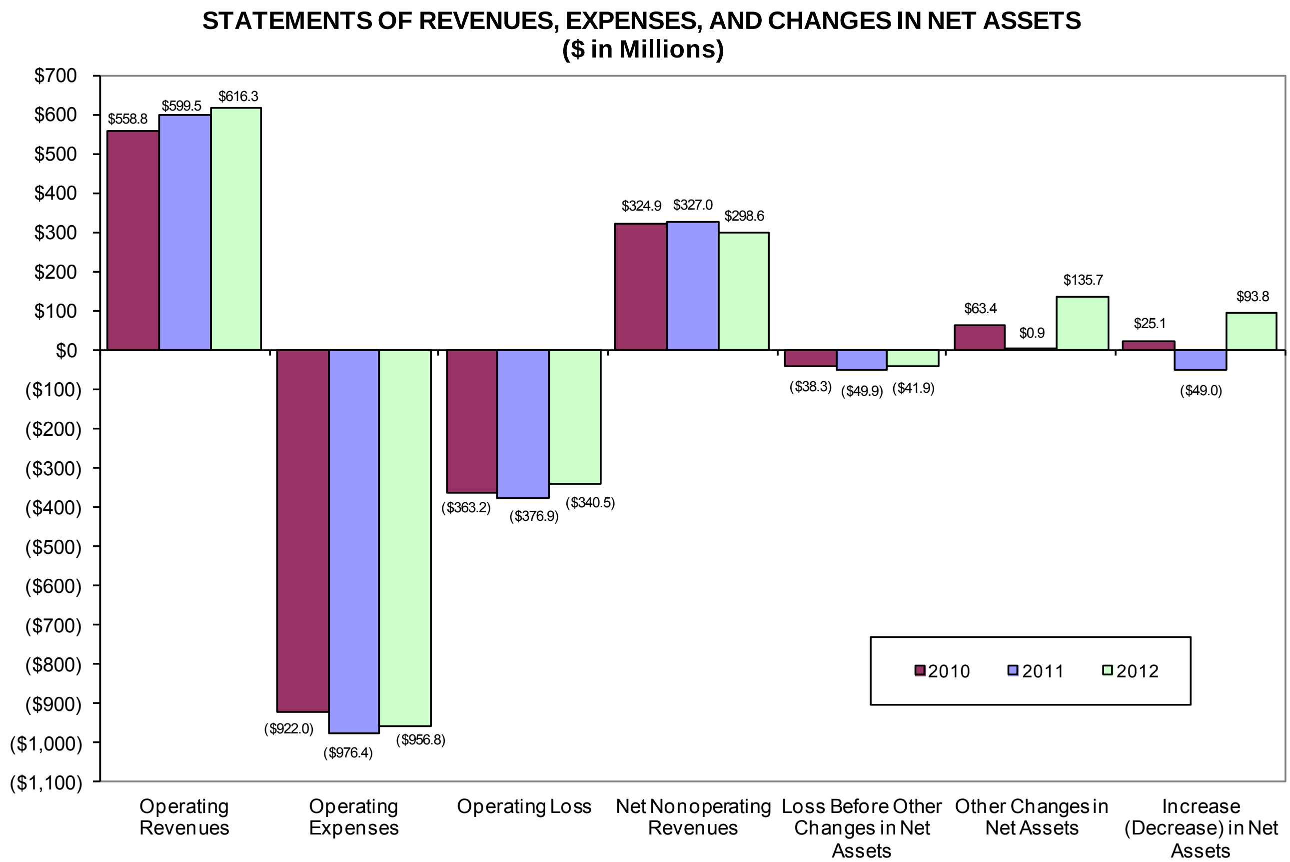
Revenues and expenses are classified as operating, nonoperating, or other changes in net assets according to definitions prescribed by GASB. Significant recurring sources of nonoperating revenues utilized in balancing the operating loss each year include State appropriation for general operations, State debt service commitment for interest, noncapital gifts, and short-term investment income. By its very nature, a State funded institution does not receive tuition, fees, and room and board revenues sufficient to support the operations of the University. Therefore, these nonoperating revenues are essential to the programs and services provided by the University. Unless a significant increase in tuition and fees and room and board revenues occurs, the University will always show a loss from operations.

In fiscal year 2012, the University determined that certain activities should be classified as an auxiliary enterprise, instead of as a component of institutional support. To enhance comparability, the amounts presented for the previous years were changed to reflect the reclassification of revenues from other sources to sales and services of auxiliary enterprises, and expenses from institutional support to auxiliary enterprises. For fiscal years 2011 and 2010, the total reclassification of revenues were $5.4 million and $5.1 million, respectively, and expenses were $3.9 million and $3.7 million, respectively. These changes have no effect on operating loss or net assets for the years ended June 30, 2011 and 2010.

The following table shows condensed Statements of Revenues, Expenses, and Changes in Net Assets for the fiscal years ended June 30 (in millions):

	2012	2011	2010
Operating revenues	$ 616.3	$ 599.5	$ 558.8
Operating expenses	956.8	976.4	922.0
Operating loss	(340.5)	(376.9)	(363.2)
Net nonoperating revenues	298.6	327.0	324.9
Loss before other changes in net assets	(41.9)	(49.9)	(38.3)
Net other changes in net assets	135.7	0.9	63.4
Increase (decrease) in net assets	$ 93.8	$ (49.0)	$ 25.1

While the Statements of Net Assets present the financial condition at a point in time, the Statements of Revenues, Expenses, and Changes in Net Assets represent the activity for a period of time – one year. These statements present either an increase or decrease in net assets based on the revenues received by the University, both operating and nonoperating, the expenses paid by the University, operating and nonoperating, and any other revenues, expenses, gains and losses received or spent by the University.



Generally, operating revenues are earned when providing goods and services to the various customers of the University. Operating expenses are incurred in the normal operation of the University and represent those expenses paid to acquire or produce the goods and services provided in return for the operating revenues. Operating expenses also include the provision for estimated depreciation and amortization of property and equipment. The difference between operating revenues and operating expenses is the operating income or loss. As a State funded agency, the University is expected to experience an operating loss each year.

Nonoperating revenues are revenues received for which goods and services are not provided, including State appropriation and State debt service commitment for interest. Such revenues are provided by the State to the University without the State directly receiving commensurate goods and services in exchange for those revenues. Nonoperating revenues (expenses) also include transfers to State General Fund, noncapital gifts, investment income, interest expense, and other expenses not considered operating expenses.

Other changes in net assets are comprised of the State's debt service commitment for principal payments on general obligation bonds used for capital purposes, capital allocation, capital grants and gifts, the disposal of property and equipment, and additions to permanent endowments. The Statements of Revenues, Expenses, and Changes in Net Assets reflect an increase in the net assets of $93.8 million in fiscal year 2012, a decrease of $49.0 million in fiscal year 2011, and an increase of $25.1 million in fiscal year 2010.

Revenues

The following table summarizes operating and nonoperating revenues and other changes in net assets for the fiscal years ended June 30 (in millions):

	2012	2011	2010
Operating revenues:			
Student tuition and fees, net	$ 251.0	$ 233.9	$ 223.8
Grants and contracts	159.7	164.5	147.2
Sales and services of educational departments	17.4	16.2	15.2
Sales and services of auxiliary enterprises, net	182.0	178.5	166.9
Other sources	6.2	6.4	5.7
Total operating revenues	616.3	599.5	558.8
Nonoperating revenues:			
State appropriation	282.4	329.0	325.5
State debt service commitment for interest	39.8	40.0	38.5
Gifts	24.3	21.1	18.1
Investment income	0.9	1.0	1.3
Total nonoperating revenues	347.4	391.1	383.4
Other changes in net assets:			
State debt service commitment for principal	115.4	-	61.7
Capital allocation	18.0	-	-
Capital grants and gifts and additions to permanent endowments	2.8	2.0	2.4
Total other changes in net assets	136.2	2.0	64.1
Total revenues	$ 1,099.9	$ 992.6	$ 1,006.3

Revenue highlights, for fiscal years 2012 and 2011 and comparison between fiscal years, including operating and nonoperating revenues and other changes in net assets, presented on the Statements of Revenues, Expenses, and Changes in Net Assets are as follows:

- Student tuition and fees, net of scholarship allowances, increased 7.3% in fiscal year 2012 (4.5% in fiscal year 2011) and 5.6% before scholarship allowances (7.5% in fiscal year 2011). The increase in fiscal year 2012 was due in part to a 2.7% (1.8% in fiscal year 2011) increase in undergraduate enrollment at the University and an increase of 2.4% (5.4% in fiscal year 2011) for undergraduate in-state tuition and mandatory fees charged, and 2.6% (5.5% in fiscal year 2011) for out-of-state tuition and mandatory fees.

- Total grants and contracts decreased $4.9 million (3.0%) in fiscal year 2012 ($17.4 million or 11.8% increase in fiscal year 2011) primarily due to a decrease in federal and state financial aid.

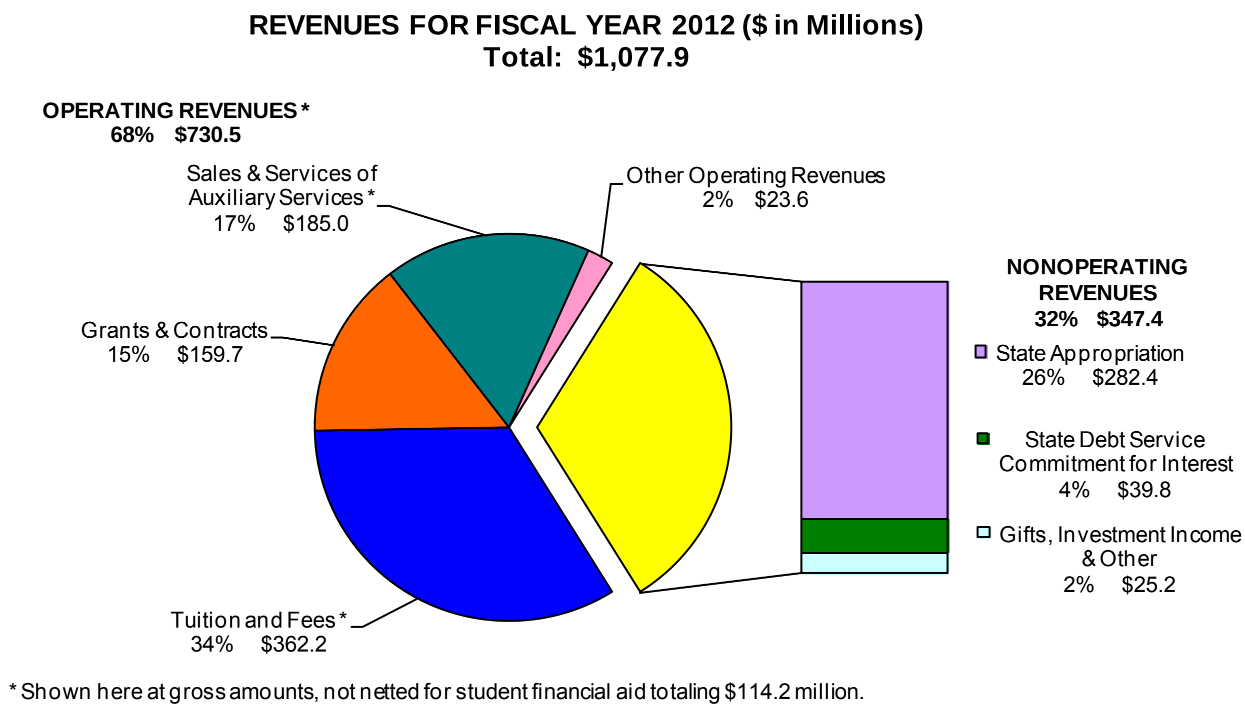
- Sales and services of auxiliary enterprises, net of scholarship allowances, increased approximately 2.0% and 7.0% during fiscal years 2012 and 2011, respectively. The increase in fiscal year 2012 resulted from an increase in fees charged for both room and board of 2.5% for undergraduate and graduate students and an increase in room occupancy of 1.6% over fiscal year 2011. The increase in fiscal year 2011 resulted from an increase in fees charged for both room and board of 6.5% for undergraduate students and 6.6% for graduate students and an increase in room occupancy of 1.2% over fiscal year 2010.

- The largest source of revenue, State appropriation including fringe benefits, decreased $46.6 million in fiscal year 2012 compared to an increase of $3.5 million in fiscal year 2011. The State appropriation is included in the nonoperating section. The State also provides State debt service commitment for the interest payments made annually on general obligation bonds. State debt service commitment for interest revenue is included with nonoperating revenues and corresponds to the total interest paid and accrued on general obligation bonds.

Effectively, this revenue offsets a significant portion of interest expense each year. Also, as general obligation bonds are issued (see Note 5) the State commits to the repayment of the future principal amounts and a receivable is recorded on the Statements of Net Assets to reflect this commitment. This results in revenue that is recorded in other changes in net assets that totaled $115.4 million in fiscal year 2012. There were no general obligation bonds issued in fiscal year 2011. In fiscal year 2012, included in other changes in net assets, the State allocated $18.0 million for design and development costs of the Technology Park on the Storrs campus (see Note 12).

- Gift revenue, both capital and noncapital, is derived from gifts made directly to the University and from the Foundation and Law School Foundation. These spendable funds are provided to the University for educational, cultural, recreational, and research activities. Both the Foundation and the Law School Foundation disburse funds to the University as requests are made, provided the request is in accordance with donor restrictions, if any. These gifts, including capital gifts, received by the University from both Foundations, totaled approximately $22.9 million in fiscal year 2012 compared to $19.4 million in fiscal year 2011. On a combined basis, both Foundations also paid approximately $3.1 million in fiscal year 2012 ($3.5 million in fiscal year 2011) to third parties on behalf of the University. This amount is not reflected in the University's financial statements. Total nonoperating gifts and capital grants and gifts revenue to the University from all sources amounted to $27.1 million and $23.2 million in fiscal years 2012 and 2011, respectively.

Revenues, excluding other changes in net assets, come from a variety of sources and are illustrated in the following graph:



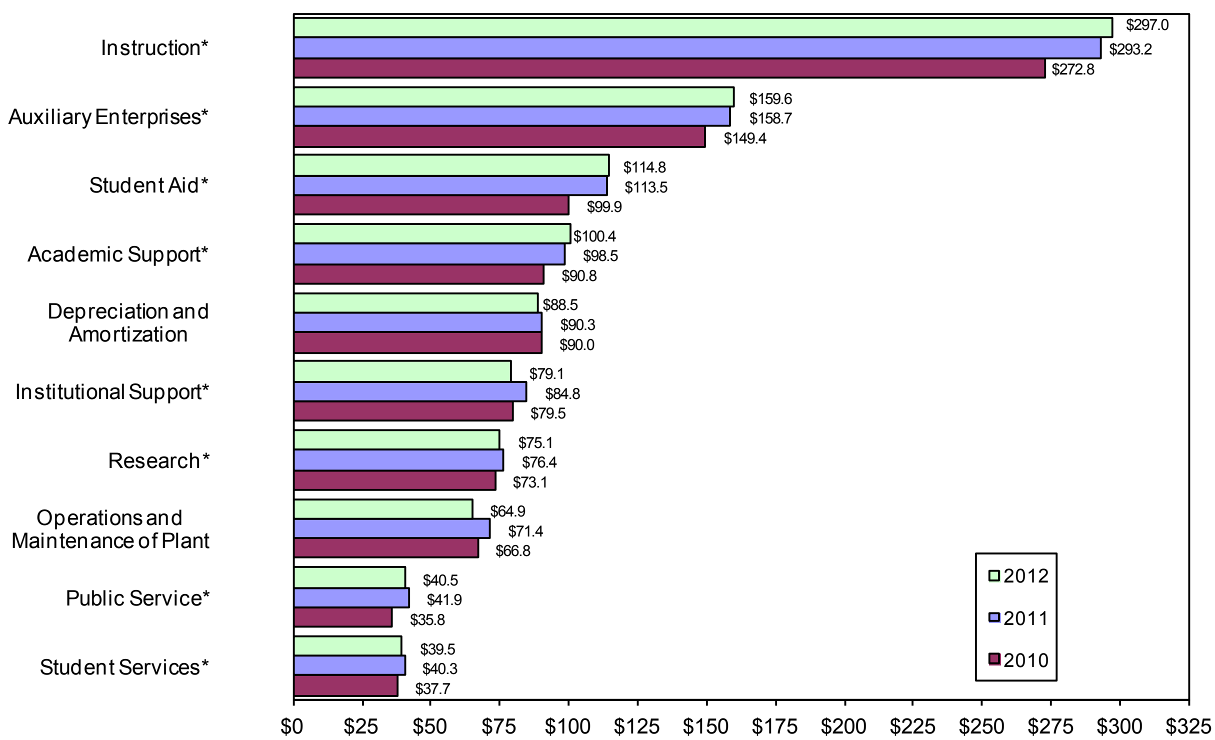
Expenses

The following table summarizes operating and nonoperating expenses and other changes in net assets for the fiscal years ended June 30 (in millions):

	2012	2011	2010
Operating expenses:			
Instruction	$ 295.7	$ 292.2	$ 271.9
Research	72.8	74.5	72.3
Operations and maintenance of plant	64.9	71.4	66.8
Auxiliary enterprises	159.3	158.4	149.1
Depreciation and amortization	88.5	90.3	90.0
Other	275.6	289.6	271.9
Total operating expenses	956.8	976.4	922.0
Nonoperating expenses:			
Interest expense	47.1	48.8	48.6
Transfers to State General Fund	-	15.0	8.0
Other nonoperating expense, net	1.7	0.3	2.0
Total nonoperating expenses	48.8	64.1	58.6
Other changes in net assets:			
Capital allocation	-	0.5	-
Disposal of property and equipment, net	0.5	0.6	0.7
Total other changes in net assets	0.5	1.1	0.7
Total expenses	$ 1,006.1	$ 1,041.6	$ 981.3

Operating expenses are classified by function in the accompanying Statements of Revenues, Expenses, and Changes in Net Assets. These functions directly contribute to the major mission of the University. The following chart depicts comparative functional expenses of the University. It does not include other operating expenses:

EXPENSES BY FUNCTIONAL CLASSIFICATION ($ in Millions)



* Shown here at gross amounts, not netted for financial aid totaling $114.2 million.

Total operating expenses were $956.8 million and $976.4 million in fiscal years 2012 and 2011, respectively, netted for student financial aid totaling $114.2 million and $112.3 million, respectively. Natural classification includes salaries, fringe benefits, utilities, and supplies and other expenses (see Note 14 for operating expenses classified by natural classification).

Highlights of expenses, including operating and nonoperating expenses and other changes in net assets, presented on the Statements of Revenues, Expenses, and Changes in Net Assets are as follows:

- Instruction, the University's largest operating expense, increased $3.5 million (1.2%) primarily due to an increase of approximately 31 full-time equivalent faculty and staff due to the University's strategic faculty hiring plan which was offset by a 4.5% decrease in supplies and other expenses. In fiscal year 2011, instruction increased $20.3 million (7.5%) primarily due to an increase of approximately 41 full-time equivalent faculty and staff, due to the strategic faculty hiring plan during fiscal year 2011, and an average compensation increase for the bargaining units of approximately 5%. In addition, there was a 15.1% net increase in supplies, commodities and other expenses.

- In fiscal year 2012, research expenses decreased $1.7 million or 2.3% ($2.2 million or 3.0% increase in fiscal year 2011). These expenses are related primarily to sponsored research revenues and are affected by the timing of salaries and the purchase of supplies and commodities that can be charged to grants.

- In fiscal year 2012, institutional support experienced a decrease of $5.6 million or 6.7%. This resulted from a 6.4% decrease (4.6% increase in fiscal 2011) in the number of full-time equivalent staff. In addition, there was a 15.8% net decrease in supplies and other expenses. In fiscal year 2011, institutional support experienced a slight increase over 2010 in contractual services related to the revenue enhancement and cost savings review performed by an outside consulting firm.

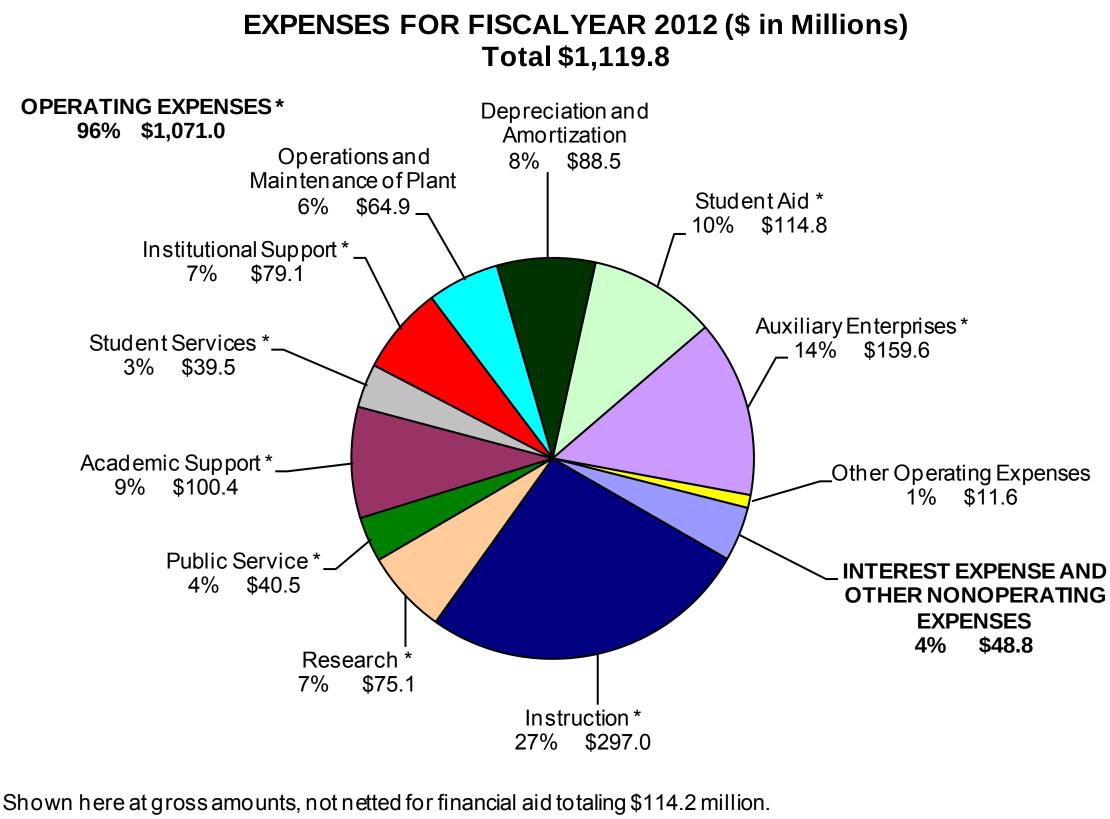
- Operations and maintenance of plant decreased $6.5 million or 9.1% in fiscal year 2012 as compared to a $4.6 million or 6.9% increase in fiscal year 2011. This is primarily attributed to a decrease in natural gas rates of approximately 8.6% in fiscal year 2012 (11.6% in fiscal year 2011). Natural gas consumption, the primary energy source that fuels the Cogeneration plant, decreased 9.5% in fiscal year 2012 (0.5% in fiscal year 2011), mainly due to an unusually mild winter. In fiscal year 2012, the University also experienced a decrease in electricity consumption of 6.2% (10.0% increase in fiscal year 2011). Electricity rates, including distribution and demand charges, decreased approximately 9.7% in fiscal year 2012 and increased 3.6% in fiscal year 2011. Concurrently, supplies and other expenses related to general maintenance and repairs decreased 7.7% (18.1% increase in fiscal year 2011).

- Fiscal year 2012 depreciation expense was lower than fiscal year 2011, mainly due to changes in the capitalization policy in fiscal year 2011 that impacted the capitalization threshold for equipment.

- Auxiliary enterprises expenses increased $0.9 million or 0.6% in fiscal year 2012 (6.3% in fiscal year 2011), primarily due to the hiring of 19 full-time equivalent staff offset by a 18.7% decrease in utilities (8.0% in fiscal year 2011).

- For the fiscal years 2012 and 2011, $3.2 million and $2.5 million, respectively, were expensed in other operating expenses for inspections, fire and safety code updates and other corrective action needed in order to achieve safety goals for all buildings. In fiscal year 2011, the University expensed $3.9 million in other operating expenses due to a cancelled software implementation project in which costs capitalized to date had no realizable value as of June 30, 2011. In addition, $2.7 million was expensed in other operating expenses to correct structural deficiencies related to the Agricultural Biotechnology Laboratory and Advanced Technology Laboratory buildings in fiscal year 2011. For fiscal year 2010, the University expensed an additional $3.3 million in other operating expenses for a project to correct structural deficiencies related to the construction of the Law School Library building. These expenses did not increase the value of the building or extend its useful life (see Note 4). The remaining amounts in other operating expenses include costs not capitalized under University policy such as repairs, project management fees, capital project studies, and mold, lead and asbestos removal projects. These expenses totaled $8.4 million in fiscal year 2012 as compared to $10.7 million in fiscal year 2011.

The pie chart below illustrates operating expenses by function, not netted for financial aid, and also includes other operating expenses. A significant portion of student aid is reflected as an allowance against tuition and fees revenue and sales and services of auxiliary enterprises on the Statements of Revenues, Expenses, and Changes in Net Assets. The chart also shows interest expense and other nonoperating expenses.



STATEMENTS OF CASH FLOWS

The Statements of Cash Flows present detailed information about the cash activity of the University during the year. The first section of these statements, cash flows from operating activities, will always be different from the Statements of Revenues, Expenses, and Changes in Net Assets' operating loss amount. The difference results from noncash items such as depreciation and amortization expense and the use of the accrual basis of accounting in preparing the Statements of Revenues, Expenses, and Changes in Net Assets. These statements show revenues and expenses when incurred, not necessarily when cash is received or used. The Statements of Cash Flows, on the other hand, show cash inflows and outflows without regard to accruals. The Statements of Cash Flows have four additional sections including: cash flows from noncapital financing activities including State appropriation, transfers to State General Fund, gifts and other nonoperating revenues and expenses; cash flows from capital financing activities that reflect the cash received and used by the University for financing, principally capital in nature, capital grants and gifts, and State debt service commitments for principal and interest; cash flows from investing activities showing the purchases, proceeds and interest received from investing activities; and a reconciliation of operating loss reflected on the Statements of Revenues, Expenses, and Changes in Net Assets to net cash used in operating activities.

The following table shows condensed Statements of Cash Flows for the years ended June 30 (in millions):

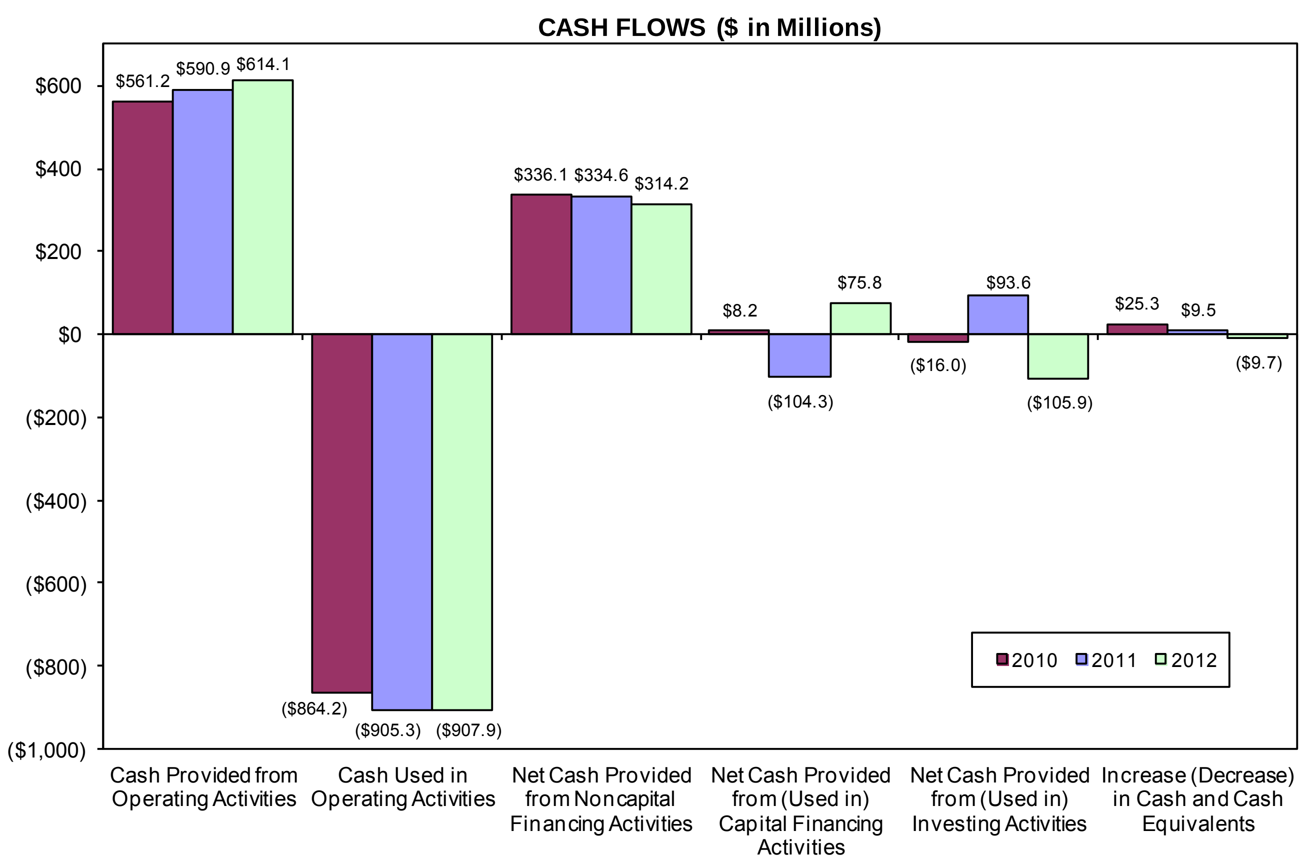
	2012	2011	2010
Cash provided from operating activities	$ 614.1	$ 590.9	$ 561.2
Cash used in operating activities	(907.9)	(905.3)	(864.2)
Net cash used in operating activities	(293.8)	(314.4)	(303.0)
Net cash provided from noncapital financing activities	314.2	334.6	336.1
Net cash provided from (used in) capital financing activities	75.8	(104.3)	8.2
Net cash provided from (used in) investing activities	(105.9)	93.6	(16.0)
Net increase (decrease) in cash and cash equivalents	$ (9.7)	$ 9.5	$ 25.3

Net cash used in operating activities was $293.8 million and $314.4 million in fiscal years 2012 and 2011, respectively, and is consistent with the operating loss discussed earlier after adding back depreciation and amortization, a noncash expense. GASB requires that cash flows from noncapital financing activities include State appropriation and noncapital gifts. Cash flows from these activities totaled $314.2 million in fiscal year 2012 ($334.6 million in fiscal year 2011), a $20.4 million decrease from fiscal year 2011 ($1.5 million from fiscal year 2010).

Cash flows provided by capital financing activities was $75.8 million in fiscal year 2012 and $104.3 million used in fiscal year 2011. The major difference between fiscal years 2012 and 2011 was an increase in proceeds from bonds of $200.0 million in fiscal year 2012 ($105.0 million decrease in fiscal year 2011) and an increase in the amount of purchases of property and equipment of $20.0 million ($10.8 million in 2011).

Net cash used in investing activities was $105.9 million in fiscal year 2012 and $93.6 million provided in fiscal year 2011. The major difference between fiscal years 2012 and 2011 is that $200.0 million in bond proceeds were received in fiscal year 2012 ($0 in fiscal year 2011) which were invested in the deposit with bond trustee.

Total cash and cash equivalents decreased $9.7 million in fiscal year 2012 and increased $9.5 million in fiscal year 2011 as a result of these activities. The following bar graph shows the cash flows from and used by major categories and as described in the preceding paragraphs:



FINANCIAL STATEMENTS

UNIVERSITY OF CONNECTICUT
STATEMENTS OF NET ASSETS
As of June 30, 2012 and 2011

($ in thousands)

	2012	2011
ASSETS		
Current Assets		
Cash and cash equivalents	$ 265,374	$ 275,129
Accounts receivable, net	33,217	34,033
Student loans receivable, net	1,744	1,864
Due from State of Connecticut	52,346	44,319
State debt service commitment	90,600	83,409
Inventories	4,198	3,857
Deposit with bond trustee	160,524	53,730
Deferred charges	785	787
Prepaid expenses	3,515	3,503
Total Current Assets	612,303	500,631
Noncurrent Assets		
Cash and cash equivalents	1,420	1,356
Investments	10,303	10,686
Student loans receivable, net	10,494	10,481
State debt service commitment	828,795	735,015
Property and equipment, net	1,422,789	1,399,263
Deferred charges	7,923	7,481
Total Noncurrent Assets	2,281,724	2,164,282
Total Assets	$ 2,894,027	$ 2,664,913
LIABILITIES		
Current Liabilities		
Accounts payable	$ 25,867	$ 27,691
Deferred income	24,809	24,777
Deposits held for others	2,887	2,362
Wages payable	40,326	55,635
Compensated absences	24,266	21,771
Due to State of Connecticut	14,570	16,984
Due to affiliate (see Note 5)	48,300	6,823
Current portion of long-term debt and bonds payable	88,372	80,589
Other current liabilities	33,360	31,653
Total Current Liabilities	302,757	268,285
Noncurrent Liabilities		
Compensated absences	8,740	12,696
Long-term debt and bonds payable	1,082,351	978,061
Refundable for federal loan program	11,076	10,516
Total Noncurrent Liabilities	1,102,167	1,001,273
Total Liabilities	$ 1,404,924	$ 1,269,558
NET ASSETS		
Invested in capital assets, net of related debt	$ 1,155,616	$ 1,144,923
Restricted nonexpendable	11,574	11,892
Restricted expendable		
Research, instruction, scholarships and other	19,536	17,915
Loans	2,425	2,818
Capital projects	121,015	35,204
Debt service	7,737	7,229
Unrestricted (see Note 1)	171,200	175,374
Total Net Assets	$ 1,489,103	$ 1,395,355

The accompanying notes are an integral part of these financial statements.

UNIVERSITY OF CONNECTICUT
STATEMENTS OF REVENUES, EXPENSES, AND CHANGES IN NET ASSETS
For the Years Ended June 30, 2012 and 2011

($ in thousands)

	2012	2011
OPERATING REVENUES		
Student tuition and fees (Net of scholarship allowances of $111,139 for 2012 and $109,106 for 2011. See Note 1.)	$ 251,017	$ 233,881
Federal grants and contracts	124,478	125,798
State and local grants and contracts	22,078	27,390
Nongovernmental grants and contracts	13,141	11,367
Sales and services of educational departments	17,348	16,161
Sales and services of auxiliary enterprises (Net of scholarship allowances of $3,030 for 2012 and $3,240 for 2011. See Note 1.)	181,974	178,494
Other sources	6,229	6,447
Total Operating Revenues	616,265	599,538
OPERATING EXPENSES		
Educational and general		
Instruction	295,684	292,203
Research	72,761	74,481
Public service	39,636	41,470
Academic support	100,142	98,393
Student services	39,048	39,755
Institutional support	79,103	84,744
Operations and maintenance of plant	64,880	71,365
Depreciation and amortization	88,478	90,335
Student aid	6,107	5,490
Auxiliary enterprises	159,310	158,422
Other operating expenses	11,644	19,740
Total Operating Expenses	956,793	976,398
Operating Loss	(340,528)	(376,860)
NONOPERATING REVENUES (EXPENSES)		
State appropriation	282,370	328,951
State debt service commitment for interest	39,755	39,978
Transfers to State General Fund	-	(15,000)
Gifts	24,377	21,168
Investment income	898	1,020
Interest expense	(47,117)	(48,824)
Other nonoperating expenses, net	(1,635)	(297)
Net Nonoperating Revenues	298,648	326,996
Loss Before Other Changes in Net Assets	(41,880)	(49,864)
OTHER CHANGES IN NET ASSETS		
State debt service commitment for principal	115,400	-
Capital allocation	18,000	(479)
Capital grants and gifts	2,768	1,989
Disposal of property and equipment, net	(540)	(618)
Net Other Changes in Net Assets	135,628	892
Increase (Decrease) in Net Assets	93,748	(48,972)
NET ASSETS		
Net Assets-beginning of year	1,395,355	1,444,327
Net Assets-end of year	$ 1,489,103	$ 1,395,355

The accompanying notes are an integral part of these financial statements.

UNIVERSITY OF CONNECTICUT
STATEMENTS OF CASH FLOWS
For the Years Ended June 30, 2012 and 2011

($ in thousands)

	2012	2011
CASH FLOWS FROM OPERATING ACTIVITIES		
Student tuition and fees	$ 248,473	$ 226,289
Grants and contracts	156,152	161,603
Sales and services of auxiliary enterprises	183,996	179,086
Sales and services of educational departments	17,382	15,692
Payments to suppliers and others	(247,396)	(274,777)
Payments to employees	(491,073)	(463,911)
Payments for benefits	(167,506)	(164,449)
Loans issued to students	(1,965)	(2,167)
Collection of loans to students	2,071	2,077
Other receipts, net	6,059	6,156
Net Cash Used in Operating Activities	(293,807)	(314,401)
CASH FLOWS FROM NONCAPITAL FINANCING ACTIVITIES		
State appropriation	289,771	329,095
Transfers to State General Fund	-	(15,000)
Gifts	24,529	21,071
Other nonoperating expenses, net	(94)	(558)
Net Cash Provided from Noncapital Financing Activities	314,206	334,608
CASH FLOWS FROM CAPITAL FINANCING ACTIVITIES		
Proceeds from bonds	200,000	-
State debt service commitment	116,684	113,530
Purchases of property and equipment	(105,885)	(85,897)
Proceeds from sale of property and equipment	182	396
Principal paid on debt and bonds payable	(88,139)	(82,367)
Interest paid on debt and bonds payable	(48,628)	(51,160)
Capital allocation	151	(10)
Capital grants and gifts	1,441	1,140
Net Cash Provided from (Used in) Capital Financing Activities	75,806	(104,368)
CASH FLOWS FROM INVESTING ACTIVITIES		
Purchase of investments, net	(54)	(18)
Interest on investments	952	1,043
Deposit with bond trustee	(106,794)	92,593
Net Cash Provided from (Used in) Investing Activities	(105,896)	93,618
INCREASE (DECREASE) IN CASH AND CASH EQUIVALENTS	(9,691)	9,457
BEGINNING CASH AND CASH EQUIVALENTS	276,485	267,028
ENDING CASH AND CASH EQUIVALENTS	$ 266,794	$ 276,485

The accompanying notes are an integral part of these financial statements.

UNIVERSITY OF CONNECTICUT
STATEMENTS OF CASH FLOWS (Continued)
For the Years Ended June 30, 2012 and 2011

($ in thousands)

	2012	2011
RECONCILIATION OF OPERATING LOSS TO NET CASH USED IN OPERATING ACTIVITIES		
Operating Loss	$ (340,528)	$ (376,860)
Adjustments to Reconcile Operating Loss to Net Cash Used in Operating Activities:		
Depreciation and amortization expense	88,478	90,335
Property and equipment	(4,995)	1,045
In-kind donations	96	176
In-kind worker's compensation	2,337	-
Obligations under capital leases	1,840	-
Changes in Assets and Liabilities:		
Receivables, net	514	(3,889)
Inventories	(341)	(514)
Prepaid expenses	(12)	(244)
Accounts payable, wages payable and compensated absences	(19,061)	6,638
Deferred income	32	(2,412)
Deferred charges	46	39
Deposits	525	(58)
Due from State of Connecticut	(2,329)	(895)
Due to affiliate	(21,075)	(25,723)
Due from related agencies	-	157
Other liabilities	(1)	(3,202)
Loans to students	667	1,006
Net Cash Used in Operating Activities	$ (293,807)	$ (314,401)

The accompanying notes are an integral part of these financial statements.

UNIVERSITY OF CONNECTICUT
COMPONENT UNIT
THE UNIVERSITY OF CONNECTICUT LAW SCHOOL FOUNDATION, INC.
STATEMENTS OF FINANCIAL POSITION
As of June 30, 2012 and 2011

($ in thousands)

ASSETS	**2012**	**2011**
Current Assets		
Cash and cash equivalents	$ 1,428	$ 1,026
Pledges receivable, net of allowance	392	248
Other receivable	49	51
Prepaid expenses	23	34
Total Current Assets	1,892	1,359
Noncurrent Assets		
Pledges receivable, net of allowance	148	138
Investments	14,990	14,872
Property and equipment, net of accumulated depreciation of $127 for 2012 and $117 for 2011	8	12
Total Noncurrent Assets	15,146	15,022
Total Assets	$ 17,038	$ 16,381
LIABILITIES AND NET ASSETS		
Current Liabilities		
Accounts payable	$ -	$ 5
Total Liabilities	-	5
NET ASSETS		
Unrestricted	1,216	1,243
Temporarily restricted	2,500	2,578
Permanently restricted	13,322	12,555
Total Net Assets	17,038	16,376
Total Liabilities and Net Assets	$ 17,038	$ 16,381

STATEMENTS OF ACTIVITIES
For the Years Ended June 30, 2012 and 2011

($ in thousands)

	Unrestricted	**Temporarily Restricted**	**Permanently Restricted**	**2012 Total**	**2011 Total**
REVENUES AND SUPPORT					
Contributions and grants	$ 440	$ 296	$ 1,044	$ 1,780	$ 1,196
Interest and dividends	23	414	-	437	411
Net realized and unrealized gains	1	42	-	43	1,755
Net assets released from restrictions	830	(830)	-	-	-
Write off of pledges receivable	277	-	(277)	-	-
Total Revenues and Support	1,571	(78)	767	2,260	3,362
EXPENSES					
Program Expenses					
Scholarships and awards	195	-	-	195	184
Student support and faculty support	609	-	-	609	646
Alumni and graduate relations	98	-	-	98	123
Total Program Expenses	902	-	-	902	953
Support Expenses					
Management and general	568	-	-	568	581
Fundraising	128	-	-	128	88
Total Support Expenses	696	-	-	696	669
Total Expenses	1,598	-	-	1,598	1,622
Changes in Net Assets	(27)	(78)	767	662	1,740
Net Assets-beginning of year	1,243	2,578	12,555	16,376	14,636
Net Assets-end of year	$ 1,216	$ 2,500	$ 13,322	$ 17,038	$ 16,376

The accompanying notes are an integral part of these financial statements.

NOTES TO FINANCIAL STATEMENTS

Notes to Financial Statements
For the Years Ended June 30, 2012 and 2011

1. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Related Entities

The University of Connecticut is a comprehensive institution of higher education, which includes the University of Connecticut Health Center (Health Center). Although governed by a single Board of Trustees, the University of Connecticut and its Health Center maintain separate budgets and are by statute separate entities for purposes of maintaining operating funds and appropriations from the State of Connecticut (State). The Health Center also has a Board of Directors to whom the Board of Trustees has delegated certain responsibility and authority. This financial report for the fiscal years ended June 30, 2012 and 2011 represents the transactions and balances of the University of Connecticut (University), herein defined as all programs except the Health Center.

Two related, but independent, corporate entities support the mission of the University: The University of Connecticut Foundation, Inc. (Foundation) (see Note 12) and The University of Connecticut Law School Foundation, Inc. (Law School Foundation). The Foundation raises funds to promote, encourage, and assist education and research at both the University and the Health Center, while the Law School Foundation, with similar objectives, supports only the University.

Governmental Accounting Standards Board (GASB) Statement No. 14, *The Financial Reporting Entity*, as amended by Statement No. 39, *Determining Whether Certain Organizations Are Component Units*, requires that legally separate and tax exempt entities be presented as component units of the reporting entity if they meet all of the following criteria: the economic resources of the organization are entirely or almost entirely for the direct benefit of the reporting unit; the reporting unit is entitled to access all or a majority of the economic resources received or held by the organization; and the economic resources received or held by the organization are significant to the reporting unit. As a result, the Law School Foundation, which is organized for the benefit of the University and whose economic resources can only be used by or for the benefit of the University, is included as a component unit of the University.

The Foundation materially supports the mission of the University and the Health Center, which are separately audited, producing their own financial statements. Displaying the Foundation's financial statements as a component unit of either the University or the Health Center would distort its actual contribution or economic benefit to that entity, and therefore, the Foundation is not included as a component unit in the accompanying financial statements.

Financial Statement Presentation

The financial statements have been prepared using the economic resources measurement focus and the accrual basis of accounting in accordance with accounting principles generally accepted in the United States of America, as prescribed by the GASB.

Effective July 1, 2001, the University adopted GASB Statement No. 35, *Basic Financial Statements - and Management's Discussion and Analysis - for Public Colleges and Universities*, as amended by GASB Statement Nos. 37 and 38. GASB Statement No. 35 establishes standards for financial reporting for public colleges and universities. These reporting standards focus on the University as a whole rather than on accountability by individual fund groups and provide accounting and financial reporting guidelines, enhancing the usefulness and comprehension of financial reports by external users. To that end, GASB requires that resources be classified for accounting and reporting purposes into the following net asset categories:

- **Invested in capital assets, net of related debt:** Capital assets, net of accumulated depreciation and amortization, and reduced by outstanding principal balances of bonds (net of State debt service commitment) and notes that are attributable to the acquisition, construction, or improvement of those assets.

- **Restricted nonexpendable:** Represents endowment and similar type assets in which donors or outside sources have stipulated, as a condition of the gift instrument, that the principal is to be maintained inviolate and in perpetuity and invested for the purpose of producing present and future income, which may be expended or reinvested in principal.

- **Restricted expendable:** Net assets that are expendable but where the University is legally or contractually obligated to spend the resources in accordance with restrictions imposed by external third parties.

- **Unrestricted:** Consists of net assets that do not meet the definition of “restricted” or “invested in capital assets, net of related debt.” These assets are not subject to externally imposed stipulations; however, they are subject to internal designations. For example, unrestricted net assets may be designated for specific purposes by action of management or the Board of Trustees or may otherwise be limited by contractual agreements with outside parties. For the most part all unrestricted net assets are internally designated to support academic and research programs, capital projects, retirement of indebtedness, and auxiliary enterprise activities.

The University follows the “business-type activities” (BTA) requirements of GASB Statement No. 35. BTAs are defined as those that are financed in whole or in part by fees charged to external parties for goods or services. In accordance with BTA reporting, the University presents a Management’s Discussion and Analysis; a Statement of Net Assets; a Statement of Revenues, Expenses, and Changes in Net Assets; a Statement of Cash Flows; and Notes to the Financial Statements. All significant intra-agency transactions have been eliminated.

Expenses are charged to either restricted or unrestricted net assets based on a variety of factors, including consideration of prior or future revenue sources, the type of expense incurred, the University’s budgetary policies surrounding the various revenue sources or whether the expense is a recurring cost.

Certain reclassifications were made to the Statement of Net Assets for the year ended June 30, 2011, to reflect changes in the classification between current and noncurrent liabilities. Additionally, in fiscal year 2012, the University determined that certain activities should be classified as an auxiliary enterprise, instead of as a component of institutional support. To enhance comparability, the amounts presented for the previous year were changed to reflect the reclassification of revenues from other sources to sales and services of auxiliary enterprises, and expenses from institutional support to auxiliary enterprises. For fiscal year 2011, the total reclassification of revenues and expenses were $5.4 million and $3.9 million, respectively. These changes have no effect on operating loss or net assets for the year ended June 30, 2011.

In order to ensure observance of limitations and restrictions placed on the use of the resources available to the University, the accounts of the University are maintained internally following the principles of "fund accounting." This is the procedure by which resources for various purposes are classified for accounting and reporting purposes into funds that are in accordance with specified activities or objectives.

New Accounting Standards

The University’s financial statements and notes for fiscal years 2012 and 2011 as presented herein include the provisions of the following GASB pronouncements:

The University adopted GASB Statement No. 59, *Financial Instruments Omnibus*, as of July 1, 2010. This statement provides additional guidance on existing standards regarding financial reporting and disclosure requirements of certain financial instruments and external investment pools for which significant issues have been identified in practice. There was no significant impact on the financial statements as a result of this adoption.

The University adopted GASB Statement No. 62, *Codification of Accounting and Financial Reporting Guidance Contained in Pre-November 30, 1989 FASB and AICPA Pronouncements*, as of July 1, 2011. This statement incorporates specific guidance found only under pronouncements issued by FASB and the American Institute of Certified Public Accountants (AICPA) into the GASB’s authoritative literature. There was no significant impact on the financial statements as a result of this adoption.

Cash Equivalents (see Note 2)

For the purposes of the Statements of Cash Flows, the University considers all highly liquid investments with an original maturity of three months or less to be cash equivalents. Funds invested in the State of Connecticut Treasurer’s Short-Term Investment Fund are considered cash equivalents.

Investments (see Note 2)

The University accounts for its investments at fair value in accordance with GASB Statement No. 3, *Deposits with Financial Institutions, Investments (including Repurchase Agreements), and Reverse Repurchase Agreements* and GASB Statement No. 40, *Deposit and Investment Risk Disclosures*, an amendment of GASB Statement No. 3. Changes in the unrealized gain (loss) on the carrying value are recorded in Nonoperating Revenues (Expenses) in the accompanying Statements of Revenues, Expenses, and Changes in Net Assets. Noncurrent investments are externally restricted by donors or outside sources that have stipulated as a condition of the gift instrument that the principal be maintained inviolate and in perpetuity. Noncurrent investments also include those amounts restricted by creditors for certain debt service payments (see Note 5).

Accounts and Student Loans Receivable (see Note 3)
Accounts receivable consist of tuition, fees, auxiliary enterprises service fees charged to students, faculty, staff and others, and amounts due from state and federal governments for grants and contracts. Student loans receivable consist primarily of amounts due from students under the Federal Perkins Loan Program, which are subject to significant restrictions. The student loans receivable is classified as current and noncurrent based on the amount estimated to be collected from students in one year and beyond one year. Accounts and student loans receivable are recorded net of an estimated allowance for doubtful accounts.

Inventories
Consumable supplies are expensed when received with the exception of certain central inventories which consist primarily of maintenance and custodial supplies, repair parts, and other general supplies used in the daily operations of the University. Inventory is valued at cost as determined by various methods, including the first-in, first-out method.

Deposit with Bond Trustee (see Note 5)
Tax-exempt bond proceeds are deposited to various accounts held by the Trustee Bank as required by certain trust indentures. The funds are invested and disbursed as directed by the University. The University's bond proceeds investment policy is to balance an appropriate risk-return level heavily weighted towards safety of assets, as defined and permitted under the relative indentures and Connecticut General Statutes.

The University directs the Trustee Bank to invest UCONN 2000 General Obligation construction fund proceeds in the State Treasurer's Short-Term Investment Fund. Similarly, the University has directed the Trustee Bank to invest the debt service funds and cost of issuance for the special obligation bonds in dedicated Short-Term Investment Fund accounts.

Investment earnings from UCONN 2000 General Obligation bond proceeds are retained by the State Treasurer's Office and do not flow to the University or to the Trustee Bank. The Student Fee Revenue Bonds investment earnings are part of the pledged revenues and are directly retained by the Trustee Bank to pay debt service on the bonds or for other indenture permitted purposes. The earnings on the UCONN 2000 General Obligation Debt Service Commitment Refunding Bonds and the Special Obligation Student Fee Revenue Refunding Redemption Fund escrows form part of the irrevocable escrows and are used by the Trustee Bank to meet the debt service payments on the defeased bonds until called.

Deferred Charges – Current and Noncurrent (see Note 10)
Deferred charges consist of payments made in advance of revenues being earned. Deferred charges also represent the cost of issuance which will be amortized over the terms of the respective bond issuances.

Noncurrent Cash and Cash Equivalents (see Note 2)
Noncurrent cash and cash equivalents are related to endowment assets and are externally restricted as to use.

Property and Equipment (see Note 4)
Property and equipment are reported at cost at date of acquisition or fair value at date of donation as in the case of gifts. Property and equipment that are exchanged for other assets are recorded based on the fair value of the asset given up or the fair value of the asset received, whichever value is most clearly evident. Renovations that significantly increase the value or useful life of an asset are capitalized. Routine repairs and maintenance, and certain library materials, are charged to operating expenses in the year incurred. Building components and non-structural improvements have estimated useful lives of 2 years to 60 years. Equipment has estimated useful lives of 3 years to 30 years.

Deferred Income (see Note 10)
Deferred income includes amounts received for services rendered in a future accounting period including tuition and fee revenues and event ticket sales. It also includes amounts received for certain restricted research grants that are included in revenue until the funds are expended.

Compensated Absences (see Note 7)
Employee vacation, holiday, compensatory, and sick leave are accrued at year-end for financial statement purposes. The liability and expense incurred are recorded at year-end as compensated absences in the Statements of Net Assets and in the various expense functions on the Statements of Revenues, Expenses, and Changes in Net Assets. The liability for

compensated absences is also classified as current and noncurrent based on the amount estimated to be paid to employees in one year and beyond one year.

Noncurrent Liabilities
Noncurrent liabilities include the long-term portion of compensated absences of the University, principal payments due on bonds (net of unamortized premiums, discounts, and debt differences), loans and capital leases with a maturity of more than one year, and governmental advances for revolving loan programs that would be returned to the federal government upon cessation of the student loan program.

Revenues and Expenses
Operating revenues consist of tuition and fees, state and federal grants and contracts, sales and services of educational activities, auxiliary enterprises revenue, and other sources of revenue. GASB Statement No. 33, *Accounting and Financial Reporting for Nonexchange Transactions*, requires recipients of government-mandated and voluntary nonexchange transactions to recognize revenue when all applicable eligibility requirements are met for these transactions. Restricted grant revenue that does not meet the nonexchange transaction definition is recognized to the extent expended or in the case of fixed price contracts, when the contract terms are met or completed.

Operating expenses, except for depreciation and amortization and other operating expenses, are reported using functional classification, including those under educational and general and auxiliary enterprises. See Note 14 for operating expenses by natural classification. All other revenues and expenses of the University are reported as nonoperating revenues and expenses including State appropriation, debt service commitment for interest, noncapital gifts, investment income, interest expense, other nonoperating revenues (expenses), net, and other changes in net assets. Revenues are recognized when earned and expenses are recognized when incurred.

GASB Statement No. 35 requires that revenues be reported net of discounts and scholarship allowances. Student aid for scholarships and fellowships, recorded in the Statements of Revenues, Expenses and Changes in Net Assets, includes payments made directly to students. Any aid applied directly to the students' accounts in payment of tuition and fees, housing charges and dining services is reflected as a scholarship allowance and is deducted from the University's revenues. Certain governmental grants, such as Pell grants, and other federal, state or nongovernmental programs, are recorded as operating revenues in the University's financial statements. To the extent that revenues from such programs are used to satisfy tuition and fees and other student charges, the University has recorded a scholarship allowance.

Component Unit
The Law School Foundation prepares its financial statements on the accrual basis of accounting in accordance with accounting principles generally accepted in the United States of America. Net assets, revenues and expenses are classified based on the terms of donor-imposed restrictions, if any. Accordingly, the Law School Foundation's net assets and changes therein are classified and reported as follows:

- **Unrestricted Net Assets:** Net assets that are not subject to donor-imposed restrictions.
- **Temporarily Restricted Net Assets:** Net assets subject to donor-imposed stipulations that may or will be met, either by actions of the Law School Foundation and/or passage of time. When the restriction expires, temporarily restricted net assets are reclassified to unrestricted net assets.
- **Permanently Restricted Net Assets:** Net assets subject to donor-imposed stipulations that they be maintained permanently by the Law School Foundation. Generally, the donors of these assets permit the Foundation to use all or part of the income earned on related investments for general or specific purposes.

Contributions, including unconditional promises to give, are recognized as revenue in the period received. Conditional promises to give are not recognized as revenue until the conditions on which they depend are substantially met. Investments are reported at fair value based upon quoted market prices. Certain amounts reported in 2011 have been reclassified in order to conform to the current year presentations.

2. CASH AND CASH EQUIVALENTS AND INVESTMENTS

GASB Statement No. 40 requires governmental entities to disclose credit risk associated with cash deposits and investment balances, and investment policies applied to mitigate such risks, especially as they relate to uninsured and unregistered investments for which the securities are held by the broker or dealer, or by its trust department or agent, but not in the University's name.

The University’s total cash and cash equivalents balance was $266.8 million and $276.5 million as of June 30, 2012 and 2011, respectively, and included the following (amounts in thousands):

	2012	2011
Cash maintained by State of Connecticut Treasurer	$ 244,342	$ 246,766
Invested in State of Connecticut Short-Term Investment Fund	16,953	16,491
Invested in State of Connecticut Short-Term Investment Fund - Endowments	1,420	1,356
Invested in Short-Term Corporate Notes	2,639	2,504
Deposits with Financial Institutions and Other	1,440	9,368
Total cash and cash equivalents	266,794	276,485
Less: current balance	265,374	275,129
Total noncurrent balance	$ 1,420	$ 1,356

Collateralized deposits are protected by Connecticut statute. Under this statute, any bank holding public deposits must at all times maintain, segregated from its other assets, eligible collateral in an amount equal to at least a certain percentage of its public deposits. The applicable percentage is determined based on the bank's risk-based capital ratio – a measure of the bank's financial condition. The collateral is kept in the custody of the trust department of either the pledging bank or another bank in the name of the pledging bank. Portions of the bank balance of the State are insured by the Federal Deposit Insurance Corporation or collateralized. As a State agency, the University benefits from this protection, though the extent to which the deposits of an individual State agency such as the University are protected cannot be readily determined.

Short-Term Investment Fund (STIF) is a money market investment pool in which the State, municipal entities, and political subdivisions of the State are eligible to invest. The State Treasurer is authorized to invest monies of STIF in United States government and agency obligations, certificates of deposit, commercial paper, corporate bonds, savings accounts, bankers’ acceptances, repurchase agreements, asset-backed securities, and student loans. For financial reporting purposes, STIF is considered to be “cash equivalents” in the Statement of Net Assets.

The University's cash management investment policy permits the University to invest in STIF, United States Treasury bills, United States Treasury notes and bonds, United States Government Agency obligations, banker's acceptances, certificates of deposit (including EURO Dollars), commercial paper, money market funds, repurchase agreements, and savings accounts. Cash and cash equivalents include amounts of $17.0 million and $1.4 million invested in STIF, which had a Standard and Poor’s rating of AAAm during fiscal year 2012. The $2.6 million invested in Short-Term Corporate Notes during fiscal year 2012 includes repurchase agreements held with a financial institution and is collateralized by the Federal National Mortgage Association and the Federal Home Loan Mortgage Corporation, both of which had an AA+ Standard and Poor’s rating.

The University designated the Foundation as the manager of the University's endowment funds. Gifts that are internally designated as endowments, and externally designated endowment gifts that are to be processed for transfer to the Foundation, are included in cash and cash equivalents. The Foundation makes spending allocation distributions to the University for each participating endowment. The distribution is spent by the University in accordance with the respective purposes of the endowments, the policies and procedures of the University and State statutes, as well as in accordance with the Foundation’s endowment spending policy described below.

The endowment spending policy adopted by the Foundation's Board of Directors, in conjunction with the strategic asset allocation policy for the long-term pooled investment portfolio, is designed to provide reliable growth in annual spending allocation levels and to preserve or increase the real value of the endowment principal over time. To meet these objectives, the Foundation utilizes a total return investment approach, with total return consisting of interest and dividends as well as realized and unrealized gains and losses, net of management fees.

Prior to Connecticut's adoption of the Uniform Prudent Management of Institutional Funds Act (UPMIFA), the Foundation's endowment spending allocation policy adhered to the predecessor, Uniform Management of Institutional Funds Act (UMIFA), which restricted spending from an endowment fund if its fair value had fallen below its historic dollar value. UPMIFA considers prudence, maintaining an endowment fund in perpetuity and eliminates the historic dollar value concept. Therefore, spending can occur from an endowment fund whose fair value is below its historic value as long as the governing body has determined that its policies will continue the perpetual nature of the endowment over time. The Foundation amended its endowment spending allocation policy in February 2009 in recognition of the change in approach to spending under UPMIFA. Calculations are performed for individual endowment funds at a rate of 4.25% of the rolling 12 quarter average market value on a unitized basis on March 31st each year for the following fiscal year beginning July 1st. The corresponding calculated spending allocations are distributed in equal quarterly installments on the first day of each quarter from the accumulated net total investment return for individual endowment funds where available, otherwise from principal.

An administrative fee is assessed to fund expenses incurred in meeting the Foundation's fiduciary and fundraising responsibilities to donors and the University. This on-going administrative fee is also assessed based on a rolling 12 quarter unitized market value calculated on March 31st each year for the following fiscal year beginning July 1st at a rate of 1.25% to cover the estimated cost of meeting the fiduciary responsibilities associated with each endowment. The calculated fee is charged in equal quarterly installments on the first day of each quarter from the accumulated net total investment return for individual endowment funds where available, otherwise from principal.

The endowment spending allocation and administrative fee taken together cannot exceed 6.5% or fall below 3.0% of the fair value of endowment funds at March 31st. Should this occur, the calculated amounts will be decreased or increased, respectively, on a pro rata basis.

Over the long term, the Foundation expects the current spending allocation and administrative fee policies to allow endowments to grow at least at the annualized rate of inflation on average. This is consistent with the organization's objective of providing resources for the underlying purposes of endowment assets over the life of the endowments whether in perpetuity or for a specified term, as well as to provide additional growth through new gifts and investment return.

University endowment investments are managed by the Foundation in a pooled portfolio, which is actively managed by professional investment managers as determined by the Investment Committee of the Foundation's Board of Directors. The Foundation has established asset allocation guidelines for the pooled investment portfolio, which provides that the maximum exposure with any one manager would be 20% for liquid assets and 5% for illiquid assets. The Foundation's Board of Directors also established an asset allocation policy for the long-term pooled investment portfolio (see following table). The Foundation expects that portfolios will be invested in only the strategies described in the table, not above or below the individual strategy percentage and its total percentage by objective, unless otherwise specified by its Board of Directors.

Investment Objective/Strategies	Allocation Range as Percentage of Market Value
Growth	
High yield fixed income	0% - 10%
Global equities	0% - 70%
Private capital	0% - 20%
Global macro strategies	0% - 10%
Event driven strategies (ex diversified)	0% - 10%
Real estate (public & private)	0% - 10%
Other opportunistic	0% - 10%
Total Growth	40% - 85%
Inflation Hedge	
TIPS	0% - 10%
Natural resources/commodities	0% - 15%
Other inflation hedging strategies	0% - 10%
Total Inflation Hedge	5% - 25%
Risk Minimizing	
Investment grade fixed income	0% - 20%
Relative value/Event driven (diversified)	0% - 15%
Cash equivalents	0% - 10%
Other low volatility strategies	0% - 10%
Total Risk Minimizing	5% - 40%

The endowments invested with the Foundation are subject to risk due to the uncollateralized nature of most of its investments. Certain investments of the Foundation include external investment pools. The bond mutual funds had average credit quality of Aa1/AA (Moody's and Standard and Poor's) and pooled investments of high yield fixed income had an average credit quality of B1/B+ (Moody's and Standard and Poor's). The University endowment's foreign publicly traded equities totaled $1.3 million and $1.6 million and private capital investments totaled approximately $1.9 million and $1.8 million at June 30, 2012 and 2011, respectively.

The University also holds a partnership interest in Campus Associates Limited Partnership (see Note 12). The cost basis was used to estimate fair market value for this investment because the fair value was not readily available as of June 30, 2012 and 2011. As a result, the estimated fair value may differ from the value that would have been assigned had a ready market for such an investment existed; however, it is unlikely that such differences would be material.

The cost and fair value of the University's investments including those managed by the Foundation at June 30, 2012 and 2011 were (amounts in thousands):

	2012		2011	
	Cost	Fair Value	Cost	Fair Value
Endowments:				
Foundation Managed	$ 9,550	$ 10,153	$ 9,496	$ 10,536
Other:				
Campus Associates Limited Partnership Interest	150	150	150	150
Total Investments	$ 9,700	$ 10,303	$ 9,646	$ 10,686

Certain other funds are held in trust for investment by outside trustees. The University is designated as the income beneficiary and the funds are not under the direct control of the University. Accordingly, the assets of these funds are not included in the financial statements. The fair value of these funds was $12.0 million and $12.6 million as of June 30, 2012 and 2011, respectively. Investment income earned on these assets is transferred to the University in accordance with applicable trust agreements. Income received from those sources for the years ended June 30, 2012 and 2011 was $486,000 and $433,000, respectively.

3. ACCOUNTS AND STUDENT LOANS RECEIVABLE

Accounts receivable at June 30, 2012 and 2011 consisted of the following (amounts in thousands):

	2012	2011
Grants and contracts	$ 22,477	$ 21,338
Student and general	16,180	17,655
Investment income	79	133
Allowance for doubtful accounts	(5,519)	(5,093)
Total accounts receivable, net	$ 33,217	$ 34,033

The University participated in the U.S. Department of Education Federal Direct Lending program during fiscal years 2012 and 2011 and distributed student loans through this program of $162.0 million and $157.0 million, respectively. These distributions and related funding are not reflected as expenses and revenues or as cash disbursements and cash receipts in the accompanying financial statements. The excess of direct loans distributed over funding received from the U.S. Department of Education as of June 30, 2012 and 2011 was $93,000 and $10,000, respectively, and these amounts were included as receivables under grants and contracts.

Student loans receivable are substantially comprised of amounts owed from students under the Federal Perkins Loan Program and was reported separately from accounts receivable on the Statements of Net Assets, net of an allowance for doubtful accounts of $1.1 million at June 30, 2012 and 2011.

4. PROPERTY AND EQUIPMENT

Land, buildings, non-structural improvements, and equipment are reported at cost at date of acquisition or fair value at date of donation as in the case of gifts. Property and equipment that are exchanged for other assets are recorded based on the fair value of the asset given up or the fair value of the asset received, whichever value is most clearly evident. Any gains or losses on the exchange are recognized immediately.

Depreciation and amortization are recorded on a straight-line basis over the estimated useful lives of the respective assets. Building components and non-structural improvements have estimated useful lives of 2 years to 60 years. Equipment has estimated useful lives of 3 years to 30 years. Library materials have an estimated useful life of 15 years. The value of library materials, before depreciation, was $80.1 million and $79.4 million at June 30, 2012 and 2011, respectively. Historical collections and art are recognized at their estimated fair values at the time of donation, and are not depreciated. Historical collections and art totaled $53.4 million and $52.8 million at June 30, 2012 and 2011, respectively. Capitalized software has an estimated life of 3 years to 5 years. The value of capitalized software, before amortization, was $25.1 million and $16.4 million at June 30, 2012 and 2011, respectively. Library materials, historical collections and art, and capitalized software are all included in equipment in the schedule of Changes in Property and Equipment.

On July 1, 2010, the University increased the capitalization threshold for equipment from $1,000 to $5,000. Equipment previously capitalized under the $5,000 threshold will be written-off when it becomes fully depreciated. For the years ended June 30, 2012 and 2011, a total of $13.9 million and $42.9 million, respectively, of fully depreciated equipment falling under the new threshold is included in equipment retirements.

For the year ended June 30, 2011, a total of $2.7 million was expensed in the accompanying Statements of Revenues, Expenses, and Changes in Net Assets in other operating expenses for a project to correct structural deficiencies related to the construction of the Agricultural Biotechnology Laboratory and Advanced Technology Laboratory buildings. These expenses will not increase the value of the buildings or extend its useful life. While the University is pursuing remedies from the original construction and design professionals involved in the original construction of the building, the total amount that may be recovered is unknown as of the date of these financial statements.

For the years ended June 30, 2012 and 2011, a total of $3.2 million and $2.5 million, respectively, were expensed in the accompanying Statements of Revenues, Expenses, and Changes in Net Assets in other operating expenses for inspections, fire and safety code updates, and other corrective action needed in order to achieve safety goals for all buildings. At June 30, 2012 and 2011, an accrual for estimated expenses to complete these projects totaling $8.8 million and $12.1 million, respectively, was recorded in other current liabilities in the Statement of Net Assets. While the University intends to pursue the recovery of costs related to the code updates and corrective work, the total amount to be recovered is unknown as of the date of these financial statements.

For the year ended June 30, 2011, a total of $3.9 million was expensed in other operating expenses in the accompanying Statements of Revenues, Expenses, and Changes in Net Assets for costs related to the implementation of certain software. The project was cancelled subsequent to June 30, 2011, and it was determined that costs capitalized to date had no realizable value as of June 30, 2011.

The following table describes the changes in property and equipment for the years ended June 30, 2012 and 2011 (amounts in thousands):

Changes in Property and Equipment for the Year Ended June 30, 2012:

	Balance July 1, 2011	Additions	Retirements	Transfers and other	Balance June 30, 2012
Property and equipment:					
Land	$ 14,676	$ -	$ (19)	$ -	$ 14,657
Non-structural improvements	205,766	3,450	-	8,351	217,567
Buildings	1,643,933	16,065	(1,844)	50,734	1,708,888
Equipment	396,841	26,088	(26,267)	-	396,662
Construction in progress	83,433	67,123	-	(59,085)	91,471
Total property and equipment	2,344,649	112,726	(28,130)	-	2,429,245
Less accumulated depreciation and amortization:					
Non-structural improvements	99,318	7,761	-	-	107,079
Buildings	619,902	55,450	(1,574)	-	673,778
Equipment	226,166	25,267	(25,834)	-	225,599
Total accumulated depreciation and amortization	945,386	88,478	(27,408)	-	1,006,456
Property and equipment, net:					
Land	14,676	-	(19)	-	14,657
Non-structural improvements	106,448	(4,311)	-	8,351	110,488
Buildings	1,024,031	(39,385)	(270)	50,734	1,035,110
Equipment	170,675	821	(433)	-	171,063
Construction in progress	83,433	67,123	-	(59,085)	91,471
Property and equipment, net:	$ 1,399,263	$ 24,248	$ (722)	$ -	$ 1,422,789

Changes in Property and Equipment for the Year Ended June 30, 2011:

	Balance July 1, 2010	Additions	Retirements	Transfers and other	Balance June 30, 2011
Property and equipment:					
Land	$ 14,826	$ -	$ (150)	$ -	$ 14,676
Non-structural improvements	196,282	5,371	(188)	4,301	205,766
Buildings	1,618,618	15,318	(1,507)	11,504	1,643,933
Equipment	428,736	18,485	(50,380)	-	396,841
Construction in progress	45,330	53,908	-	(15,805)	83,433
Total property and equipment	2,303,792	93,082	(52,225)	-	2,344,649
Less accumulated depreciation and amortization:					
Non-structural improvements	91,805	7,701	(188)	-	99,318
Buildings	565,315	55,611	(1,024)	-	619,902
Equipment	249,143	27,023	(50,000)	-	226,166
Total accumulated depreciation and amortization	906,263	90,335	(51,212)	-	945,386
Property and equipment, net:					
Land	14,826	-	(150)	-	14,676
Non-structural improvements	104,477	(2,330)	-	4,301	106,448
Buildings	1,053,303	(40,293)	(483)	11,504	1,024,031
Equipment	179,593	(8,538)	(380)	-	170,675
Construction in progress	45,330	53,908	-	(15,805)	83,433
Property and equipment, net:	$ 1,397,529	$ 2,747	$ (1,013)	$ -	$ 1,399,263

5. LONG-TERM DEBT PAYABLE

Public Act No. 95-230 enabled the University to borrow money in its own name for a special ten year capital improvement program (UCONN 2000) designed to modernize, rehabilitate, and expand the physical plant of the University. It authorized projects for Phases I and II of UCONN 2000, estimated to cost $1,250.0 million, of which $962.0 million was to be financed by bonds of the University; $18.0 million was to be funded by State general obligation bonds; and the balance of $270.0 million to be financed by gifts, other revenue, or borrowing resources of the University.

In fiscal year 2002, the General Assembly of the State of Connecticut enacted and the Governor signed into law Public Act No. 02-3 of the May 9 Special Session, An Act Concerning 21st Century UConn (Act). The new Act authorized additional projects for the University and the Health Center for what is called Phase III of UCONN 2000 at an estimated cost of $1,348.4 million of which $1,300 million is to be financed by bonds of the University. This Act amended Public Act No. 95-230 and extended the UCONN 2000 financing program that was scheduled to end in 2005, for an additional 10 years to June 30, 2015. The 21st Century UConn program was amended in fiscal year 2008, extending it an additional year to June 30, 2016, without any change in the total amount. In fiscal year 2010, the Act was amended again including a $25.0 million reallocation from existing UCONN 2000 Health Center allocations, and a $207.0 million increase in UCONN 2000 debt service commitment authorizations for the UConn Health Network. This also extended the UCONN 2000 program two additional years to fiscal year 2018. In fiscal year 2011, the General Assembly enacted and the Governor signed Public Act No. 11-75, An Act Concerning the University of Connecticut Health Center, which increased the authorized project costs for the Health Center under Phase III by $262.9 million. The Act, as amended, authorized projects under Phase III at a total estimated cost of $1,818.3 million, of which $1,769.9 million is to be financed by bonds of the University and $48.4 million is to be financed by the issuance of special obligation bonds of the University, from gifts, other revenue or borrowing resources of the University, or through the deferring of projects or achieved savings. Total project costs estimated under Phase III are $775.3 million for the Health Center and $1,043.0 million for the University.

The total estimated cost for the UCONN 2000 program, including Phases I, II and III, is $3,068.3 million.

The table below lists general obligation bonds issued to finance UCONN 2000 projects as of June 30, 2012 (amounts in thousands). Please refer to the subsequent detailed schedules for outstanding balances.

1996 Series A	$ 83,930
1997 Series A	124,392
1998 Series A	99,520
1999 Series A	79,735
2000 Series A	130,850
2001 Series A	100,000
2002 Series A	100,000
2003 Series A	96,210
2004 Series A	97,845
2005 Series A	98,110
2006 Series A	77,145
2007 Series A	89,355
2009 Series A	144,855
2010 Series A	97,115
2011 Series A	179,730
Total issued	$ 1,598,792

The University has also issued several series of general obligation refunding bonds, providing debt service savings for bonds refunded in advance of maturity. Sufficient proceeds were deposited into irrevocable escrow accounts held by the Trustee Bank to meet all obligations on the refunded debt (see Note 1) and invested in U.S. Treasury, State and Local Government Securities and cash in accordance with the Escrow Agreement. These bonds are general obligations of the University, for which its full faith and credit are pledged, and are payable from all assured revenues. The bonds are additionally secured by the pledge of and a lien upon the State debt service commitment. The State debt service commitment is the commitment by the State to pay an annual amount of debt service on securities issued as general obligations of the University. The University, consistent with the Act, is relying upon the receipt of the annual amount of the pledged State debt service commitment for the payment of the bonds and, accordingly, is not planning to budget any revenues for the payment of these bonds. Under the Master Indenture, the University expects to issue additional bonds to finance UCONN 2000 projects secured by the State debt service commitment.

In fiscal year 2012, the University recorded $179.7 million as State debt service commitment for principal together with part of the original issue premium, which resulted in total proceeds of $200.0 million for the 2011 Series A bonds. The proceeds included $62.5 million to finance projects for the Health Center for fiscal year 2012. As bonds are issued, the amount of the commitment for the Health Center is reflected as an offset to the revenue for the University. In fiscal year 2012, this offset to finance projects for the Health Center resulted in net revenue of $115.4 million, recorded in the Other Changes in Net Assets section of the Statements of Revenues, Expenses, and Changes in Net Assets in the accompanying financial statements. A corresponding liability is recorded in due to affiliate in the Statements of Net Assets for the unspent portion of the bonds due to the Health Center ($48.9 million and $6.8 million at June 30, 2012 and 2011, respectively). Also, for the years ended June 30, 2012 and 2011, nonoperating revenues include the State debt service commitment for interest on general obligation bonds of $39.8 million and $40.0 million, respectively. A portion of interest on general obligation bonds is associated with Health Center projects.

In addition to the 2011 Series A bonds, during fiscal year 2012, the University issued the 2011 Refunding Series A bonds to refund portions of the previously issued Series A General Obligation Bonds in advance of maturity. The difference between the carrying value of the defeased debt and its reacquisition price (refunding bonds) is amortized over the remaining life of the debt, and the reduction of the face value of the bonds in the amount of $1.8 million is reflected as an expense in fiscal year 2012 on the Statement of Revenues, Expenses, and Changes in Net Assets under State debt service commitment for principal. The refunding reduced the general obligation debt service payments in future years by approximately $1.9 million and resulted in an economic gain (the present value of the savings) of approximately $1.7 million.

The following table reflects the change in debt as a result of this Series A 2011 refunding (amounts in thousands):

2003 Series A	$ 11,135
2004 Series A	22,600
Total defeased debt	33,735
Total refunding bonds	31,905
Decrease in bonds as a result of refunding	$ 1,830

In fiscal year 2011, there were no general obligation bonds issued or refunded.

The University may also issue special obligation bonds, also called student fee revenue bonds, which are backed by certain pledged revenues of the University. In 1998, 2000 and 2002, the University issued $33.6 million, $89.6 million and $75.4 million of special obligation bonds, respectively, to fund new construction of dormitories, apartments, a parking garage, and the renovations of several dormitories. The 2000 special obligation bonds were refunded in advance of maturity in fiscal year 2002 with the issuance of $96.1 million in refunding bonds. The 1998 and a portion of the 2002 special obligation bonds were refunded in advance of maturity in fiscal year 2010 with the issuance of $47.5 million refunding bonds. Similar to general obligation bond refundings, the proceeds from special obligation or student fee revenue bond refundings are deposited into certain escrow accounts to meet all obligations of the refunded maturities. In fiscal years 2012 and 2011, there were no special obligation bonds issued or refunded.

The special obligation bonds are secured by certain pledged revenues, as defined in the indenture, including gross and net revenue amounts. The total gross and net pledged revenues from tuition and fees, auxiliary, investment and other revenues of the University were approximately $75.4 million and $73.2 million in fiscal years 2012 and 2011, respectively. Gross pledged revenues include the infrastructure maintenance fee and the general university fee plus investment income on the bond accounts held by the Trustee Bank, prior to any payments, deductions, offsets, or provisions. Net pledged revenues include the residential life room fee, student apartment rentals, Greek housing fee, the board (dining) fee, and the parking and transportation fees, after providing for the cost of maintaining, repairing, insuring, and operating the facilities for which the fees are imposed. In addition to securing revenue bonds, the gross and net pledged revenues available are pledged toward certain other debt. The University has covenanted to collect in each fiscal year, fees representing pledged revenues so that the sum of gross and net revenue amounts is no less than 1.25 times the debt service requirements in such fiscal year for the special obligation bonds.

The total principal and interest remaining to be paid on all special obligation bonds as of June 30, 2012 and 2011 was $231.5 million and $244.2 million, respectively. The total amount paid by pledged revenues were $5.1 million for the principal and $7.6 million for the interest of this debt in both fiscal years 2012 and 2011.

Subsequent to the year ended June 30, 2012, the University issued $88.0 million of special obligation student fee revenue bonds, 2012 Refunding Series A, to refund $106.0 million of the 2002 Series A Bonds and 2002 Refunding Series A bonds previously issued. The sale of this issue concluded in November 2012, with the closing date of December 13, 2012.

Net unamortized premium, discounts, and debt differences due to refundings are recorded as additions to the face value of bonds payable. These amounts are amortized using the straight-line basis over the life of the bonds, reducing interest expense for premiums and increasing it for discounts.

The State issues certain general obligation bonds that are categorized as self-liquidating bonds. These bonds were issued to fund the construction and renovations of revenue-generating capital projects. The University reimburses the State primarily with revenue from student fee charges in the amount equal to the debt service on self-liquidating bonds.

During fiscal year 2009, the University purchased a unit in Campus Associates Limited Partnership for $50,000 and the loan related to this purchase was retired during fiscal year 2011.

Long-term debt activity, including refunding of debt, for the years ended June 30, 2012 and 2011 was as follows (amounts in thousands):

Long-term Debt Activity for the Year Ended June 30, 2012:

	Balance July 1, 2011	Additions	Retirements	Balance June 30, 2012	Current portion
General obligation bonds	$ 804,310	$ 211,635	$ (112,395)	$ 903,550	$ 74,755
Revenue bonds	159,290	-	(5,120)	154,170	5,705
Self liquidating bonds	2,953	-	(782)	2,171	569
Installment loans	150	1,840	(263)	1,727	408
Obligation under capital lease for Cogeneration	66,098	-	(3,313)	62,785	3,465
Total long-term debt	1,032,801	213,475	(121,873)	1,124,403	84,902
Premiums/discounts/debt difference due to refunding	25,849	24,663	(4,192)	46,320	3,470
Total long-term debt, net	$ 1,058,650	$ 238,138	$ (126,065)	$ 1,170,723	$ 88,372

Long-term Debt Activity for the Year Ended June 30, 2011:

	Balance July 1, 2010	Additions	Retirements	Balance June 30, 2011	Current portion
General obligation bonds	$ 877,492	$ -	$ (73,182)	$ 804,310	$ 69,295
Revenue bonds	164,375	-	(5,085)	159,290	5,120
Self liquidating bonds	3,793	-	(840)	2,953	781
Installment loans	241	-	(91)	150	89
Obligation under capital lease for Cogeneration	69,267	-	(3,169)	66,098	3,314
Campus Associates Limited Partnership loan	12	-	(12)	-	-
Total long-term debt	1,115,180	-	(82,379)	1,032,801	78,599
Premiums/discounts/debt difference due to refunding	27,956	-	(2,107)	25,849	1,990
Total long-term debt, net	$ 1,143,136	$ -	$ (84,486)	$ 1,058,650	$ 80,589

Long-term debt outstanding at June 30, 2012 and 2011 consisted of the following (amounts in thousands):

Type of debt and issue date	Type of issue	Principal payable	Maturity dates through fiscal year	Interest rate*	Balance 2012	Balance 2011
Bonds:						
GO 2002 Series A	original	annually	2012	4.3%	$ -	$ 5,000
GO 2003 Series A	original	annually	2013	3.2-4.4%	4,735	20,595
GO 2004 Series A	original	various	2024	3.0-5.0%	27,055	54,550
GO 2004 Ref. Series A	refund	annually	2020	3.9-5.0%	149,730	174,080
GO 2005 Series A	original	annually	2025	3.625-3.7%	60,530	65,430
GO 2006 Series A	original	annually	2026	4.0-5.0%	53,990	57,850
GO 2006 Ref. Series A	refund	annually	2020	3.2-5.0%	59,555	59,555
GO 2007 Series A	original	annually	2027	3.6-5.0%	63,005	68,275
GO 2007 Ref. Series A	refund	various	2022	5.0%	46,030	46,030
GO 2009 Series A	original	annually	2029	3.0-5.0%	122,815	130,165
GO 2010 Series A	original	annually	2030	3.0-5.0%	87,400	92,260
GO 2010 Ref. Series A	refund	annually	2021	2.0-5.0%	26,435	30,520
GO 2011 Series A	original	annually	2031	3.515-5.0%	170,745	-
GO 2011 Ref. Series A	refund	various	2023	2.0-5.0%	31,525	-
Total general obligation bonds					903,550	804,310
Rev 2002 Series A	original	various	2030	4.758-5.0%	32,430	34,425
Rev 2002 Ref. Series A	refund	annually	2030	4.5-5.25%	76,230	78,410
Rev 2010 Ref. Series A	refund	annually	2028	3.0-5.0%	45,510	46,455
Total revenue bonds					154,170	159,290
March 1993	original	annually	2012	5.5%	-	65
October 1993	refund	various	2012	6.0%	-	206
June 2001	refund	annually	2016	4.4 -5.5%	301	377
November 2001	refund	annually	2014	5.0-5.125%	592	883
August 2002	refund	various	2016	3.75-5.25%	552	552
April 2005	refund	various	2017	4.37-5.25%	275	275
December 2007	refund	annually	2015	5.0%	451	595
Total self liquidating bonds					2,171	2,953
Total bonds					1,059,891	966,553
Loans and other debt:						
Installment loans		various	various	1.01-1.959%	1,727	150
Obligation under capital lease for Cogeneration		monthly	2026	4.42-5.09%	62,785	66,098
Total loans and other					64,512	66,248
Total bonds, loans and installment purchases					1,124,403	1,032,801
Premiums/discounts/debt difference due to refunding					46,320	25,849
Total bonds, loans and installment purchases, net					1,170,723	1,058,650
Less: current portion, net					88,372	80,589
Total noncurrent portion, net					$ 1,082,351	$ 978,061

**Weighted average coupon rates averaged by year of redemption.*

Long-term debt including general obligation bonds, revenue bonds and loans are scheduled to mature in the following fiscal years as of June 30 (amounts in thousands):

	General obligation bonds			Long-term debt other than general obligation bonds			Total obligations		
Year(s)	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total
2013	$ 74,755	$ 41,998	$ 116,753	$ 10,147	$ 10,184	$ 20,331	$ 84,902	$ 52,182	$ 137,084
2014	77,750	38,502	116,252	10,440	9,751	20,191	88,190	48,253	136,443
2015	77,595	35,145	112,740	10,877	9,267	20,144	88,472	44,412	132,884
2016	72,965	31,561	104,526	11,227	8,750	19,977	84,192	40,311	124,503
2017	71,295	28,146	99,441	11,480	8,227	19,707	82,775	36,373	119,148
2018-2022	293,325	94,183	387,508	63,584	32,818	96,402	356,909	127,001	483,910
2023-2027	170,905	37,686	208,591	69,928	16,855	86,783	240,833	54,541	295,374
2028-2032	64,960	6,809	71,769	33,170	2,804	35,974	98,130	9,613	107,743
Total	$ 903,550	$ 314,030	$ 1,217,580	$ 220,853	$ 98,656	$ 319,509	$ 1,124,403	$ 412,686	$ 1,537,089

6. RETIREMENT PLANS AND POST EMPLOYMENT BENEFITS

All eligible employees participate in essentially one of three retirement plans. The State Employees' Retirement System (SERS), a single-employer defined-benefit pension plan, is administered by the State and covers approximately 40% of the University's eligible employees. Plan benefits and contribution requirements of plan members and the University are described in Section 5-152 to 5-192 of the General Statutes. The State is statutorily responsible for the pension benefits of University employees who participate in this plan; therefore, no liability for pension benefits is recorded in the University's financial statements. The State is required to contribute at an actuarially determined rate, which may be reduced by an act of the State legislature. The plan does not issue stand-alone financial reports. Information on the plan is publicly available in the State of Connecticut's Comprehensive Annual Financial Report.

The University also sponsors the Alternative Retirement Plan (ARP) for unclassified eligible employees, a defined contribution plan administered through a third-party administrator, ING Life Insurance and Annuity Company. Plan provisions, including contribution requirements of plan members and the University, are described in Section 5-156 of the General Statutes.

In accordance with the State Employees Bargaining Agency Coalition (SEBAC) ARP Grievance Award signed by the State and SEBAC on September 22, 2010, employees enrolled in ARP have the one-time opportunity to make their irrevocable choice to either remain in ARP or transfer to SERS. The University employs approximately 2,600 individuals eligible for the conversion. If eligible individuals choose to convert to SERS, fringe benefit costs for these individuals would increase. The deadline for this election shall be determined following receipt of the Internal Revenue Service Private Letter Ruling. It is unclear at this time what the financial impact on the University will be, if any.

On July 22, 2011, an agreement between the State and SEBAC was signed which created a new hybrid plan option for professional employees of higher education institutions. In accordance with the 2011 SEBAC agreement, all employees hired on or after July 1, 2011, that are otherwise eligible for the ARP, shall have the choice to enroll into a new hybrid plan, in addition to the other two retirement plan options. Also, employees who are currently members of the ARP will be eligible to join the hybrid plan on a one time option at the full actuarial cost. The hybrid plan has defined benefits identical to SERS, but will require additional employee contributions, and have the option of taking out a lump sum cash payment, including interest, at the time of retirement in lieu of a lifetime benefit. The University makes contributions on behalf of the employees for all plans, through a fringe benefit charge assessed by the State.

Employees previously qualified for the Teachers' Retirement System (TRS) continue coverage during employment with the University, and do not participate in the above mentioned retirement plans. TRS is a single-employer defined-benefit plan covering any teacher, principal, superintendent, or supervisor engaged in service of public schools in the State. Plan benefits and required contributions of plan members and the University, are described in Section 10-183b to 10-183pp of the General Statutes.

With respect to the University's Department of Dining Services (DDS), of its approximately 520 full-time employees, 73 participate in either the State Employees' Retirement System or ARP, while 447 are eligible to participate in two other retirement plans: the Department of Dining Services Money Purchase Pension Plan (MPPP) or the University of Connecticut Department of Dining Services 403(b) Retirement Plan. Under the provisions of MPPP, the University DDS is required to contribute 6% or 7% of employee's covered compensation for eligible employees and its employees do not make any contributions to the Plan. The MPPP is a defined contribution plan administrated through a third-party administrator, Pension Consultants, Inc. On behalf of MPPP participants, DDS contributed $590,000 and $575,000 to the plan for the years ended June 30, 2012 and 2011, respectively.

In addition to the pension benefits, the State provides post retirement health care and life insurance benefits to University employees in accordance with State Statutes Sections 5-257(d) and 5-259(a). When employees retire, the State may pay up to 100% of their health care insurance premium cost (including dependents' coverage) based on the plan chosen by the employee. In addition, the State pays 100% of the premium cost for a portion of the employee's life insurance continued after retirement. The amount of life insurance continued at no cost to the retiree is determined by a formula based on the number of years of State service that the retiree had at the time of retirement. The State is responsible and finances the cost of post retirement health care and life insurance benefits on a pay-as-you-go basis through an appropriation in the General Fund; therefore, no liability is recorded in the University's financial statements.

7. COMPENSATED ABSENCES AND WAGES PAYABLE

Compensated absences are recorded in accordance with GASB Statement No. 16, *Accounting for Compensated Absences*. The liability for compensated absences is classified as current and noncurrent based on the amount estimated to be paid to eligible employees in one year and beyond one year, respectively. Compensated absences include accrued unused vacation, holiday, compensatory and sick leave balances for employees. As of June 30, 2012 and 2011 compensated absences totaled $33.0 million and $34.5 million, respectively. During fiscal year 2009, the State offered a Retirement Incentive Plan (RIP) to University employees. According to the terms of the RIP, unused vacation and sick leave will be paid in three equal payments on July 1 of each year, beginning July 1, 2012. Included in the noncurrent compensated absences liability as of June 30, 2012 and 2011, were $1.7 million and $2.4 million, respectively, for accrued vacation and sick leave for University employees that participated in RIP. The following table shows activity for compensated absences for the fiscal years ended June 30 (amounts in thousands):

	2012	**2011**
Beginning balance, July 1st	$ 34,467	$ 31,187
Additions, net	1,250	5,378
Deductions (separations only)	(2,711)	(2,098)
Ending balance, June 30th	$ 33,006	$ 34,467

Wages payable includes salaries and wages for amounts owed at the fiscal year end June 30. The State administers benefit and retirement plans for the University. Therefore, the payable for fringe benefits related to wages payable is included in due to the State as of June 30.

8. COMMITMENTS

On June 30, 2012, the University had outstanding commitments in excess of $500,000 each, which totaled $120.1 million, and included $115.2 million of commitments related to capital projects. Of this amount, commitments totaling $36.6 million related to UCONN 2000 capital projects that are administered by the University for the Health Center. The commitments on behalf of the Health Center are included in the due to affiliate (see Note 5). A portion of the total amount of outstanding commitments was also included in accounts payable on the Statement of Net Assets as of June 30, 2012. In addition to the amount for capital outlay, commitments were also related to instruction, research, institutional support, and auxiliary enterprises. Of these commitments, the University expects approximately $1.1 million to be reimbursed by federal grants.

9. LEASES

Operating Leases

The University leases equipment and building space which expire at various dates. Future minimum rental payments at June 30, 2012 under non-cancelable operating leases, that exceeded $500,000 each, were as follows (amounts in thousands):

Fiscal Year	Payments
2013	$ 1,518
2014	1,564
2015	1,635
2016	1,311
2017	477
Thereafter	1,465
Total	$ 7,970

Expenses related to operating lease commitments in excess of $500,000 each were approximately $1.0 million and $814,000 for the fiscal years ended June 30, 2012 and 2011, respectively.

Capital Leases

In December 2003, the University entered into a lease purchase agreement for a project to provide on-site generation of electricity, steam and chilled water for heating and cooling for the University at its Storrs campus. The project initially assumed a total cost of $75.0 million and included construction of a building, engineering, design and installation of certain equipment at the Storrs campus. The lease was amended in August 2005 as a result of an increase in the total anticipated cost to $81.9 million. With the amendment, monthly payments of $471,000 increased to $517,000. Payments began January 2006 and the lease matures 20 years from commencement with interest at a nominal rate of 4.42% on the first $75.0 million and 5.09% for the last $6.9 million of advances. Amounts advanced by the lessor include capitalized interest during construction, and are reflected as long-term debt in the accompanying financial statements. At the completion of the lease term, the University has an option to purchase the project assets for one dollar. The historical cost and accumulated depreciation of the Cogeneration facility were $82.6 million and $21.6 million, respectively, as of June 30, 2012.

The University leases equipment assets with an historical cost and accumulated depreciation of $2.2 million and $280,000, respectively, as of June 30, 2012.

All assets subject to capital lease agreements are included in property and equipment on the accompanying Statements of Net Assets, and depreciation on these assets is included in depreciation and amortization expense in the accompanying Statements of Revenues, Expenses, and Changes in Net Assets (see Note 4). Loans related to these capital lease agreements are included in long-term debt and bonds payable on the accompanying Statements of Net Assets (see Note 5).

10. DEFERRED INCOME AND CHARGES

Deferred income is comprised of certain restricted research grants that are not included in revenue until the funds are expended; tuition and fees and auxiliary enterprises fees received in advance of services rendered for summer and fall sessions; athletic ticket sales and commitments received in advance of the season; and other revenues received but not earned.

As of June 30, 2012 and 2011 deferred income was as follows (amounts in thousands):

	2012	2011
Certain restricted research grants	$ 8,363	$ 10,768
Tuition and fees and auxiliary enterprises	13,619	10,133
Athletic ticket sales and commitments	2,827	3,876
Total deferred income	$ 24,809	$ 24,777

A portion of current deferred charges totaling $741,000 and $697,000 and noncurrent deferred charges totaling $7.9 million and $7.5 million at June 30, 2012 and 2011, respectively, represented the cost of issuance on certain bond issuances which is amortized over the terms of the respective bond issues (see Note 5).

11. TUITION WAIVERS AND GRADUATE ASSISTANTSHIPS

The University is required by law to waive tuition for certain veterans and children of veterans, certain students over the age of 62, graduate assistants, and certain other students. The University is also required by collective bargaining agreements to waive tuition for certain employees and their dependents. The University has included the portion of waived tuition related to employees and their dependents as a fringe benefit cost and the same amount as tuition revenue in the Statements of Revenues, Expenses and Changes in Net Assets. This increased tuition and fee revenues and operating expenses by $5.2 million and $4.6 million for the fiscal years ended June 30, 2012 and 2011, respectively. The total amount of waivers not reflected in the accompanying financial statements were $43.6 million and $42.4 million in fiscal years 2012 and 2011, respectively. In fiscal years 2012 and 2011, approximately 93% were provided to graduate assistants and, of these amounts, $1.1 million and $404,000, respectively, were charged back to grants for reimbursement.

12. RELATED PARTY TRANSACTIONS

The Foundation

The Foundation is a tax-exempt organization supporting the University and the Health Center (see Note 1). The University has entered into a written agreement with the Foundation whereby the University agreed to provide financial support to the Foundation through a guaranteed contractual amount and the Foundation agreed to reimburse the University for certain operating expenses incurred on the Foundation's behalf. The terms of the agreement also stipulate that goals, objectives, and financial arrangements are reviewed and agreed-upon by both parties on a bi-annual basis. The University also provides other services to the Foundation in addition to this agreement.

The following transactions occurred between the University and the Foundation as of and for the years ended June 30, 2012 and 2011 (amounts in thousands):

	2012	**2011**
Amount paid to the Foundation for its guaranteed contractual services	$ 7,120	$ 7,120
Reimbursements from the Foundation for operating expenses	$ 331	$ 212
Accrued capital and noncapital gifts and grants revenue from the Foundation	$ 22,335	$ 18,923
Amount receivable from the Foundation*	$ 2,885	$ 5,589

**Included in accounts receivable, net, in the accompanying Statements of Net Assets.*

In accordance with the terms of a ground lease between the University and the Foundation, the University leases approximately 1.58 acres to the Foundation, on which the Foundation building was constructed, at an annual rental amount of one dollar. The initial term of the ground lease is ninety-nine years and the Foundation has the right to extend the term of the ground lease for another ninety-nine years. The ground lease provides that at its expiration or earlier termination the Foundation shall surrender the premises and title to the building will be transferred to the University.

The State

The State supports the University's mission primarily via two mechanisms: State appropriation and the provision of payments for fringe benefits. State appropriation represents amounts appropriated to the University from the State's General Fund. Payments for fringe benefits were made by the State for reimbursements related to salaries expensed from the General Fund. The transactions for the years ended June 30, 2012 and 2011 were as follows (amounts in thousands):

	2012	2011
Amount of General Fund appropriation received from the State	$ 205,586	$ 232,656
Amount of payments for fringe benefits received from the State	86,522	96,439
Decrease of General Fund payroll included in receivable from the State	(9,738)	(144)
Total appropriation and payments for fringe benefits from the State	$ 282,370	$ 328,951

Due to the State's deficit mitigation plan that was enacted in fiscal year 2010, the University transferred $15.0 million from the University's unrestricted net assets to the State's General Fund in fiscal year 2011. There were no transfers issued in fiscal year 2012; however, the University experienced a reduction of approximately $39.4 million in appropriation and payments for fringe benefits as a result of the State's economic initiatives. For fiscal year 2013, the University anticipates a reduction of approximately $15.0 million in appropriation and payments for fringe benefits from the State in response to the widening State deficit.

Pursuant to various public or special bond acts, the General Assembly empowers the State Bond Commission to authorize bonds for a variety of projects or purposes. On August 26, 2011, the State Bond Commission authorized the issuance of $18.0 million in State General Obligation Bonds to finance the initial design and development costs of the Technology Park on the Storrs campus. These bonds are an obligation of the State; therefore, they are not recorded as a liability in the accompanying financial statements. The total amount of $18.0 million allotted by the State was recorded as a capital allocation in other changes in net assets in the accompanying Statement of Revenues, Expenses, and Changes in Net Assets for the year ended June 30, 2012. Of this amount, approximately $200,000 was expended and capitalized with the remaining unspent portion of $17.8 million included under due from the State of Connecticut in the accompanying Statement of Net Assets for the year ended June 30, 2012. The total cost of the project is estimated to be approximately $172.5 million.

Health Center and Office of Technology Commercialization

The Office of Technology Commercialization (OTC) was established as a university-wide function consisting of the following divisions: the Center for Science and Technology Commercialization, the Research and Development Corporation, and the Technology Incubation Program. For the current and prior fiscal years, the funding for these divisions was consolidated into the Health Center's budget, a part of which was reimbursed by the University in accordance with an annual memorandum of agreement for the transfer of funds. The aggregate total contributed by the University to fund the OTC in fiscal years 2012 and 2011 was $952,000 and $1.0 million, respectively. Of these amounts, $326,000 and $431,000, respectively, represented expenses paid by the University associated with OTC functions based on the Storrs campus.

During fiscal year 2012, the Office of Economic Development (OED) was established to ensure the successful economic development outcomes for the Technology Park and Bioscience Connecticut initiative along with coordinating all of the University's economic development activities. The OED consists of divisions formally under the OTC with the addition of the U.S. Economic Development Administration Program. Beginning in fiscal year 2013, the funding for these divisions will be consolidated into the University's budget which, in part, will be reimbursed by the Health Center in accordance with an annual memorandum of agreement.

The University also engaged in certain cost share arrangements with the Health Center for shared services such as senior management salaries and managed UCONN 2000 funds for the Health Center's construction projects as well.

University of Connecticut Alumni Association

The University and the University of Connecticut Alumni Association (Association), a Connecticut non-stock corporation that is exempt from taxation under section 501(c)(3) of the Internal Revenue Code have an agreement that recognizes the benefits of a coordinated approach to alumni relationship building and defines the responsibilities of the parties. During the years ended June 30, 2012 and 2011, the University directed support to the Association in the amount of $1.1 million and $1.0 million, respectively. The amounts supported by the University consist primarily of payroll and other operating expenses which facilitate the alumni programs and services for the benefit of the University. The Association also agreed to reimburse the University for certain operating expenses incurred on the Association's behalf. The amounts owed to the University related to these expenses from the Association as of June 30, 2012 and 2011 were $14,000 and $44,000, respectively, which were included in accounts receivable, net, in the accompanying Statements of Net Assets.

Additionally, the Association manages the University's license plate program that has been established through the Department of Motor Vehicles. All revenue received by the University from the license plate program is disbursed to the Association to fund scholarships and to further support alumni outreach efforts. There was approximately $1,400 payable to the Association for the license plate program as of June 30, 2012 and no amounts were due as of June 30, 2011.

Campus Associates Limited Partnership

The University entered into a 50-year land lease with Campus Associates Limited Partnership (Campus Associates) on February 1, 2000. The limited partnership was formed for the purpose of managing the Nathan Hale Inn, a hotel located on campus. The lease provided for base rents of $5,000 for the first five years and $25,000 for the sixth year. For the seventh year and every year thereafter, base rent is adjusted by the increase in the Consumer Price Index. In exchange for a rent concession amounting to $100,000 in total for five years, the University received two limited partnership units. On June 15, 2009, the University purchased a third unit in the limited partnership paying $50,000 for the limited partnership interest (see Note 2). Under the land lease agreement, Campus Associates is responsible for certain costs which include real estate taxes, charges for public utilities, and other services. The amounts owed by Campus Associates for these costs as of June 30, 2012 and 2011, were $104,000 and $206,000, respectively, which were included in accounts receivable, net, in the accompanying Statements of Net Assets.

Mansfield Downtown Partnership, Incorporated

The Mansfield Downtown Partnership, Incorporated (MDP) is a not-for-profit corporation that is exempt from taxation under section 501(c)(3) of the Internal Revenue Code and is comprised of the Town of Mansfield (Mansfield), the University, and individual business members and residents. MDP is responsible for organizing the enhancement and revitalization of three of Mansfield's commercial areas: Storrs Center, King Hill Road and the Four Corners. In accordance with its governing by-laws, members are required to submit annual dues, as determined by the board of directors, in lieu of financial support. In fiscal years 2012 and 2011, the University paid $125,000 each year in annual membership dues to MDP.

In connection with the Storrs Center project, the University entered into an agreement with the master developer of the project to sell 18.80 acres of land for approximately $101,000 per acre which is to be divided up in phases. In fiscal years 2012 and 2011, the University conveyed 1.80 acres and 3.96 acres, respectively, to the master developer as well as 5.09 acres subsequent to June 30, 2012, which were sold at the stated price per acre. Related to the respective land sales in fiscal years 2012 and 2011, the University conveyed 4.04 acres and 2.71 acres, respectively, that were in turn, transferred to Mansfield at no cost for the provision of public improvements. In a separate transaction, the University also transferred 24.2 acres of land subject to a conservation restriction to Mansfield for consideration of one dollar in fiscal year 2012. Further land transactions are expected as the Storrs Center project continues to progress. Moreover, the University has agreed to provide water and sewer services, which will be billed in accordance with the University's standard billing practices.

In addition, the University has also provided office space and administrative support for certain other related parties.

13. CONTINGENCIES

The University is a party to various legal actions arising in the ordinary course of its operations. While it is not feasible to predict the ultimate outcome of these actions, it is the opinion of management that the resolution of the majority of these matters will not have a material effect on the University's financial statements. However, there are a small number of outstanding matters of potential individual significance. With respect to these matters, certain claimants seek an aggregate of approximately $30.0 million. The State expects these matters to be resolved for less than that amount. The amounts pertaining to the other remaining claims are still unknown at this time.

The University also participates in a number of federal programs subject to financial and compliance audits. The amount of expenditures that may be disallowed by the granting agencies cannot be determined at this time; however, the University does not expect these amounts, if any, to be material to the financial statements.

14. OPERATING EXPENSES BY NATURAL CLASSIFICATION

The table below details the University's operating expenses by natural classification for the years ended June 30, 2012 and 2011 (amounts in thousands):

For the fiscal year ended June 30, 2012:

	Salaries and wages	Fringe benefits	Supplies and other expenses	Utilities	Depreciation and amortization	Total
Instruction	$ 200,293	$ 66,054	$ 29,337	$ -	$ -	$ 295,684
Research	40,489	9,263	23,009	-	-	72,761
Public services	23,706	7,227	8,703	-	-	39,636
Academic support	55,353	21,881	22,908	-	-	100,142
Student services	24,632	9,396	4,889	131	-	39,048
Institutional support	42,792	20,569	15,669	73	-	79,103
Operations and maintenance	18,786	11,706	20,301	14,087	-	64,880
Depreciation and amortization	-	-	-	-	88,478	88,478
Student aid	361	1	5,745	-	-	6,107
Auxiliary enterprises	67,919	26,632	57,366	7,393	-	159,310
Other operating expenses	54	36	11,554	-	-	11,644
	$ 474,385	$ 172,765	$ 199,481	$ 21,684	$ 88,478	$ 956,793

For the fiscal year ended June 30, 2011:

	Salaries and wages	Fringe benefits	Supplies and other expenses	Utilities	Depreciation and amortization	Total
Instruction	$ 198,436	$ 63,054	$ 30,713	$ -	$ -	$ 292,203
Research	40,519	8,831	25,131	-	-	74,481
Public services	25,028	7,985	8,457	-	-	41,470
Academic support	52,439	20,459	25,495	-	-	98,393
Student services	24,526	9,361	5,708	160	-	39,755
Institutional support	45,045	21,004	18,608	87	-	84,744
Operations and maintenance	20,089	12,122	21,993	17,161	-	71,365
Depreciation and amortization	-	-	-	-	90,335	90,335
Student aid	366	1	5,123	-	-	5,490
Auxiliary enterprises	66,018	25,230	58,076	9,098	-	158,422
Other operating expenses	259	86	19,395	-	-	19,740
	$ 472,725	$ 168,133	$ 218,699	$ 26,506	$ 90,335	$ 976,398

TRUSTEES AND FINANCIAL OFFICERS
As of June 30, 2012

BOARD OF TRUSTEES

FINANCIAL OFFICERS

APPENDIX G: PROJECT BUDGET

UCONN
UNIVERSITY OF CONNECTICUT

October 23, 2013

TO: Members of the Board of Trustees

FROM: Richard D. Gray
Executive Vice President for Administration and Chief Financial Officer

Mun Y. Choi
Provost and Executive Vice President for Academic Affairs

RE: Project Budget for fMRI – Acquisition and Installation
(Planning Budget: $8,000,000)

RECOMMENDATION:

That the Board of Trustees approve the Planning Budget in the amount of $8,000,000 for the acquisition of the fMRI (Functional Magnetic Resonance Imaging) equipment; as well as the installation to include planning, design, and construction of space to house the equipment at the University of Connecticut.

BACKGROUND:

UConn has a growing faculty base that uses fMRI equipment in research. The UConn faculty do not have access to a Storrs-based unit and expend grant funding to rent time at fMRI centers at other institutions. The purpose of this project is to develop fMRI capability for human subjects at the University of Connecticut.

New collaborations and new external funding opportunities may be available if an MRI Center is located on the UConn campus and convenient to the UConn faculty. In addition, such a center would enhance recruitment of faculty and graduate students. The continuing evolution of MRI technology and methods also creates research opportunities for physicists, engineers, computer scientists, and statisticians.

The University conducted preliminary studies of several sites and identified the Philips Communication Science Building as having the best potential for the installation of an fMRI center. The parameters for evaluation included location, suitable and available space, availability of utilities and access.

The Planning Budget is attached for your consideration and approval.

Office of the Executive Vice President for
Administration and Chief Financial Officer
352 MANSFIELD ROAD, UNIT 1122
GULLEY HALL
STORRS, CT 06269-1122
PHONE 860.486.3455
FAX 860.486.1070

ADDITIONAL INFORMATION REGARDING MRI RESEARCH:

MRI is a technology that involves the use of a high-strength magnetic field to allow for 3D visualization of the internal structure of both biological tissue and certain non-biological materials. Because MRI involves no radiation, it poses minimal risk to human and animal subjects. fMRI is the use of MRI to monitor the flow of oxygenated blood in the brain, and has become a powerful and dominant tool in the study of brain function in both impaired and unimpaired individuals.

Specific areas of targeted research that may be enabled and enhanced by the existence of a fMRI at UConn may include:

Cognitive Neuroscience, which seeks to provide an integrated understanding of the psychological, computational, and neural mechanisms of cognition. Research in cognitive neuroscience has grown dramatically over the past decade, due in large part to rapid advances and increased availability of neuroimaging technology, including MRI.

Behavioral Genetics, which analyses and correlates genes and environments with behavioral, cognitive, and neural phenotypes. A tenet of behavioral genetics is that the more data one has describing phenotypes, the more likely it is that correlations will be discovered. An MRI Center adds the possibility of adding brain structure and function to the range of phenotypes that can be described using straight cognitive and behavioral tests.

Educational Neuroscience, which is an emerging discipline that extends the theories and methods of cognitive neuroscience to the fields of educational psychology, education theory, and other related disciplines. Investigations of the brain bases of reading and mathematics may provide a deeper understanding of what is required for competence in these domains and why some individuals fail to achieve competence in them.

CAPITAL PROJECT BUDGET REPORTING FORM

TYPE BUDGET: PLANNING

PROJECT NAME: FMRI-ACQUISITION AND INSTALLATION

BUDGETED EXPENDITURES		PROPOSED PLANNING 10/23/2013
CONSTRUCTION	$	3,500,000
DESIGN SERVICES		350,000
TELECOMMUNICATIONS		35,000
FURNITURE, FIXTURES AND EQUIPMENT*		3,225,000
CONSTRUCTION ADMINISTRATION		90,000
OTHER AE SERVICES (including Project Management)		150,000
ART		-
RELOCATION		10,000
ENVIRONMENTAL		60,000
INSURANCE AND LEGAL		10,000
MISCELLANEOUS		20,000
OTHER SOFT COSTS		-
SUBTOTAL	$	7,450,000
PROJECT CONTINGENCY		550,000
TOTAL BUDGETED EXPENDITURES	$	8,000,000
SOURCE(S) OF FUNDING		
UCONN 2000 PHASE III - FY14 DM	$	4,700,000
UCONN 2000 EQUIPMENT*		3,225,000
UNIVERSITY PLANT FUNDS		75,000
TOTAL BUDGETED FUNDING	$	8,000,000

* The Equipment will be purchased outside of the project budget process and in accordance with standard UConn procurement policies and procedures

BOT 10.23.13
201630

APPENDIX H: FINANCIAL ATTACHMENTS I-A & II-A

Financial Attachment I-A

12. C (i). Please provide one year of actual results and three years of projections of **Total Facility** revenue, expense and volume statistics without, incremental to and with the CON proposal in the following reporting format:

Total Facility: Description	FY** Actual Results	FY 2015 Projected W/out CON	FY 2015 Projected Incremental	FY 2015 Projected With CON	FY 2016 Projected W/out CON	FY 2016 Projected Incremental	FY 2016 Projected With CON	FY 2017 Projected W/out CON	FY 2017 Projected Incremental	FY 2017 Projected With CON	FY 2018 Projected W/out CON	FY 2018 Projected Incremental	FY 2018 Projected With CON
NET GRANT REVENUE* **													
Grant Revenue	$0	$0	$109,200	$109,200	$0	$360,000	$360,000	$0	$600,000	$600,000	$0	$750,000	$750,000
Other Operating Revenue****	$0	$0	$63,336	$0	$0	$208,800	$0	$0	$348,000	$0	$0	$435,000	$0
Revenue from Operations	$0	$0	$172,536	$109,200	$0	$568,800	$360,000	$0	$948,000	$600,000	$0	$1,185,000	$750,000
OPERATING EXPENSES													
Salaries and Fringe Benefits	$0	$0	$216,480	$216,480	$0	$373,433	$373,433	$0	$394,916	$394,916	$0	$405,681	$405,681
Professional / Contracted Services	$0	$0	$165,000	$165,000	$0	$165,000	$165,000	$0	$165,000	$165,000	$0	$165,000	$165,000
Supplies and Drugs	$0	$0	$13,650	$13,650	$0	$45,000	$45,000	$0	$75,000	$75,000	$0	$93,750	$93,750
Bad Debts	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Operating Expense	$0	$0	$15,000	$15,000	$0	$15,000	$15,000	$0	$15,000	$15,000	$0	$15,000	$15,000
Subtotal	$0	$0	$410,130	$410,130	$0	$598,433	$598,433	$0	$649,916	$649,916	$0	$679,431	$679,431
Depreciation/Amortization*****	$0	$0	$108,667	$108,667	$0	$217,333	$217,333	$0	$217,333	$217,333	$0	$217,333	$217,333
Interest Expense	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Lease Expense	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Expense	$0	$0	$518,797	$518,797	$0	$815,766	$815,766	$0	$867,249	$867,249	$0	$896,764	$896,764
Gain/(Loss) from Operations	$0	$0	($346,261)	($409,597)	$0	($246,966)	($455,766)	$0	$80,751	($267,249)	$0	$288,236	($146,764)
Plus: Non-Operating Revenue	$0	$0	$0	$0	$0		$0	$0	$0	$0	$0	$0	$0
Revenue Over/(Under) Expense	$0	$0	($346,261)	($409,597)	$0	($246,966)	($455,766)	$0	$80,751	($267,249)	$0	$288,236	($146,764)
FTEs	0	0	1.5	1.5	0	2.75	2.75	0	2.75	2.75	0	2.75	2.75

*Volume Statistics:
Provide projected inpatient and/or outpatient statistics for any new services and provide actual and projected inpatient and/or outpatient statistics for any existing services which will change due to the proposal.
**Not applicable as there is no MRI currently at UConn Storrs
***Since there are no patients or patient revenue, this section has been changed to grant revenue as revenue will be generated through the receipt of grant dollars per hour of usage.
****Other operating revenue would include Office of Sponsored Projects F&A rates on grants.
*****Equipment value is assumed to be $3,260,000 and the expected life of the equipment is 15 years. FY2015 is a partial year, so depreciation is halved.

Financial Attachment IIA

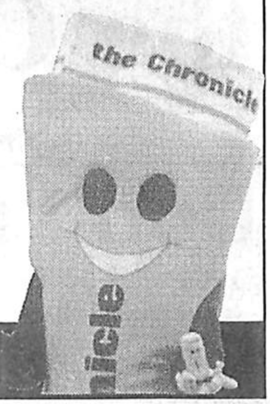
12.C(II). Please provide **three** years of projections of <u>incremental</u> revenue, expense and volume statistics **attributable to the proposal** in the following reporting format:

Type of Service Description ____________
Type of Unit Description: ____________
# of Months in Operation ____________

FY ______ **FY Projected Incremental** **Total Incremental Expenses:** ____________ **Total Facility by** **Payer Category:**	(1)	(2) Rate	(3) Units	(4) Gross Revenue Col. 2 * Col. 3	(5) Allowances/ Deductions	(6) Charity Care	(7) Bad Debt	(8) Net Revenue Col.4 - Col.5 -Col.6 - Col.7	(9) Operating Expenses Col. 1 Total * Col. 4 / Col. 4 Total	(10) Gain/(Loss) from Operations Col. 8 - Col. 9
Medicare				$0				$0	$0	$0
Medicaid		$0		$0				$0	$0	$0
CHAMPUS/TriCare		$0		$0				$0	$0	$0
Total Governmental			0	$0	$0	$0	$0	$0	$0	$0
Commericial Insurers		$0	5	$0				$0	$0	$0
Uninsured		$0	2	$0				$0	$0	$0
Total NonGovernment		$0	7	$0	$0	$0	$0	$0	$0	$0
Total All Payers		$0	7	$0	$0	$0	$0	$0	$0	$0

APPENDIX I:

COPIES OF PUBLIC NOTICE



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Legal Notices

Legal Notice

University of Connecticut

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Richard Gray, Executive Vice President for Administration and Chief Financial Officer at the University of Connecticut, 352 Mansfield Road, Unit 1122, Storrs, CT 06269-1122 is filing an application for a Certificate of Need with the Office of Health Care Access in the State of Connecticut for the acquisition of a 3T MRI scanner for human research. The fair market value of the equipment to be procured is projected to be $3 million to $4 million. The proposed location for the scanner is the Phillips Communication Sciences Building at 850 Bolton Road, Unit 1085, Storrs, CT 06269.

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The Chronicle ass no financial resp bility for errors i vertisements, bu reprint that pa the ad that wa correct and al the meaning or e of the ad.

Advertisers must r the Chronicle a tising depart within 24 hour such error and th will be rerun onc

The Chronicle wil knowingly a any advertise that is in violatio any applicable la

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Help Wanted

BARGAIN BOX

Bargain Box

ALLEN EDMONS MEN'S DRESS SHOES Size 12 A, black, new, never worn. Includes set of cloth storage bags & polish. Selling for $345 **asking $150.** Call 860-917-9192

ANTIQUE MCGEE 1900, coal/gas, kit. cook stove. $300 OBO. (860)-742-0245

DRYER electric whirlpool $75. Mini Refrigerator. Used for 1 yr only $40. Call 860-423-4278

GE profile Dishwasher, $75 860-228-4468.

MULTIPLE ITEMS FOR SALE Jacobson Snow Thrower 36 inch chief, 2 stage, model 12180, $250; Electric golf cart with battery charger, needs batteries, $250; CW36 Snow thrower Cub Cadet, $150; 2A42 Cub Snow Thrower, $250; Wheel Horse Snow Plow, 36 in., $100; Alice Charmer B10, 42 in. plow, $150; Sears Snow Plows, $150-$250; Heavy Duty Snow Plow w/push arms extended to the rear, $300. All blowers & Plows are for garden tractors. Call 860-228-3607 or 860-573-0851

MULTIPLE ITEMS FOR SALE furn., exercise equip., mens clothing, & kit. gadgets. Prices negotiable. Call 860-836-0352 for further info.

TV Toshiba, 55 in. - $75. Box King Wood Stove - $75. Cap for full-size pick-up - $75. 860-423-1958 or 860-705-6266.

Puzzle

Complete the grid so every row, column and 3 x 3 box contains every digit from 1 to 9 inclusively.

Previous puzzle solution

MERCHANDISE

Merchandise For Sale

WOOD STOVE all nighter, takes 22 inch logs, exc. cond. $650. Call 860-742-5029

REAL ESTATE

Unfurnished To Rent

ASHFORD 2BR Duplexes, some w/carport. Big closets, on-site laundry. No dogs. $695-$785/MO. (860) 429-2354.

CHAPLIN/WINDHAM – Route 6, Two bedroom town house w/storage, $800.Two bedroom apt w/ washer & dryer, $750. Heat & hot water included. No dogs. 1 ½ mth sec. 860-742-9846

COLUMBIA – 2 BR, $850/mth. Heat & HW included. Lg. Yard. Call after 5 PM. 860-933-4227.

MANSFIELD 1 BR, $595/mth. 860-455-6973

MANSFIELD 2BR, some w/attic storage, some w/free H/HW. $650-$775. 860-429-2354.

WILLIMANTIC Efficiency, $765/mth. Includes all utilities. **860-455-6973**

WILLIMANTIC New Const., 1BR, $615+ Sec., ref., no pets. IMA 860-423-3936

WMTC (2) 1 BR for rent. $550 & $575. 860-228-0109

WMTC 1,2&3BRs, $615+ up. Sec./Refs. No pets. IMA 860-423-3936.

WMTC 2 BR w/ 5 RM, off st. prkg., wood floors. Nice! $820 heat incld. Available now! Refs. & no pets. 1219 Main St. 860-456-4347

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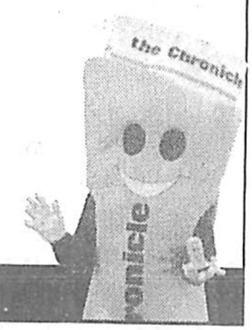

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Help Wanted

ANNOUNCEMENTS

Lost & Found

FOUND Black & White domestic male neutered adult Cat from 11/13/13 in the vicinity of 122 North Rd., Rt. 14., Windham Center, CT. VERY FRIENDLY. Call 860-456-3135

EMPLOYMENT

Help Wanted

Help Wanted

Help Wanted

WARNING

Readers are advised that some "work at home" ads or ads offering information on jobs, government homes or vehicles, may require an initial investment. We urge you to investigate the company's claims thoroughly with the Better Business Bureau of the state you are writing or calling before sending any money and proceed at your own risk. If you choose to call an 800 number, let the tape recorded message end before you hang up.

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WMTC 1,2&3BRs, $615+ up. Sec./Refs. No pets. IMA 860-423-3936.

WMTC 2 BR w/ 5 RM, off st. prkg., wood floors. Nice! $820 heat incld. Available now! Refs. & no pets. 1219 Main St. 860-456-4347

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OFFICE space for rent in Tolland, Mansfield and Windham. Small suites to 3,150 sq. ft. Call Tom, 860-539-4953. www.crossenbuilders.com

UNIVERSAL Sudoku Puzzle

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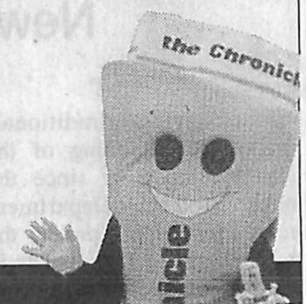

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Legal Notices

comments on the following application:

7:00 P.M. - John H. Shadler for a Variance of Art. X, Sec L.2.a & L.2.a.4 to allow an efficiency unit within a single-family residence that would be larger than permitted and have an occupancy of more than 2 persons at 32 Baxter Rd.

At this public hearing, interested parties may appear and written communications may be received. No information shall be received after the close of the public hearing. Additional information is available in the Mansfield Town Clerk's Office. Dated November 21, 2013.

Sarah Accorsi
Chairman

Legal Notice

University of Connecticut

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EMPLOYMENT

Help Wanted

CTjobs.com

Wheels

Auto & SUV's

MERCEDES, S500 2006 62K mi, loaded, excellent condition, white ext and leather int, sun roof, 17" alloy rim, new tires. $21,995. 860-202-3030.

NISSAN MAXIMA 2002 runs like new, AT, 141K mi. $3,700. 860-578-3823.

OLDSMOBILE CALAIS 1987 6 cyl. cpe, very low milage (83K), red interior, estate car. Price reduced $2,250. This offer won't last long. 203-245-4530

PONTIAC GRAND PRIX GTP 2003
2003 Pontiac Gran Prix GTP, Sliver, 4 Door,3.8L Supercharged V6, Many extras, excellent condition, 52,000 miles. $5995
860-384-3337

PORSCHE CAYMAN S 2007
Excellent Condition 2 DOOR COUPE S 3.4L Automatic Tiptronic, METALLIC SILVER w/BLACK LEATHER INTERIOR LOJACK® Stolen Vehicle Recovery System,19" SPORT ALLOY WHEELS w/ Locks, RED BRAKE CALIPERS, FOUR NEW MICHELIN TIRES, NEW BATTERY, BOSE® SURROUND SOUND w/CD, AC, 29k Miles $39,500 860-749-0366

SATURN AURA GREEN LINE 2008
Hybrid with 64K miles, automatic, 4-door, power windows, power seats, power moonroof, Sirius radio. Maroon w/tan interior. $10,000 860-805-0000

SUBARU LEGACY 2002
Runs/Looks Mint,5SPD,AWD,wagon,126K,clean reliable,CD,$3800,203 509 3007

VOLVO S60 TURBO 2008 5 cyl. Mint. 250K. $4400, obo. 860-919-9726

Trucks & Vans

DODGE CARAVAN 2007 95k, new tires, runs like new. $4,900. 860-325-2021

FORD CONVERSION VAN 1994 Reduced price $2,990. 203-245-4530.

FORD F250 '95 60K, Auto, plow, dump, new tires. $4750. 860-983-8408

PUBLIC NOTICES

Connecticut

Independent Dealer-Kirby:
Worked for a Kirby vacuum distributor since Nov 2010?
Get info on wage/hour lawsuit
www.kirbylawsuit.com

NOTICE OF AUCTION

THE FOLLOWING IS A PARTIAL LISTING OF ITEMS STORED BY PERSONS AND/OR ENTITIES WHOSE UNITS ARE ENUMERATED BELOW, WHICH WILL BE SOLD AT PUBLIC LEIN SALE AUCTION ON: TUESDAY DECEMBER 17TH AT 3:30PM AT PLANET SELF STORAGE, 350 ALUMNI ROAD NEWINGTON CT 06111 (860) 665-7000. PERSUANT TO SECTION 42-159 THROUGH 42-168 OF THE CONNECTICUT GENERAL STATUTES, REVISION OF 1958 AS OF JANUARY 01, 1985.

Unit 370 Jan Zbroja: Furniture, Bags, Misc
Unit 588 Patricia Dobie: Boxes, Furniture, Luggage, Bags, Boxes, Misc
Unit 282 Paul Grady: Misc

SALE SUBJECT TO PRIOR CLAIM. ALL SALES FINAL AND MUST BE PAID IN CASH. OPERATOR RESERVES RIGHT TO BID AND SET MINIMUM BIDS: PLEASE CALL MORNING OF THE SALE TO ASSURE AVAILABILITY.

State of Connecticut

Court of Probate, District of Central Connecticut Regional Children's Probate District

NOTICE TO William J. Ross, whose last known residence was in the town of Bloomfield, CT.

Pursuant to an order of Hon. Joseph D. Marino, Judge, a hearing will be held at Central Connecticut Regional Children's Probate District, 1501 East Main Street, Suite 203, Meriden, CT 06450 on December 2, 2013 at 9:00 AM on an application for Temporary Custody, Immediate Temporary Custody having been granted, Pending Removal of Guardian concerning a certain minor child born on February 15, 1997. The Court's decision will affect your interest, if any, as in said application on file more fully appears.

RIGHT TO COUNSEL: If the above-named person wishes to have an attorney, but is unable to pay for one, the Court will provide an attorney upon proof of inability to pay. Any such request should be made immediately by contacting the court office where the hearing is to be held.
By Order of the Court

Joseph D. Marino, Judge

Request For Quotation #04-1314A

The State of Connecticut Judicial Branch is soliciting bids for the sale of surplus used Hewlett Packard Alpha GS-160 computer equipment and Enterasys Networks equipment.

Sealed quotations must be received by 11:30 A.M. on December 9, 2013. Immediately thereafter all quotations will be publicly opened.

VENDORS CURRENTLY REGISTERED UNDER THE STATE'S SMALL BUSINESS SET-ASIDE PROGRAM ARE ENCOURAGED TO BID.

Bid package may be picked-up at Judicial Purchasing Services, 90 WASHINGTON Street, 4th Floor, Hartford, CT or call 860-706-5200 to request by mail.

PLEASE CHECK THE JUDICIAL WEB SITE AT:

www.jud.ct.gov/external/news/busopp/Default.htm

JUDICIAL BRANCH
PURCHASING SERV ICES
90 WASHINGTON STREET
HARTFORD, CT 06106

An Equal Opportunity/Affirmative Action Employer

University of Connecticut
FILING APPLICATION FOR A CERTIFICATE OF NEED
OFFICE OF HEALTH CARE ACCESS

Richard Gray, Executive Vice President for Administration and Chief Financial Officer at the University of Connecticut, 352 Mansfield Road, Unit 1122, Storrs, CT 06269-1122 is filing an application for a Certificate of Need with the Office of Health Care Access in the State of Connecticut for the acquisition of a 3T MRI scanner for human research. The fair market value of the equipment to be procured is projected to be $3 million to $4 million. The proposed location for the scanner is the Phillips Communication Sciences Building at 850 Bolton Road, Unit 1085, Storrs, CT 06269.

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NEWS UPDATES 24/7

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Connecticut

STATE OF CONNECTICUT

Connecticut
STATE OF CONNECTICUT

ORD CROWN VIC 2003 New tires & attery, 198K. $2100. 860-882-9207

AUDI A4 2.0T QUATTRO 2007
Near mint, 65.5 K mi. $14.9K/BO. rwb928@aol.com; 860 749 6727

BMW 650I 2007 91K mi. Lded. Blk on blk. $22,000 obo. 860-970-6452

Connecticut

Independent Dealer-Kirby:
Worked for a Kirby vacuum distributor since Nov 2010?
Get info on wage/hour lawsuit
www.kirbylawsuit.com

Connecticut

University of Connecticut
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Connecticut

STATE OF CONNECTICUT
SUPERIOR COURT
JUVENILE MATTERS

ORDER OF NOTICE

Notice to **Jose Diaz Jr., father of minor child born on 2/27/07 to Maria S-D.** of parts unknown

A petition has been filed seeking:

Termination of parental rights of the above named in minor child(ren).

The petition, whereby the court's decision can affect your parental rights, if any, regarding minor child(ren) will be heard on **12/19/13 at 2:15 PM** at Hartford Superior Court, Juvenile Matter, **920 Broad Street, Hartford, CT 06106.**

Therefore, ORDERED, that notice of the hearing of this petition be given by publishing this Order of Notice once, immediately upon receipt, in **Hartford Courant**, a newspaper having circulation in the town/city of: **Hartford, CT.**

Hon. Thelma Santos - Judge
Asst. Clerk: C. Wilson
Signed: 11/20/13

Right to Counsel: Upon proof of inability to pay for a lawyer, the court will make sure that an attorney is provided to you by the Chief Public Defender. Request for an attorney should be made immediately in person, by mail, or by fax at the court office where your hearing is to be held.

Request For Proposal
RFP #02-1311

The State of Connecticut Judicial Branch, is seeking proposals from experienced firms to provide twenty-four (24) hour facility management, operation, and maintenance services for Region 1 locations that consist of Enfield, Hartford, Manchester, Tolland Judicial Districts.

A Mandatory Pre-Proposal Conference is scheduled for December 12, 2013 at 9:00 a.m. Complete details are available in the RFP documents.

Proposals must be sealed and be received **before 2:30 p.m. on January 3, 2014.** Immediately thereafter, all proposals will be publicly opened and prices read aloud. Late proposals will NOT be accepted.

VENDORS CURRENTLY REGISTERED UNDER THE STATE'S SMALL BUSINESS SET-ASIDE PROGRAM ARE ENCOURAGED TO APPLY.

Proposal package may be obtained at Judicial Materials Management Unit, Purchasing Services at: 90 Washington Street, 4th Floor, Hartford, CT or call (860) 706-5200 to request by mail, or access the web site below.

PLEASE CHECK
THE JUDICIAL WEB SITE AT:
www.jud.ct.gov/external/news/busopp/Default.htm

JUDICIAL BRANCH
MATERIALS MANAGEMENT UNIT
PURCHASING SERVICES
90 WASHINGTON STREET
HARTFORD, CT 06105

An Equal Opportunity/
Affirmative Action Employer

Connecticut

LEGAL NOTICE

LEGAL NOTICE: The Greater Bridgeport Regional Council (GBRC) is seeking the services of a professional planning consulting firm to assist in the development of a Plan of Conservation and Development for the Greater Bridgeport Region.

The Regional Plan of Conservation and Development (RPOCD) will provide a plan for regional growth management: sustainable land use patterns that are supported by and coordinated with the region's transportation infrastructure, and a model for future local planning efforts.

For a complete copy of the RFQ please visit http://www.gbrct.org/about-us/for-vendors/. All responses to any consultant inquiries will be periodically updated and available at http://www.gbrct.org/about-us/for-vendors/.

NOTICE OF PUBLIC HEARING CONCERNING THE PROPOSED ACQUISITION OF CONTROL OF HOMESITE INSURANCE COMPANY, a Connecticut domiciled insurance company

Notice is hereby given that the Insurance Commissioner of the State of Connecticut will conduct a public hearing on December 10, 2013 at 9:00 a.m. in room 701 at the Connecticut Insurance Department, 7th Floor, 153 Market Street, Hartford, CT. The hearing will be conducted pursuant to sections 38a-129 through 38a-140, 4-166 through 4-184, as applicable, of the Connecticut General Statutes; and sections 38a-8-1 through 38a-8-104, and 38a-138-1 through 38a-138-16, as applicable, of the Regulations of the Connecticut State Agencies. The hearing will include a period devoted exclusively to public comment. Persons interested in being designated a party or intervenor should consult sections 38a-8-48 and 38a-8-49 of the Regulations of the Connecticut State Agencies.

The public hearing is being held on the question of granting approval pursuant to section 38a-132(b)(1) of the Connecticut General Statutes of the application filed by American Familiy Mutual Insurance Company (AFMIC") and AMFAM, Inc. ("AMFAM" and with AFMIC, "Applicants"), dated October 8, 2013 as amended and restated (the "Application"). The Application requests the Insurance Commissioner's approval, as required by section 38a-130 of the Connecticut General Statutes, of the proposed acquisition of control of Homesite Insurance Company, a Connecticut domiciled insurance company ("Domestic Insurer").

The Proposed Acquisition will be effected pursuant to the terms of the Agreement and Plan of Merger (the "Agreement") between by and among Homesite Group, Inc., AMFAM, HGI Acquisition Co. Inc. ("Merger Sub"), a Delaware corporation, and Henry Securityholder Representative, LLC ("Henry") dated as of September 4, 2013. The official record of this proceeding, which includes a copy of the Application and the Agreement, is on file with the Connecticut Insurance Department, 153 Market Street, 7th floor, Hartford, Connecticut, and is available for public inspection during regular business hours.

At the public hearing, representatives of the Applicant and the Domestic Insurer as well as any other party or intervenor designated by the Insurance Commissioner pursuant to sections 38a-8-48 and 38a-8-49 of the Regulations of the Connecticut State Agencies, and his appointed hearing officer, will appear and be heard concerning the consideration by the Insurance Commissioner of the Application. The public will, at the hearing officer's discretion and in accordance with section 4-177c(b) of the Connecticut General Statutes, be given an opportunity to comment on the Application with respect to the issues to be considered by the Insurance Commissioner. Written

BMW X5 2008 58K miles, still under warranty until 2015. Spotless, great shape! White on black. $29,000 or best offer. 860-970-6452

BUICK PARK AVENUE 2002 80K mi, champagne. $5800. 413-219-4341

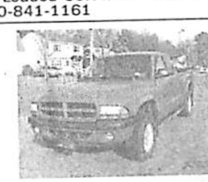
CADILLAC FLEETWOOD 1990 1990 Cadillac Fleetwood - Well maintained, senior owned. Call for maintennce records. 860 721-1806 $3100 OBO

CADILLAC SEVILLE STS 2001 New transmission. 112K mi. 4DR, white. Non-smoker, 2nd owner. $5000. 860-676-0411

CHEVROLET CORVETTE 2005
Conv. Red/tan/Blk 6SP 18,000 miles One owner Mint Cond price reduced for quick sale $29,000; 860-395-8633

CHEVROLET CORVETTE 2001
Car is absolutely flawless! Has never seen snow, only occasional rain. Kept in a heated garage. Has Corsa SS exhaust and Callaway Honker ram air system and chromed wheels. 860-824-0751

CHRYSLER CROSSFIRE SRT-6 2005
Cpe AT 3.2L AMG 330HP Supercharged V6 Loaded 35K ml Like New $24,950 860-841-1161



DODGE DAKOTA SPORT 4X4 2001 Great condition. Red $4,800/obo 860-997-2649

FORD MUSTANG SVT COBRA 2004
Yellow/Black CVT, 34k miles, wife's car, no winters. cindy7149@gmail.com, (860)202-3138.

GMC ENVOY SLT 2005 96,000 mi.gray/blk. 6 cyl. auto, clean, garaged, $8,300 obo, 860-665-9862

HONDA ACCORD 2004 30K, leathr, fully loaded. Auto, $10999. 860-983-8408

HONDA ACCORD 2005, AT. Sunroof 98,000m.$7900. 860-965-4141.

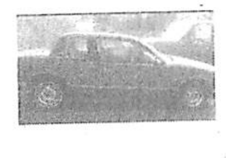
MERCEDES BENZ CLK 55 EMG 2001 loaded, 2dr auto, snrf, GPS. cd player & camera,amp & sub woofers. 110k mi, exc cond. $7500 obo 860-839-9170

MERCEDES 190E 2.3 1993 - 203,625 miles, decent, need a trans. $2500 firm 860-428-8752

MERCEDES C300 2010 4dr, AWD. 40K mi. Mint cond. $23K. 860-676-0411

MERCEDES, S500 2006 62K m loaded, excellent condition, white e and leather int, sun roof, 17" alloy rim new tires. $21,995. 860-202-3030.

NISSAN MAXIMA 2002 runs like ne AT, 141Kmi. $3,700. 860-578-3823



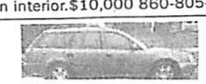
OLDSMOBILE CALAIS 1987 6 cyl. c very low milage (83K), red interior, tate car. Price reduced $2,250. This of won't last long. 203-245-4530

PONTIAC GRAND PRIX GTP 200
2003 Pontiac Gran Prix GTP, Sliver Door,3.8L Supercharged V6, Many tras, excellent condition, 52,000 mil $5995
860-384-3337

PONTIAC TRANS AM 1979 good co 2nd owner $65 (860)628-1505

PORSCHE CAYMAN S 2007
Excellent Condition 2 DOOR COUPI 3.4L Automatic Tiptronic, METALLIC VER w/BLACK LEATHER INTERIOR LOJACK® Stolen Vehicle Recov System,19" SPORT ALLOY WHEELS Locks, RED BRAKE CALIPERS, F NEW MICHELIN TIRES, NEW BATT BOSE® SURROUND SOUND w/CD, 29k Miles $39,500 860-749-036

SATURN AURA GREEN LINE 20
Hybrid with 64K miles, autom 4-door, power windows, power s power moonroof, Sirius radio. Ma w/tan interior.$10,000 860-805-0



Stuff

Antiques/ Collectibles

ART - A long time art collector wants to sell all or parts of a large collection of American & European oil paintings & watercolors. Also Japanese art & artifacts. 860-567-2167

CASH FOR U.S. GERMAN, JAPANESE WWII Items, guns, etc. 860-543-3617

MGA 1962 Many spare parts, red. $14,000 Best Offer. 860-738-1004

Auctions

B&S AUCTION SERVICE
Est. 1946 . ANTIQUES & ESTATES
BOUGHT OR SOLD ON COMM.
No lot too large or too small
Tel. 860-342-2540
Thomas Barrows & Sons
350 Main Street Portland, CT.

Auto & Truck Parts

AUTO/TRUCK PARTS '78 Chevy 454 engine and trans. Model 30. '78 Chevy Suburban w/ target 350 crate engine$1000/each. 860-676-0411

Stuff

ANGLE IRON CUTTER whitney roper missing cutters $50 860-670-4741

BUYING MACHINIST TOOLBOXES Tools & tooling, contents of machine shops, car bide inserts and mechanic tools. Call anytime 860-985-5760.

CLOTHES WASHER Automatic washer. Works fine. $100. 860-529-0545

COUCH - Burgandy & green plaid. Small. You pick up. Free. 860-303-5530

DAY BED/MATTRESS Like new. $85/obo. 860-232-2431.

DINING ROOM SET 6 chairs and buffet. $350/obo. 860-232-2431.

FIREWOOD Oak. Seasoned 1 yr. Unsplit. P/U truck load $50 860-218-8691

GIRLS BIKE magna 24" 15 speed girls bike $60 860-670-4741

GUITAR Beginner/child acoustic. with case. $25 860-632-8666

HOTTUB, 6 person, 51 jets, all options, w/cover & warranty, never used, cost $6800, sell for **only $3600!** 860-344-1244

KEROSENE HEATER Like new,in box,wicks . $60.00 860-214-8727

MAGAZINES Nintendo power. older copies box of 40. $15 860-632-8666

MATTRESS & Box spring. Queen. Brand new. Comfy. $425 neg. 860-224-0889.

QUEEN matress & boxspring. Brand new 203-213-3833. $50 203-213-3833

Wanted To Buy

1 BUY VINTAGE ELECTRONICS GUITARS, AMPS, TUBE HI-FI, RECEIVERS, AUDIO EQ, RADIOS, HAM, CB, SAXOPHONES. CALL 860-707-9350

All Musical Instruments Accordians Sax,, Guitars, drums, trumpets. Cash paid, Any Condition. Lasalle Music. 993 Main St., E. Hartford 860-289-3500

BUYING OLD MAHJONG SETS Incompl. sets okay. Greater Hrftd. 860-231-8466

WANTED TO BUY Aaron buy machinist tool, blades, milling, tool maker, industrial lights, chairs and much much more! Call 203-525-0608.

Announcements

Lost/Found

IMPOUND 388 pitbull, female, tan/white. Call Hartford PD 860-527-6300

IMPOUNDED #391 Terrier mixed, male. White/Tan #372 Pitbull hound, mixed. male. Tan/white. #393 Terrier ,mixed. male. Tan/white. Call Hartford P.D. 860-527-6300.

Business

Business Opportunities

NOTICE

"Investigate Before Investing"

Call the Connecticut Department of Banking BEFORE investing in a business opportunity or franchise. See if the seller or the investment is registered with the Securities Division.
Call 860-240-8230 or visit our Web site at www.ct.gov/dob.
This notice provided as a public service by The Hartford Courant.

Real Estate

ELLINGTON - Autumn Chase Brand new 1 & 2BR Luxury Apartments with garage. Close to I84, I91 and Bradley Airport Please call 860-872-1000

HARTFORD - Studio $550, 1BR $675, 2BR $850. Well-kept, elev building, ht/hw included, parking available. No Pets. 860-549-3181

Hartford Deep South End effic. & 1 BR apt. Starting @ $580. 860-296-2778

HARTFORD SW- New Britian Ave Area. 1 & 2 bed apts, parking, $525-$800. SML 249-1396, 559-0178, 978-3725.

★ HARTFORD ★
Heat & Hot Water included
1 Block from
Hartford Hospital
1 Bedrooms $675
Sec. Cameras / Gated Prkg
www.layfayettearms.com
860-249-7980
194 Washington St

HARTFORD
Sigourney
Studio: $495
Westland Place
2 BD: $700
3 BD: $825
All apartments include HT & HW
JRH Asset Mgmt 860-246-0613

MIDDLETOWN - Highview Apts Huge 1&2 BR. Fully appl.eat in kitchen. Large liv.room w/ balcony. Laundry, prkg Free H&HW. $895/$925 860-704-0102.

NEW BRITAIN 860-223-8866
Evergreen Townhouse Apartments Remodeled 2 & 3 Bedroom Town-homes in quiet area. Private entry, hardwood floors. Laundry. On bus line. Heat & Hot Water included. $825 & up for two beds.
www.Harvest-Properties.com

PUBLIC NOTICES

The University of Connecticut
REQUEST FOR STATEMENT OF QUALIFICATIONS
Landscape Consultant
– Project # 112213AA

Issue Date: November 27, 2013
Submission Due Date: December 17, 2013

THE UNIVERSITY OF CONNECTICUT IS SOLICITING THE SERVICES OF EXPERIENCED FIRMS TO PERFORM LANDSCAPING CONSULTING SERVICES ON THE MAIN, DEPOT AND AVERY POINT CAMPUSES. TO FIND OUT MORE ABOUT THIS PROJECT, INTERESTED FIRMS SHOULD VISIT OUR WEBSITE AT:

http://www.cpca.uconn.edu/profserv/profserv_currentops.html

Connecticut

University of Connecticut
FILING APPLICATION FOR A CERTIFICATE OF NEED
OFFICE OF HEALTH CARE ACCESS

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Conn

CONNECTICUT JUDICIAL BRANCH

REQUEST FOR PROPOSALS

The State of Connecticut Judicial Branch, Purchasing Services Office, invites qualified organizations or individuals to submit proposals for the following program services:

RFP #3400 ADVANCED SUPERVISION INTERVENTION AND SUPPORT TEAM – WATERBURY, MANCHESTER, BRIDGEPORT, & NEW LONDON

Request for Proposal documents outlining procedures for submittal of proposals will be available online at

www.jud.ct.gov/external/news/busopp/Default.htm or by contacting:

Purchasing Services Office
90 Washington Street
Hartford, CT 06106
Tel: 860-706-5200

DEADLINE FOR SUBMITTAL OF PROPOSAL IS:

BEFORE 2:30 P.M. JANUARY 8, 2014

VENDORS CURRENTLY REGISTERED UNDER THE STATE'S SMALL BUSINESS SET-ASIDE PROGRAM ARE ENCOURAGED TO APPLY.

PLEASE CHECK
THE JUDICIAL WEB SITE AT:

www.jud.state.ct.us/external/news/busopp/Default.htm

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Connecticut

LEGAL NOTICE

The Public Utilities Regulatory Authority will conduct an administrative proceeding, pursuant to its Decisions rendered in Docket No. 07-09-09, DPUC

APPENDIX J:

HUMAN VOLUNTEERS IN RESEARCH STUDIES USING MRI TECHNOLOGY

Research on human subjects at the UConn Storrs campus is governed by the Institutional Review Board. All research studies receive a review for protection of human subjects prior to the conduct of the study. As with any other research, the UConn IRB will evaluate study protocols for research using the new MRI scanner.

The UConn IRB is composed of eight members from the university and local communities and five alternate members. It meets in full session every 3 weeks. As detailed on their web site (<http://irb.uconn.edu/about.html#>):

"The responsibility of the UConn-Storrs IRB is to work with the University research community to help make sure that human subjects engaged in research are:

treated with dignity;
adequately protected from risk of harm; and,
voluntarily give informed consent to participate in research.

The IRB also follows the ethical principles found in the Belmont Report and codified in "The Common Rule" set out in 45 CFR 46, subpart A. It also follows subparts B-D of 45 CFR 46.

Before any work may begin on a research protocol, the IRB must review and approve the research. The IRB also reviews ongoing research at least annually to help investigators ensure the continued protection of subjects. In addition, the IRB reviews all changes to research protocols before implementation. In accordance with federal regulations, the IRB has the authority to suspend or terminate approval of research that is not being conducted in accordance with the IRB's decisions, conditions, and requirements, or that has been associated with unexpected serious harm to subjects.
The IRB's Regulatory Authority

The IRB is governed by federal regulations Title 45, Part 46, Protection of Human Subjects that dictate the scope and purpose of IRB activities. The Office of Human Research Protection (OHRP) is the federal administrative agency that monitors the IRB and its activities. The Food and Drug Administration (FDA) also protects human research subjects through its investigational drug and device regulations. Both the OHRP and the FDA monitor human research subjects protections through educational efforts, site visits, and reporting requirements. Both have the authority to suspend research for failure to adhere to the regulations."

Prior to the opening of the MRI scanner for research studies, UConn investigators will work with the IRB to detail common language for some portions of the IRB forms related to MRI study details. Participation in research studies using MRI technology is now common at research intensive universities across the country. In fact, some MRI centers post such common language on their web sites, e.g., the Rochester Center for Brain Imaging (https://www.rcbi.rochester.edu/research/startup.php) and the Brown University MRI Research Facility (http://www.brown.edu/research/about-brown-research/policies/irb-mri-research-facility-informed-consent-addendum-form). It is anticipated that UConn will be able to do that same.

What follows is the current IRB-1 protocol review form on which researchers must describe the purpose and method of their study, the process of obtaining Informed Consent, and the weighing of risks versus benefits. It should be clear from the details requested, and from the formal review conducted by the IRB before any research is conducted, that human subjects participating in MRI research studies will be given full protection.

UConn IRB Form (IRB-1) for New Research Protocols

UNIVERSITY OF CONNECTICUT

Please contact the Office of Research Compliance at 6-8802/0986 with any questions or concerns.

Internal office use only:

(IRB-1) Protocol Application for the Involvement of Human Participants in Research

Institutional Review Board, Office of Research Compliance

Whetten Graduate Center, Rm #214, 438 Whitney Road Ext., Unit 1246 Storrs, CT 06269-1246 860-486-8802

SECTION I: General Information

Nature of Study: (Place an "X" in the column. Check only one.)

Faculty Research Graduate Research

Dissertation Undergraduate Research

Masters Thesis Staff Research

Study Title: ______

Study Objective (2-3 sentence summary of study): ______

______

______

PI, Student Investigator, Correspondent Information:

	Principal Investigator (PI)	**Student Investigator** (only for Student Initiated Research)
	Correspondent (primary point of contact for correspondence, if applicable)	
Name (First, Last, Degree):		
Department:		
Mailing Address:		
Preferred Phone #:		
Emergency Phone # (Required Full Board, More than Min. Risk only):		
Preferred E-Mail Address:		

Very Important: Complete and attach the Appendix A form to list all UConn key personnel engaged in research and other non-UConn investigators.

Section II: Collaborating Institutions/Facilities and Other IRB Reviews

Will the research be conducted only at Storrs and/or the five regional campuses, School of Law, or School of Social Work with no involvement of a collaborating institution? ___ **Yes** ___ **No (If yes, skip to Section III)**

Collaborating Institutions with a Collaborative Agreement with UConn-Storrs

UConn has formal agreements with the University of Connecticut Health Center (UCHC), Hartford Hospital (HH) and the Connecticut Children's Medical Center (CCMC) that authorize one IRB to take the lead with some research protocols. This decision is made by the IRBs involved, but the PI may request which IRB he/she prefers to be the IRB of record. See the IRB website for additional information. If you are collaborating with one of the institutions listed below, place an X in the appropriate cell to indicate which institution, based on the preponderance of expected enrollment, you are requesting serve as the IRB of record or that independent IRB approval will be sought from each applicable site. If you request that UConn-Storrs be the IRB of record, place an X in the appropriate cell.

Institution Name	% to be enrolled/consented	Requested IRB of Record	Independent IRB Review
UConn Health Center			
Hartford Hospital			
Connecticut Children's Medical Center			
UConn – Storrs			

Provide additional comments as needed:

If the PI, Student Researcher or other Key Personnel has an affiliation/appointment with an Institution listed above, please explain: ____

Other Collaborating Institutions/Facilities

If you are collaborating with other sites, provide the name of each institution/facility (e.g. other university, K-12 school, nursing home, tribal affiliation, etc.) and describe the type of involvement of each institution (e.g. recruitment, enrollment/consenting, study procedures, follow-up, data analysis). Indicate if IRB approval/site permission is attached (indicate yes, no, or pending). You will need to obtain IRB approval from every collaborating institution that has an IRB before you can initiate research there.
Note: tabbing out of the bottom right cell will insert another row if needed.

Name of Institution	Describe Involvement	IRB Approval/Site Permission Attached?

Provide additional comments as needed:

If the PI, Student Researcher or other Key Personnel has an affiliation/appointment with an Institution listed above, please explain: ____

International Research

Will any aspect of the study take place outside of the United States? ___ **Yes** ___ **No**
(If yes, complete table below)

NOTE: You may need to obtain IRB approval in the country where the research is taking place and/or a Federal-wide Assurance with the Office of Human Research Protections (OHRP). Please see the IRB website for additional information.

List Location(s)	Name of Collaborating Institution/Facility	Describe Involvement
	IRB/Ethics Approval and/or Site Permission Attached?	

Provide additional comments as needed:

If the PI, Student Researcher or other Key Personnel has an affiliation/appointment with an Institution listed above, please explain: ____

SECTION III: Funding

It is the responsibility of the Principal Investigator to notify the IRB via an Amendment (IRB-3) or at Re-Approval, on an IRB-2 form if the funding source changes in any way.

Funding Source: (Place an "X" in the column next to the funding source.)

Departmental Funds	Human Rights Institute
External (including subawards)	Research Incentive Account
Faculty Grants (Large/Small)	Faculty Start-Up Funds
Graduate School DDF or EE Award	Investigator Out-of-Pocket
Office of Undergraduate Research Award	Unfunded

For Internal, UConn Funded Studies:

If the research is supported either in whole or in part by internal funds (Internal Program Support, Office of Undergraduate Research, Research Incentive Accounts, etc) one COMPLETE copy of each grant application (if applicable) must be included with this application.

Name of Internal/UConn Funding Source:

Principal Investigator**:**

Grant Title (if applicable and if different from protocol title):

FRS Account Number (if known and only applicable for Faculty Large and Small Grants funded by Internal Program Support)

Proposal Number (if applicable, e.g. PD00-0000):

Grant Status (i.e., pending/awarded):

Provide any additional comments as needed:

Note: If there is more than one funding source, copy the table format and add the additional funding source.

For Externally Funded Studies:

If the research is supported either in whole or in part by external funds (federal, state or private), one COMPLETE copy of each grant application or contract must be included with this application.

For each funding source, please identify the following:

NOTE: If the PI on the grant/contract is not the PI on this IRB protocol, submit an e-mail with this application in which the PI who is receiving the grant acknowledges use of this protocol under the grant**.**

Name of Funding Source I (if UConn is the recipient of a subaward, list the institution providing the funding then list the primary source of funds):

Principal Investigator of Contract/Grant**:**

Contract/Grant Title:(if different from protocol title)

FRS Account Number:

OSP Proposal Number:

Grant/Contract Status:

(i.e., pending/awarded)

(i.e., pending, awarded)

Will funds from this contract/grant be awarded to an individual or institution (via a PSA or subcontract) that will be engaged in human participant research? ___ **Yes** ___ **No**

If yes, indicate the name of the institution: ____

Provide any additional comments as needed:

Name of Funding Source II(if UConn is the recipient of a subaward, list the institution providing the funding then list the primary source of funds):

Principal Investigator of Contract/Grant**:**

Contract/Grant Title: (if different from protocol title)

FRS Account Number:

OSP Proposal Number:

Grant/Contract Status:

(i.e., pending/awarded)

(i.e., pending, awarded)

Will funds from this contract/grant be awarded to an individual or institution (via a PSA or subcontract) that will be engaged in human participant research? ___ **Yes** ___ **No**

If yes, indicate the name of the institution: ____

Provide any additional comments as needed:

Note: If there are more than two funding sources, copy the table format and add the additional funding source.

SECTION IV: Conflict of Interest (only required for externally funded research)

At the time of proposal submission to the Office for Sponsored Programs (OSP), all investigators and key personnel are required to submit a Significant Financial Interest Review Form to OSP. For more information, please go to the Conflict of Interest Committee website, http://www.compliance.uconn.edu/conflict.cfm.

Is any investigator listed on this protocol required to submit the follow-up form, *"supplemental"* Significant Financial Interest Review Form? ___ **Yes** ___ **No**

If yes, please identify each individual: ____

SECTION V: Human Participants

Place your responses BELOW, not within, the box containing each item's description.

How many participants will be enrolled? If you are enrolling more than one population describe the total enrollment for each. Note: Participants are generally considered to be 'enrolled' when they sign the consent form or have gone through an oral consent process. Therefore, be sure to account for attrition in your enrollment number.

If applicable, how many potential participants will be screened? When screening procedures are conducted as part of the consent process, participants that fail to screen will be counted as being enrolled in the study.

Participant Population(s): Describe the participant population(s) including gender, ethnicity, age range, income, level of education, and language spoken.

Recruitment: Describe the recruitment process including *who* will recruit, *when* and *where* recruitment will take place and *how* participants will be identified and recruited (e.g., direct recruitment by study team in person, on the phone, by mail/email/internet, random sampling, referrals from other participants, snowball sampling and/or healthcare providers). Attach copies of all advertisement/recruitment materials for IRB review including phone scripts, web postings, newspaper advertisements. If recruiting at off-campus sites, written permission and/or local IRB approval may be required.

Special Population(s):

Identify any special participant population(s) that you will be **specifically targeting** for the study.

Check **all** that apply: (Place an "X" in the column next to the name of the special population.)

Minors	Economically/Educationally Disadvantaged
Prisoners	Members of the Armed Forces
Pregnant Women/Neonates	Non-English Speaking
Decisionally Impaired	Individuals Living with AIDS/HIV
UConn Students	Other (Please identify):
UConn Employees	

UConn Students or Employees:

Are you recruiting students who are in a class you teach or for which you have responsibility? ___ **Yes** ___ **No**

Are you recruiting employees who report to you? ___ **Yes** ___ **No**

If 'Yes," explain why this population is necessary to the study and indicate precautions taken by the researchers to minimize potential undue influence or coercion:

____

____

SECTION VI: Drugs/Devices, Genetic Testing, Radiation and Biological Samples

Drug/Device Use

Does the study involve the use of any of the following (check all that apply)?

- An FDA approved drug or medical device ___ **Yes** ___ **No**
- An investigative/unapproved drug, supplement or medical device ___ **Yes** ___ **No**
- A non-medical device ___ **Yes** ___ **No**
- A proprietary product ___ **Yes** ___ **No**
- A biological agent ___ **Yes** ___ **No**

If yes, please complete the **Drug/Device Supplemental Form** (IRB-1A) and attach it to this application.

Biological Samples

Does the study involve the use of biological samples?
(Either banked or prospectively obtained) ___ **Yes** ___ **No**

If 'Yes,' you will need to obtain approval from the Biosafety Officer before the study can be initiated. Please attach a copy of the approval letter if approval has already been granted from the BSO.

Genetic Testing
Does the study involve the genetic testing of biological samples? ___ **Yes** ___ **No**
If yes, please complete the **Genetic Testing Supplemental Form** (IRB-1B) and attach it to this application.

Radiation or Radioisotopes
Does the study involve the use of radiation or radioisotopes? ___ **Yes** ___ **No**
If yes, you will need to obtain approval from the Radiation Safety Officer before the study can be initiated. Please attach of copy of approval letter if approval has already been granted from the RSO.

SECTION VII: Research Plan

Purpose
State the reason for the study, the research hypothesis, and the goals of the proposed study as related to the research question(s).

Introduction
Provide a clear and succinct summary description of the background information that led to the plan for this project. Provide references as appropriate and, when applicable, previous work in animal and/or human studies. Provide previous UConn protocol number, if applicable.

Design, Procedures, Materials and Methods
Describe the study design, including the sequence and timing of all study procedures. Indicate expected start and completion dates. Include screening procedures, if any. The IRB strongly suggests that investigators incorporate flexibility into the study design to accommodate anticipated events (i.e. explain how missed study appointments can be made up by participants). If the research involves study of existing samples/records, describe how authorization to access samples/records will be obtained. If the study involves use of deception explain the reason why this is necessary. If applicable, describe the use of audiotape and/or videotape and provide justification for use. If this study offers **treatment** for the participants' condition, complete the **Treatment Study Supplemental Form** (IRB-1C) and attach it to this application for review. **If the study includes measures, survey instruments and questionnaires, i**dentify each and, if available, provide references for the measures. Describe what they intend to measure (relate to purpose/hypothesis) and their psychometric properties (e.g., reliability and validity). Identify any that were specifically created for the study.

Justification of Sample Size/Data Analysis
Justification of Sample Size: For qualitative and pilot studies, describe how the proposed sample size is appropriate for achieving the anticipated results. For quantitative studies, provide a power analysis that includes effect size, power and level of significance with references for how the sample size was determined. Explain the rate of attrition, with references as appropriate. Data Analysis: For all studies, provide a description of the statistical or qualitative methods used to analyze the data.

Inclusion/Exclusion Criteria
List major inclusion and exclusion criteria. Any proposed exclusion criterion based on gender (women of childbearing potential), age, or race must include justification for the exclusion. Describe the conditions under which participants may be removed from the study, i.e., noncompliance with study rules, study termination, etc.

Risks and Inconveniences
Describe the potential risks to participants (and secondary participants, if applicable) and *steps taken to minimize risks*. Assess the likelihood of the risk occurring and, if it were to occur, the seriousness to the participant. Types of risks to consider include: physical, psychological, social, legal, employment, and financial. Also describe any anticipated inconveniences the participants may experience (time, abstention from food, etc.).

Benefits
Describe anticipated benefits to the individual participants. If individual participants may not benefit directly, state so here. Describe anticipated benefits to society (i.e., added knowledge to the field of study) or a specific class of individuals (i.e., athletes or autistic children). Do not include compensation or earned course credits in this section.

Risk/Benefit Analysis
Describe the ratio of risks to benefits. Risks to research participants should be justified by the anticipated benefits to the participants or society. Provide your assessment of anticipated risks to participants and steps taken to minimize these risks, balanced against anticipated benefits to the individual or to society.

Economic Considerations
Describe any costs to the participants or amount and method of compensation that will be given to them. Describe how you arrived at the amount and the plan for compensation; if it will be prorated, please provide the breakdown. Experimental or extra course credit should be considered an economic consideration and included in this section. Indicate when participants will receive compensation.

Data Safety Monitoring
This is a prospective plan set up by the study investigators to assure that adverse events occurring during studies are identified, evaluated, and communicated to the IRB in a timely manner. Although the investigators initially propose a Data Safety Monitoring Plan (DSMP), the IRB must approve the plan and may require revision of the plan. A DSMP is required for all human studies at the University of Connecticut except for studies determined to be exempt from continuing IRB review. For studies that present more than minimal risk to participants, the IRB will review and determine on a case-by-case basis whether a data safety monitoring board is most appropriate. Please refer to the IRB's policy regarding data safety monitoring *before* completing this section - http://irb.uconn.edu/irb_sop/IRBSOP_submission.html#data_safety_monit.

Issues that should be addressed in the DSMP include the following:

1) frequency of the monitoring
2) who will conduct the monitoring (Under UConn policy a student cannot be the sole person responsible for monitoring the data and safety of the protocol procedures.)
3) what data will be monitored
4) how the data will be evaluated for problems
5) what actions will be taken upon the occurrence of specific events or end points
6) who will communicate to the IRB and how communication will occur

Sample response to issues listed above for minimal risk/slight increase over minimal risk – "Survey results will be monitored by the PI in conjunction with the student investigator once every two weeks (items 1, 2 and 3). Survey responses will be reviewed to monitor for clarity (i.e., the same question is skipped by 5 or more participants). In that case, the question will be revised and an amendment will be submitted to the IRB (items 4, 5 and 6)."

Privacy/Confidentiality
Explain how the privacy interests of participants will be maintained during the study (note that privacy pertains to the individual not to the data). Describe procedures for protecting confidentiality of data collected during the study and stored after study closure. Describe how data will be coded. Describe plans for storage and security of electronic data (plan must comply with the University's Policy on the Security Requirements for Protecting University Data at Rest). If identifiable, sensitive information (illegal drug use, criminal activity, etc.) will be collected, state whether a Certificate of Confidentiality will be obtained. Be sure to state whether any limits to confidentiality exist and identify any external agencies (study sponsor, FDA, etc.) that will have access to the data. If participants will be screened, describe the plans for storage or destruction of identifiable data for those that failed the screening.

SECTION VIII: Informed Consent

As PI, you are responsible for taking reasonable steps to assure that the participants in this study are fully informed about and understand the study. Even if you are not targeting participants from "Special Populations" as listed on page 4, such populations may be included in recruitment efforts. Please keep this in mind as you design the Consent Process and provide the information requested in this section.

Consent Setting
Describe the consent process including *who* will obtain consent, *where* and *when* will it be obtained, and *how* much time participants will have to make a decision. Describe how the privacy of the participants will be maintained throughout the consent process. State whether an assessment of consent materials will be conducted to assure that participants understand the information (may be warranted in studies with complicated study procedures, those that require extensive time commitments or those that expose participants to greater than minimal risk).

Capacity to Consent
Describe how the capacity to consent will be assessed for participants with limited decision-making capacity, language barriers or hearing difficulty. If a participant is incapable of providing consent, you will need to obtain consent from the participant's legal guardian (please see the IRB website for additional information).

Parent/Guardian Permission and Assent
If enrolling children, state how many parents/guardians will provide permission, whether the child's assent will be obtained and if assent will be written or oral. Provide a copy of the script to be used if oral assent will be obtained.

Documentation of Consent
Specify the forms that will be used for each participant population, i.e., adult consent form, surrogate consent form, child assent form (written form or oral script) or an information sheet. Copies of all forms should be attached to this application in the same format that they will be given to participants (templates and instructions are available on the IRB website).

Waiver or Alteration of Consent
The IRB may waive or alter the elements of consent in some minimal risks studies. If you plan to request either a **waiver of consent** (i.e., participants will not be asked to give consent), an **alteration of consent** (e.g., deception) or a **waiver of signed consent** (i.e., participants will give consent after reading an information sheet), please answer the following questions using specific information from the study:

Waiver (i.e. participants will not be asked to give consent) or alteration of consent (e.g. use of deception in research):

• Why is the study considered to be minimal risk?

• How will the waiver affect the participants' rights and welfare? The IRB must find that participants' rights are not adversely affected. For example, participants may choose not to answer any questions they do not want to answer and they may stop their participation in the research at any time.

• Why would the research be impracticable without the waiver? For studies that involve deception, explain how the research could not be done if participants know the full purpose of the study.

• How will important information be returned to the participants, if appropriate? For studies that involve deception, indicate that participants will be debriefed and that the researchers will be available in case participants have questions.

Waiver of signed consent (i.e. participants give consent only after reading an information sheet):

• Why is the study considered to be minimal risk?

• Does a breach of confidentiality constitute the principal risk to participants? Relate this to the risks associated with a breach of confidentiality and indicate how risks will be minimized because of the waiver of signed consent.

• Would the signed consent form be the only record linking the participant to the research? Relate this to the procedures to protect privacy/confidentiality.

• Does the research include any activities that would require signed consent in a non-research setting? For example, in non-research settings, normally there is no requirement for written consent for completion of questionnaires.

HIPAA Authorization

On the Storrs campus, the following sites are covered entities under the Health Insurance Portability and Accountability Act:

1. Nayden Rehabilitation Clinic (outpatient physical therapy)

2. Speech and Hearing Clinic

3. Emergency Medical Services (EMS, Ambulance)

If research participants are recruited through these entities, it may be necessary to obtain a Waiver of Authorization to allow you to access records for recruitment and an Authorization to use and disclose Protected Health Information (PHI). Contact the Office of Research Compliance at 860-486-8802 for additional information. **Note:** Student Health Services is not covered by HIPAA; however, FERPA regulations apply.

Principal Investigator Certification

I understand the University of Connecticut's policies concerning research involving human participants and I agree:

1. To comply with all IRB policies, decisions, conditions, and requirements;
2. That this study has been designed, to the best of my knowledge, to protect human participants engaged in research in accordance with the standards set by the University of Connecticut, the United States Department of Health and Human Services, the Food and Drug Administration, and any other sponsoring agency;
3. To obtain prior approval from the IRB before amending the research protocol or the approved consent/assent form;
4. To report to the IRB in accordance with IRB policy, any adverse event(s) and/or unanticipated problem(s) involving risks to participants;
5. To submit the Re-Approval/Completion Form as needed;
6. That my participation and the participation of any co-investigators does/do not violate the University of Connecticut policy on Individual Conflicts of Interest in Research;
7. That each individual listed as study personnel in this application has a) completed the required human subjects training, and b) are knowledgeable of the study procedures described in the protocol;
8. That each individual listed as study personnel in this application possesses the necessary training and experience for conducting research activities in the role described for them in this research study.

Furthermore, by signing below, I also attest that I have appropriate facilities and resources for conducting the study.

Origin Signature of Principal Investigator	**Date**

OriginSignature of Student Investigator **(Only for Student-Initiated Research)**	**Date**

Origin Signature of Medical Monitor **(Requi required for all studies that will be monitore by a** **Physician)**	

Department Head Certification

This is to certify that I have read the protocol and believe that there is value in asking and answering these research questions using the approach described in this application. To the best of my knowledge, the researcher(s) have the time, facilities, and expertise to conduct this study.

Origin Signature of Department Head **Requi (Required for ALL studies, unless grant** **application/contract is attached; see Section**	**Date**

APPENDIX K:

INITIAL ARCHITECTURAL PLANS

CONSTRUCTION TIMELINE

Task Name	Duration	Start	Finish
Construction Timeline	**251 days**	**Tue 11/5/13**	**Tue 10/21/14**
Schematic Design	41 days	Tue 11/5/13	Tue 12/31/13
Field Conditions	3 days	Tue 11/26/13	Thu 11/28/13
Review/Estimate	11 days	Tue 12/31/13	Tue 1/14/14
Construction Documents	51 days	Tue 1/14/14	Tue 3/25/14
Review/Estimate	11 days	Tue 3/25/14	Tue 4/8/14
Bidding	10 days	Wed 4/9/14	Tue 4/22/14
Construction	120 days	Wed 4/23/14	Tue 10/7/14
Close Out	10 days	Wed 10/8/14	Tue 10/21/14

SPACE PROGRAM- SCHEME 'F'
2 December 2013

Program Summary - Phillips Building

Space Type	#	Room Size (ft.)	ASF		Description
fMRI System Related Spaces					
MRI Exam Room	1	21.8W x 25D x 8H(min)	546		fMRI Magnet, subject table, and related support items. Add 8"-14" thick walls for shielding.
MRI Equipment Room	1	9.3W x 20.5D x 7.5H(min)	166		Location of all support electronics, power dist., radio freq. shielding panels, and cooling system interfaces req by MRI system.
MRI Control Room	1	10W x 17.8D x 7.5H(min)	178		Location of MRI control console.
fMRI Support Spaces					
Data Post Processing Area	1	12.3W x 21.5D x 7.5H(min	263		Located near MRI control room.
Simulator Room	1	10.5W x 16D x 7.5H(min)	168		Located at any available space.
Control Room	1	7W x 10.5D	74		Adjacent to simulator
EEG Testing Room	1	9.6W x 10.5D	100		Located at any available space.
Other Related Areas					
Reception	1	5W x 10.5D	50		Desk, Comp. Tel., Printer
Prepped Waiting	1	7.5w x 10.5D	79		Secured waiting for patients
Changing Room					
Unisex	1	6W x 7.5D	45		Seating area, gown storage, lockers for subjects property.
Restroom					
Patient	1	7.5W x 10.5D	79		Unisex
Staff	1	7W x 8D	56		Unisex- TBD re: building
B. Test/Exercise	1	12W x 14D	168		Could be adjacent to Simulator Room or separate space.
Behavioral Testing Areas 'A'	2	9.6W x 10.5D	200		View window between rooms for observation; varying size
Behavioral Testing Area 'B'	1	8.8W x 15.4 D	136		
Conference Room	1	14W x 18D	250		6-8 seats
Research Director's Office	1	10.5W x 12D	126		Located within fMRI facility.
MRI Physicist's Office	1	10.5W x 12D	126		Located nearer to MRI facility.
Storage (Mezz)	1	10.3W x 14D	141		
Storage	2	3D x 8W	50		
Total Net SF			**3001**		
With Gross Factor (1.4%)			**4201**		


SVIGALS + PARTNERS
84 Orange Street • New Haven, Connecticut
203.786.5110 • www.svigals.com
REVISION LOG
No. Description Date
PROJECT NAME:
PHILLIPS DC
fMRI
PHASE:
PROGRAMMING
DRAWING TITLE:
FLOORPLAN- OPTION 2
SCALE: 1/8" = 1'-0"
DATE: 12-12-2013
JOB NO: 1336.01
SHEET NO:
A1.02f
PROJECT LIMIT LINE
SUITE ENTRANCE
RECEPTION
EEG TESTING
STORAGE
BEHAVIORAL TESTING
SIMULATOR ROOM
CTRL ROOM
MRI EXAM ROOM
CONFERENCE
DATA PROCESSING
DIRECTOR'S OFFICE
PHYSICIST'S OFFICE
CORRIDOR
EQUIP ROOM
OPEN STORAGE
MECHANICAL ROOM
ELEC RM
3 A1.02f EQUIP LEVEL 1/8" = 1'-0"
2 A1.02f ANECHOIC CHAMBER- LOWER LEVEL OPT 2 1/8" = 1'-0"
1 A1.02f FLOORPLAN- OPTION 2 1/8" = 1'-0"

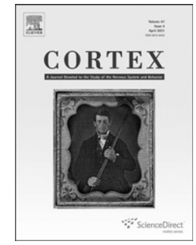
APPENDIX L:
Sample Research Papers from UConn Storrs Faculty

cortex 47 (2011) 416–431

available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/cortex



Research report

Unification of sentence processing via ear and eye: An fMRI study

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ABSTRACT

We present new evidence based on fMRI for the existence and neural architecture of an abstract supramodal language system that can integrate linguistic inputs arising from different modalities such that speech and print each activate a common code. Working with sentence material, our aim was to find out where the putative supramodal system is located and how it responds to comprehension challenges. To probe these questions we examined BOLD activity in experienced readers while they performed a semantic categorization task with matched written or spoken sentences that were either well-formed or contained anomalies of syntactic form or pragmatic content. On whole-brain scans, both anomalies increased net activity over non-anomalous baseline sentences, chiefly at left frontal and temporal regions of heteromodal cortex. The anomaly-sensitive sites correspond approximately to those that previous studies (Michael et al., 2001; Constable et al., 2004) have found to be sensitive to other differences in sentence complexity (object relative minus subject relative). Regions of interest (ROIs) were defined by peak response to anomaly averaging over modality conditions. Each anomaly-sensitive ROI showed the same pattern of response across sentence types in each modality. Voxel-by-voxel exploration over the whole brain based on a cosine similarity measure of common function confirmed the specificity of supramodal zones.

1. Introduction

Supramodal potential, or the ability to glean similar information from spoken and written forms of a message, is an essential characteristic of the language brain, making it possible to convey linguistic messages by writing as well as speech. Of course, many perceptual abilities, such as object and person perception, also exhibit supramodal potential in the sense that people can recognize the same entity on the basis of sensory input in various modalities. Supramodality in language is special in requiring for its realization a long period of learning and instruction. Clearly, the human brain is not automatically adapted for reading and writing as soon as a person is able to speak and understand speech. Yet, only in

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recent years has the neural architecture of the supramodal language system and its development been an object of study in its own right. In undertaking this research, we exploit functional neuroimaging (fMRI) to study the cerebral interrelations between speech and print modalities in persons who have learned to read fluently to determine how the cerebral network that supports reading comprehension is aligned with the network for comprehension of spoken language. We adopted a strategy motivated by a number of previous studies: we compare difficult language processing to easy language processing with closely matched materials and seek the areas where speech and print both produce the same type of response in brain. If difficult language processing causes extra effort to be expended in regions of brain whose job it is to perform the computations associated with the language processing task, then the comparison of difficult to easy will pinpoint loci of relevant processing. We can then look for regions in which speech and print produce similar deflections under conditions of stress in order to identify tissue that may be part of a supramodal system.

In the next two sections, we review prior work that motivates our approach. A variety of evidence can now be cited pertaining to convergence of activity stemming from speech and print inputs on common populations of neurons. Earlier research with neuroimaging tools has examined the neural response to spoken and printed material of widely varying sorts. Since our concern is with comprehension at the sentence level, our review will be selective, focusing on studies exploiting sentence material, especially those incorporating specific challenges to comprehension, especially due to syntactic complexity, such as posed by the contrast between object-relative clauses and subject relatives (Michael et al., 2001; Constable et al., 2004).[1] In undertaking the present study, we aimed to extend and generalize the findings of these studies to another type of challenge to comprehension, sentences containing anomalies of morpho-syntax and of pragmatics (Ni et al., 2000; Carpentier et al., 2001; Homae et al., 2002; Caplan, 2004).

1.1. *Motivation from comparative anatomy and physiology*

We use the term heteromodal association cortex to refer to the probable loci of convergence in humans of neural signals coming from different sensory regions as indicated by neurophysiological studies on nonhuman primates. Because the neurophysiological work is not based on humans, the boundaries of heteromodal cortex in the human brain are only approximately known. Regions that have undergone expansion in the human brain relative to other primates, such as the posterior parietal region and prefrontal region, comprise zones that are certainly hetermodal (Geschwind, 1965; Mesulam, 1998). It is generally considered that heteromodal cortex includes portions of temporal cortex, including Wernicke's area, portions of the inferior parietal lobe, as well as portions of prefrontal cortex, including Broca's area (Seltzer and Pandya, 1994; Poremba et al., 2003). Heteromodal regions are obvious candidates for participation in the supramodal language network. Here, we adopt the assumption that delineation of an actual supramodal network, including the specifics of the alignment of the neural substrate for printed language with the substrate for spoken language, while helpfully guided by data from other primates, can best be inferred from examination of correlations between specific language behaviors and appropriate indicators of brain activity.

The cerebral basis of reading in relation to the spoken language system cannot be fixed and immutable because the relation changes over the course of a person's lifetime. Therefore, the network for reading is likely to be fluid to some degree, reflecting in part the biological commitments of primary language, but reflecting also the variables of type of orthography, education, and experience that may loom especially large in the configuration of the supramodal brain. In this research, we have studied young adults who are experienced readers (of English), and can be expected to have achieved at least a moderately high degree of synergy in dealing with language inputs in each modality (see also Shankweiler et al. (2008), which addresses the influence of differences in reading skill on BOLD responses during sentence processing).

Direct comparisons of brain activity elicited by speech and print have more often been directed to individual words and their parts than to connected text (see, for example Howard et al., 1992; Bookheimer et al., 1995; Chee et al., 1999; Shaywitz et al., 2001; Booth et al., 2002). Imaging studies of orthographic skills supporting printed word recognition have reliably implicated temporo-parietal and temporo-occipital regions together with the inferior frontal region (Rumsey et al., 1997; Pugh et al., 2000a), all arguably, portions of heteromodal cortex. Word-level neuroimaging studies, valuable though they have been in supplementing evidence from clinical studies on delineating the reading brain, are limited in the information they can provide about the cerebral basis of reading syntactically structured groups of words, i.e., sentences. In the present study, we chose sentence material as the stimuli because sentences are necessary to convey propositions while admitting of variations in their processing difficulty. At the same time, sentence stimuli can be compact enough to allow the temporal pattern of brain activity to be correlated with specific events during the course of a stimulus trial.

1.2. *Motivation from functional evidence based on neuroimaging*

There is evidence dating from previous neuroimaging studies of sentence processing that easy or predictable material, or

[1] Here, following the literature in sentence processing, we use the term "differences in complexity" to refer to what could also be called "differences in difficulty". The term refers to empirically well-established cases in which one grammatical type takes reliably longer and/or causes reliably more errors than a closely-related different grammatical type. The use of the term "complexity" in this context stems from a variety of theoretical perspectives which explain the empirical difference by positing a contrast in the complexity of the mechanism involved (measured, for example, by number of nodes in a tree diagram, or amount of load on the syntactic memory system). We use the term not to adopt a theoretical stance on why the differences in processing difficulty occur, but only to label a body of empirical findings that is relevant to our discussion.

passive listening tasks, do not reliably produce activation of all portions of the language-relevant cortex (e.g., Crinion et al., 2003). Accordingly, in our earlier work (Constable et al., 2004) we introduced differences in complexity, contrasting subject-gapped and object-gapped relative clauses, in the context of a comprehension task. Particularly relevant to our present concerns are findings by Carpentier et al. (2001), Michael et al. (2001), Homae et al. (2002); Constable et al. (2004), Spitsyna et al. (2006), and Lindenberg and Scheef (2007). Each of these studies was designed in part to compare the neural architecture of sentence processing in speech and print modes. In each study, experienced adult readers read or heard sentences that varied in the kinds of processing demands they posed, either because the materials varied or the task varied. Cortical regions engaged by processes involved in the apprehension of sentence meaning were mapped, using fMRI or PET, under experimental conditions that allowed the influences of input modality (speech *vs* print) and type of stimulus material to be assessed.

Michael et al. (2001) and Constable et al. (2004) each exploited similar, widely-used manipulations of syntactic complexity, contrasting object-gapped relative clauses with simpler subject-gapped relative clauses or semantically similar conjoined clauses. Thus, these studies included explicit contrasts of text difficulty. A common goal of these studies was to determine the location and extent of cortical sites that respond to sentence material irrespective of modality and that also register differences in difficulty. Michael et al. (2001) contrasted sentences containing object-gapped relative clauses with less complex conjoined active clauses. The participants' explicit task was to read or listen to alternating blocks of print and speech sentences and for each sentence to press a button indicating TRUE or FALSE in response to a probe question. Activity associated with sentences in each modality was assessed relative to a common rest/fixation baseline at anatomically-defined regions of interest (ROIs). Peri-sylvian language areas in inferior frontal, and superior and middle temporal lobes responded to sentence material in both auditory and visual presentation. In the main, these areas also showed a significant increase in activity with increases in sentence complexity. Increased activation for spoken sentences, relative to printed ones, was seen at anterior temporal sites and in the anterior portion of the inferior frontal gyrus (IFG). Printed sentences showed significant increases, relative to spoken ones, in the visual extra-striate region. A limitation of this study is that the rest/fixation baseline does not separate task-related auditory and visual processes inherent in each task from activity specific to linguistic processing of speech and print. Among other things, this could distort estimates of the overlap in activity associated with the reading and listening tasks.

In contrast, the study by Constable et al. (2004) incorporated modality-specific baseline conditions. Constable et al. contrasted sentences containing object-gapped relative clauses with less complex subject-gapped relative clauses. Participants made an acceptability judgment by button press for each sentence. Activity elicited by sentences in each modality was measured against a non-linguistic baseline task matched for sensory channel (tone similarity or line-orientation judgments). As in Michael et al., sentences in each modality activated the inferior frontal region and the posterior temporal region bilaterally, with the response to print more strongly left-lateralized. Auditory presentation was associated with activity in proximity to primary auditory cortex and across the middle and anterior portions of the superior temporal gyrus. Printed sentences, by contrast, evoked major activity at posterior temporal and inferior parietal sites. Speech-print overlapping sites were largely within the left hemisphere and included the occipito-temporal (OT) region, middle temporal and superior temporal gyri (MTG, STG), and IFG. The more complex object-relative sentences evoked heightened responses (in comparison to subject-relative sentences) most strongly in left IFG but also in STG. Despite differences in stimulus materials, and baseline condition, Michael et al. (2001) and Constable et al. (2004) confirm sentence complexity effects at inferior frontal and temporal locations previously shown to express them. (See meta-analysis by Indefrey, 2010). Further, in reporting sites where activation is modulated by complexity independent of input modality, the studies lend support to our hypothesis that, for syntactic and semantic processing necessary to apprehension of propositional meaning, print processing merges with speech processing in particular regions of the brain.

The two studies just discussed, Constable et al. (2004) and Michael et al. (2001), are closest in design to the study we report. In particular, each of these studies compared two sentence conditions in which, according to many theories of sentence parsing, stimulus sentence types contrasted with respect to how severely they taxed the parsing system (see, for example, Pearlmutter and MacDonald, 1995; Gibson, 1998; Van Dyke and Lewis, 2003; Lewis and Vasishth, 2005; van der Velde and de Kamps, 2006). Moreover, the in-magnet task was designed to ensure that the participants attempt to interpret each sentence, thus lending support to the assumption that the parsing system was involved.

Four additional studies report locations of speech-print convergence under different stimulus and task conditions and baselines, but none of these studies included a minimal contrast in sentence processing conditions motivated by a strong theory of sentence processing. Three of them also employed passive listening or reading in the magnet without an explicit comprehension probe, so we are less confident that the critical language systems were strongly engaged. In the first, by Spitsyna et al. (2006), the task was passive viewing or listening to narrative passages against a baseline of unintelligible spectrally rotated speech or false font, or alternatively, an odd-even number discrimination task presented as speech. Sites of modality convergence were noted at anterior and posterior temporal regions, the fusiform gyrus and the parieto-temporal-occipital junction (for the number task), but not in prefrontal regions. The second study, by Lindenberg and Scheef (2007), also with narrative material, required no in-magnet response and employed either non-linguistic baselines (fixation cross, or alternatively, white noise) or low-level semi-linguistic baselines consisting of letter strings and pseudowords, or alternatively, backwards speech. Sites of modality convergence with the corresponding non-linguistic baseline yielded both temporal and inferior frontal sites of activation, whereas compared against language-like stimuli, convergent activity was focused on MTG and the posterior parietal lobule. In a third study (Jobard et al., 2007) participants attended passively to word lists, sentences and brief texts. Clusters located within temporal and frontal cortex were jointly activated by reading and listening. Left IFG, the left pre-central region and posterior STG were recruited more by sentence or text conditions than by word lists. None of the preceding three studies incorporated a text difficulty contrast in their stimulus materials, making it difficult to compare their results to the previously discussed Michael et al. (2001) and Constable et al. (2004).

In the fourth additional study, by Homae et al. (2002), participants had to indicate whether each successive block of connected sentence material contained an anomaly of pragmatic content. A modality-matched control task tested for recognition of pseudowords within randomly ordered phrases. The conjunction of sentence comprehension-related activity with modality isolated a ventral portion of left IFG. This region was selectively activated by discourse comprehension and was independent of whether the input was spoken material or printed text. Like our study, Homae et al. used a task that required sentence comprehension in the magnet, but the contrast between conditions (coherent sentences *vs* randomly ordered phrases) is a complex relation for which current theories of processing do not give us much guidance.

Encouragingly, each of the studies we have reviewed identified one or more zones of modality overlap within temporal and/or frontal regions. However, there is a good deal of variation of implicated areas across the studies. In the current work, we followed the example of Michael et al. (2001) and Constable et al. (2004) in adopting a design that was motivated by processing theory and a task that encouraged sentence comprehension. We believe designs with these properties are best suited to identify regions of convergent processing across modalities because the crucial processing is occurring at a level of linguistic abstraction that is modality independent.

To introduce the stimulus materials and task, we describe another study from our laboratory by Ni et al. (2000). This study showed that sentences incorporating anomalies of morpho-syntax and of pragmatic content could yield similar effects on the distribution of brain activity as the complexities involving relative clause syntax studied by Michael et al. (2001) and Constable et al. (2004). Ni et al. (2000) investigated the cortical responses of experienced readers to spoken sentences containing anomalies of verbal morpho-syntax, <u>trees can grew</u>, and pragmatic content, <u>trees can eat</u>. In one study (Ni et al., Experiment 1), the task was to make acceptability judgments for these kinds of sentences, while a tone-pitch judgment task provided a baseline. The results implicated frontal and temporal regions for each anomaly type. Moreover, sites activated by sentences representing each anomaly condition minus the non-linguistic baseline were largely the same. Response to anomaly was found in both hemispheres in frontal, temporal and temporo-parietal regions at or near sites that showed the influence of relative clause complexity in Michael et al. (2001) and Constable et al. (2004). Using identical sentence materials as Ni et al., Carpentier et al. (2001) arrived at a similar result.[2]

Inconsistencies among the putative sites of modality convergence, especially in regard to IFG, likely reflect variations among the studies in task and choice of baseline. In particular, the use of sentence acceptability judgments may have contributed to this situation. Acceptability judgments introduce incommensurability by requiring different overt responses to anomalous and non-anomalous items, and they focus participants' attention directly on the anomaly manipulation, posing an artificial, metalinguistic task. Such incidental task factors may modulate frontal activations, as several have suggested (Stromswold et al., 1996; Dapretto and Bookheimer, 1999; Meyer et al., 2000; Ni et al., 2000; Love et al., 2006). Ni et al. (2000), Carpentier et al. (2001), Experiment 1, and Homae et al. (2002) are all open to that criticism. In choosing materials and task for the present study, we built on the work of Ni et al. (2000), Experiment 2, which studied neural responses to the same morpho-syntactic and pragmatic anomalies with the same participants as their Experiment 1 summarized above, but discarding explicit acceptability judgments in favor of judgments about the presence of a target semantic category (animate beings) which, by design, was orthogonal and irrelevant to the presence of anomaly. In Ni et al. Experiment 2 the anomaly-irrelevant semantic identification task was mated with an event-related oddball design, embedding the anomalous sentences (presented by ear) in a matrix of more frequently occurring non-anomalous sentences. Due to differences in design and task, caution must be used in comparing the results of the two Ni et al. experiments. However, their Experiment 2, again, implicated inferior frontal as well as temporal regions, suggesting that IFG involvement is not an artifact of the task elicited by metalinguistic judgments.

In the present study, we asked where parallel streams originating from speech and print merge for sentence processing. We adopt a methodology based on the considerations just discussed. We manipulated morpho-syntactic and pragmatic anomalies of main verbs in simple sentence materials, and presented them in parallel speech and print conditions, with a sentence-level linguistic baseline consisting of matched non-anomalous sentences. As noted, our choice of task, a semantic category identification that is irrelevant to the anomalies, avoids requiring participants to attend to anomaly or to make judgments pertaining to anomaly. An

[2] Carpentier et al. (2001) used the sentence materials of Ni et al. in order to obtain baseline data for evaluation of listening and reading comprehension in epileptic patients undergoing brain resections. Findings from their control sample of 10 neurologically normal subjects are in general agreement with those of Constable et al. (2004). Cortical activations of left and right IFG were present in all subjects for anomalous sentences relative to the non-linguistic baseline for sentences in both print and auditory modality, although activity in the posterior portion of IFG was stronger for the print than the speech condition. Posterior STG was also active for both modalities in all subjects. Primarily unimodal speech-elicited activity was noted in auditory cortex, and primarily reading-elicited activity was noted at IPL and the OT-fusiform region. Although Carpentier et al. incorporated both morpho-syntactic and pragmatic anomalies, they did not attempt to distinguish their effects.

oddball design, interspersing anomalous sentences among a much larger set of non-anomalous control sentences, further works against the formation of response sets that could distort the results. Thus, our goal was to delineate the supramodal language comprehension system by examining the joint effects on brain activity of input modality and sentence characteristics during sentence comprehension by adults who are experienced readers. We anticipated that this would allow us to identify cortical sites that are responsive to anomaly-based challenges to comprehension independent of input modality, and compare them with sites differentially engaged (in other studies) by object- and subject-relative clauses. Furthermore, we go a step beyond prior studies by exploiting the structure of our three-level anomaly factor (non-anomaly *vs* pragmatic anomaly *vs* syntactic anomaly) to discern regions of parallel patterning more specific than simple activation in common. We adopt a cosine similarity measure which allows us to apply this more refined approach systematically to the whole brain.

2. Method

2.1. Participants

Neurocognitive data reported here are derived from a study of 44 young adults who represented a wide range of reading ability. Individuals were recruited primarily from adult education centers and community colleges. Criteria for inclusion in that study were: age from 16 through 24 years; no uncorrected hearing or visual impairments; full-scale IQ via the Wechsler Abbreviated Scale of Intelligence, (The Psychological Corporation, 1999) of at least 80 (mean = 104.9; sd = 12.8); native speaker of English; no history of neurological problems; ability to read and comprehend simple expository material. The performance of many of the individuals in this sample on reading ability tasks was far below the levels typically seen in samples from university students. Shankweiler et al. (2008) reported on the effect of individual skill differences on modality relations using the data from this participant pool.

In the present study our interest was to develop a new analytic method to assess supramodal language areas. Accordingly, we considered it most appropriate to apply this new tool initially to a more homogeneous population of skilled readers. To this end, we selected young adults from our sample presenting levels of literacy in keeping with university students who were the participants in the existing body of research to which we wished to compare our results. Eighteen participants of the aforementioned group of forty-four contributed to the present report. Identification of the subset proceeded as follows. First, it was determined that thirty-six of the forty-four yielded analyzable data on the fMRI exam, scans from the remaining eight being contaminated with excessive motion artifact. Then, eighteen from the upper quantile of a median split on a composite measure of reading comprehension were selected for the present report (12 female; mean age 21.7 years, sd = 2.2). The reading comprehension composite has two components. These were adapted from the sentence comprehension subtest of the Peabody Individual Achievement Test – Revised (Markwardt, 1998) and the Gray Oral Reading Test, 4th edition (Wiederholt and Bryant, 2001). See Braze et al. (2007) for details. Thus, participant selection made it possible to achieve comparability with findings based on university students. Participants gave informed consent and were paid $80 for completing the protocols reported here, as well as an extensive battery of behavioral protocols reported elsewhere (Braze et al., 2007). Protocols were approved by the Yale University Human Investigation Committee.

2.2. Materials

Stimuli consisted of short sentences, varying in length from 4 to 8 words (mean = 6.06, sd = .77) and generated from common vocabulary. Three sentence types are represented, shown in Table 1. Non-anomalous sentences, which were grammatically well-formed and expressed a conventional meaning, were the most numerous. In addition, there were two types of anomalous sentences which had most of their words in common: a morpho-syntactic anomaly type and a pragmatic anomaly type. Each anomalous sentence was generated from a non-anomalous base sentence by substitution of the subject noun (pragmatic anomaly) or the auxiliary verb (mropho-syntactic anomaly). Base sentences, like the bracketed examples in Table 1, were not actually presented to the subjects. They were never seen or heard. Non-anomalous test sentences that were included in the test were created anew, observing the same constraints on length and vocabulary. Thus, they were similar, but unrelated, to the pairs of anomalous sentences.

Like Ni et al. (2000), the morpho-syntactic anomaly used in the present study is created through a violation of the normal dependency between main verbs and modals or auxiliary verbs (See Table 1). These sentences were meaningful, but contained violations of verbal morphology. This type of anomaly presents challenges to the hierarchical structure building aspect of language processing (Friederici, 1995) and may serve to trigger mechanisms of structural reanalysis (Fodor et al., 1996). The morpho-syntactically anomalous items were crafted to avoid pragmatically odd combinations of content words. We anticipated that cortical activations to this type of anomaly would be similar to those elicited by complex non-anomalous sentences, specifically the object-relative sentences of Michael et al. (2001) and Constable et al. (2004). This expectation is based on the similarities in the spatial and temporal distributions of event-related brain potentials of object-relative clauses (e.g., Kluender and Kutas,

Table 1 – Examples of sentence anomaly types used in the present study, without (A) and with (B) the target semantic category (a plant, part of a plant, or something made from a plant).

A	New cars might shrink when washed.	Pragmatic anomaly
	New shirts have shrink when washed.	Syntactic anomaly
	[New shirts might shrink when washed.]	Non-anomalous
B	Paint can attack wooden fences.	Pragmatic anomaly
	Termites are attack wooden fences.	Syntactic anomaly
	[Termites can attack wooden fences.]	Non-anomalous

1993; King and Kutas, 1995) and morpho-syntactic anomalies (e.g., Friederici et al., 1993; Friederici, 1995). In each case the characteristic event-related potential is a P600, a left-anterior negativity, or both (also see Kaan et al., 2000). In the pragmatic anomaly condition, sentences were grammatical, but expressed meanings that were unusual or inconsistent with world knowledge. Note that for each anomaly type, the anomaly becomes apparent at the main verb.

The test protocol consisted of 560 sentences, half presented in the print modality and half in speech. Modality was counterbalanced across subjects. There were 28 occurrences of each anomaly type in each modality, giving a total of 112 anomalous sentences on the model of Table 1 and 448 unrelated non-anomalous sentences. Consequently, 80% of trials contained non-anomalous sentences and the remaining 20% were evenly divided between pragmatic anomalies and syntactic anomalies.

Within the stimulus set, counterbalancing ensured that each participant read or heard one member of each anomaly pair. So, for each such pair, a participant would be presented with one member of that pair in either print or speech. Non-anomalous sentences were also counterbalanced across modality. Counterbalancing resulted in 4 presentation lists, with participants randomly assigned to lists.

Additionally, 25% of sentences, evenly distributed across anomaly and modality, included mention of a specific semantic category (a plant, part of a plant, or something made from a plant). The other 75% of sentences did not contain an item from this category. When a sentence contained mention of the target category, that mention always occurred after the main verb. See Table 1B.

2.3. Procedure

The 560 trials of each presentation list were evenly divided into 14 blocks; each block was presented during a single functional activation imaging run. See Image acquisition and analysis, below. Blocks contained 40 sentence trials: 32 non-anomalous sentences and 4 trials each of pragmatically anomalous and syntactically anomalous sentences. Thus, anomalous sentences occurred infrequently in the stimulus sequence, distributed pseudo-randomly among the non-anomalous trials. Sentence order within each block was fixed. Number and proportions of items in each condition are shown in Table 2.

Each participant's 14 image activation runs were evenly divided between print and speech blocks, 7 of each. For all participants, odd numbered runs contained speech stimulus blocks, while even numbered runs contained print stimulus blocks. Block order was randomized within each modality. The inter-trial interval for both modalities was 5 sec. At least 2 non-anomalous sentences occurred between each pair of anomalous sentences. So, a minimum of 15 sec intervened between occurrences of anomalous verbs, allowing the associated hemodynamic response to relax between anomaly trials. Print stimuli were presented word by word in a rapid serial visual presentation (RSVP) format at a rate of 2 Hz. Thus, print sentences lasted between 2 and 4 sec. Spoken sentences were presented at a moderate speaking rate and ranged from 1.51 to 3.40 sec in duration. Participants were instructed to monitor sentences for mention of the target semantic

Table 2 – Number and proportion of sentences in each stimulus condition. Note that 25% of the items in each condition require an affirmative response in the in-magnet behavioral task.

	No anomaly	Syntactic anomaly	Pragmatic anomaly
Print	224 40%	28 5%	28 5%
Speech	224 40%	28 5%	28 5%

category (a plant or plant product) and, at the end of each sentence, to press a button indicating whether or not the category was mentioned. Button presses were made with the first and second fingers of the right hand, corresponding to YES and NO, respectively. Expected YES and NO responses were evenly distributed across all anomaly and modality conditions. Participants were given practice on the task in both modalities before entering the scanner. Stimulus presentation and response collection was controlled by an Apple PowerPC computer running Psyscope software (Cohen et al., 1993). Speech stimuli were presented through MR compatible headphones and print stimuli were displayed through an LCD projector onto a back-projection screen located at the foot of the MR scanner table. Participants viewed the screen through a mirror situated inside the scanner bore. A fiber optic button box was used to collect participants' responses.

2.4. Image acquisition and analysis

Imaging was performed on a Siemens 1.5 T Sonata MR system. Sagittal localizer images (TE, 14 msec; TR, 500 msec; FOV, 24×24 cm; matrix, 256×192; 5 mm slice thickness, no skip; 1 NEX) were acquired to identify the inter-commissural line. Subsequently, 20 axial-oblique anatomic images, parallel to the AC-PC line, were acquired (TE, 11 msec; TR, 420 msec; FOV, 20×20 cm; matrix, 256×256; 6 mm slice thickness, no skip; 1 NEX). Functional activation images were collected at the same slice locations using single shot, gradient echo-planar sequencing (flip angle, 80°; TE, 50 msec; TR, 2000 msec; FOV, 20×20 cm; matrix 64×64; 6 mm slice thickness, no skip; 1 NEX, resulting in voxel dimensions $3.125 \times 3.125 \times 6$ mm). Fourteen runs of functional activation images were acquired. Each run provided 103 full volume images, for a total of 1442 per participant.

Each participant's functional images were first corrected for slice acquisition time, then motion-corrected (Friston et al., 1995) and spatially smoothed using a gaussian filter of 3.125 mm full-width at half-maximum. For each participant, an affine transformation to Montreal Neurologic Institute (MNI) standard space was obtained using the intensity-only module of the algorithm described in Papademetris et al. (2004), mapping between the subject-space anatomic image and the MNI-space "Colin" brain (available at http://www.bic.mni.mcgill.ca). Prior to across-subjects analysis, this transformation is applied to the single-subject activation maps, with trilinear interpolation, into 2 mm isotropic MNI space.

Map-based data analysis was performed using in-house software within MATLAB (Matlab, 2001). Multiple regression was used for single-subject, event-related analyses. At each voxel, signal intensity over time was modeled with a set of synthetic hemodynamic response functions (HRF) created from a gamma variate (tau: .9, n: 5, onset delay: 1.4, time to peak: 5 sec). The specific time to peak was chosen based on previous work from our lab using similar materials and protocols (Ni et al., 2000). The onset of the synthetic HRF was temporally aligned to the onset of the critical word (the verb) in each stimulus sentence. See Fig. 1. Individual regressors were employed for each of 12 sentence conditions [3 anomaly (non-, syntactic, pragmatic) $\times$ 2 modality (print, speech) $\times$ 2 target category (yes, no)]. A simultaneous multiple regression was employed with these 12 predictors of interest, and additional regressors to account for run-to-run mean offsets in signal intensity. The resulting regression parameters (B-weights) were converted to standardized activation scores by scaling them against the square root of the error mean-square for the model (Frost et al., 2005). These standardized activation scores are best viewed as effect size scores scaled in standard deviation units of the background noise for the voxel.[3] Standardized activation maps were transformed into MNI space for subsequent analysis. Across subjects, at each voxel, an ANOVA was employed with stimulus condition as a within-subjects variable, implementing a mixed-model or repeated measures ANOVA (Kirk, 1982). Planned comparisons were applied within this model to address hypotheses of interest. Resulting activation and contrast maps were corrected for multiple comparisons using the False Discovery Rate method (FDR; Genovese et al., 2002).

Two additional treatments of whole-brain data were implemented. In the first, across-subject contrast maps were used to create images showing both the logical intersection and the union of activations for two contributing contrasts (Ledberg et al., 1995; Hadjikhani and Roland, 1998; Friston et al., 1999). For example, consider two contrasts, A and B, each evaluated at threshold of $p < .05$. The probability of a chance activation at any given voxel by either A or B, but not both (symmetric difference) is then .0975, and the probability that a voxel will be activated by both contrasts (intersection) is .0025. While, for expository purposes, we will show both the symmetric differences and intersections on such maps, our chief interest lies with the intersections.

A second, novel, whole-brain analysis was designed to illuminate brain regions that showed a similar pattern of response to our three sentence anomaly conditions, regardless of modality. So, for each modality separately, we extracted the 3-vector of response levels (activation values) under the three conditions of our experiment: non-anomalous, pragmatically anomalous, and syntactically anomalous. This vector characterizes the "shape" or signature of activation for the three sentence types within a modality. We then compare the shape of this response vector for speech versus print using a cosine-based metric [cosine of the angle between the speech 3-vector ($\vec{s}$) and the print 3-vector ($\vec{p}$)]:

$$\cos(\vec{s}, \vec{p}) = \frac{\vec{s} \cdot \vec{p}}{\|\vec{s}\| \ \|\vec{p}\|}$$

The cosine measure is commonly used as an unbiased index of similarity that is sensitive to consonance of patterning independent of vector magnitude (for example, see Hinton and Shallice, 1991 for an application to modeling of lexical recognition by artificial neural networks; Mitchell et al., 2008 for a different application to neurological data.). To provide an initial test-bed of the cosine metric, we identified six left-hemisphere regions whose response to sentence materials, in previous studies, had proved to be contingent upon sentence difficulty: two frontal sites, three temporal sites in the posterior superior temporal, the posterior middle temporal and the OT regions, and one site in the inferior parietal region. Within these regions, centers of 6 spherical ROIs (6 mm radii) were established at the maximally activated voxel for the contrast between anomalous sentences with non-anomalous sentences, collapsing the two anomaly types and averaging over modality.

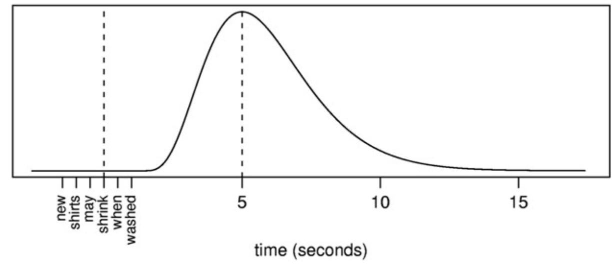

Fig. 1 – The synthetic HRF and its relationship to words in stimulus sentence. For both print and speech stimuli, the synthetic HRF peaks 5 sec after the onset of the verb. Annotation reflects the two word per second presentation rate for print stimuli.

3. Results

3.1. *Semantic category identification task*

Response rates to the category identification task (plant judgments) were high overall, with 16 of 18 participants responding to more than 98% of the 560 trials (a response failure arises when the trial times out before a response is made). Each of the two exceptions responded to about 85% of trials. Failures to respond were similarly distributed across modality and sentence type [all Fs $\approx$ 1]. Category identification accuracy, considering only trials on which responses were made, was high, as shown in Table 3. There is a marginal effect of modality on accuracy [$F(1,17) = 3.60$, $p = .08$, MSe = .310], as well as a reliable effect of anomaly [$F(2,34) = 5.01$, $p = .01$, MSe = .046]. The modality by anomaly interaction is marginal [$F(2,34) = 2.61$, $p = .09$, MSe = .040]. The anomaly effect is due to accuracies in the syntactic and

[3] We use this measure for the sake of consistency and comparability with other studies within our research program, some of which involve data collected from multiple MRI scanners. To be clear, all participants providing data for the present report were scanned in the same MRI device.

Table 3 – Mean percent accuracy (sd) for category identification, by anomaly and modality.

	No anomaly	Syntactic anomaly	Pragmatic anomaly
Print	97% (16)	96% (19)	97% (18)
Speech	97% (17)	94% (25)	94% (24)

pragmatic conditions being slightly lower than in the non-anomaly condition [$F(1,17) = 10.49$, $p = .005$, $MSe = .035$; $F(1,17) = 7.42$, $p = .01$, $MSe = .058$], but not differing from each other.

3.2. *Activation in relation to sentence anomaly*

Non-anomalous sentences provide a linguistic baseline for evaluating the effects of modality. Fig. 2 shows the spatial distribution of evoked responses to speech and print versions of the non-anomalous sentences and their intersection (Ledberg et al., 1995) averaged over the 18 participants. Voxels that exceed threshold ($p < .00001$, uncorrected) for spoken sentences are represented by green, for printed sentences by red, with zones that are above threshold in both listening and reading coded as yellow. Thus, the conjoint probability for the intersection is $p < 1.0e-10$. Regions of co-activation of both modalities occur in large portions of left IFG, as well as dorsolateral frontal cortex, bilateral MTG and STG, OT, and occipital (lingual) areas. Sites more active on listening trials are distributed throughout the IFG, insula, inferior temporal (IT), MTG, and STG, with smaller areas of activity in occipital cortex. Temporal and occipital activations in response to speech are predominantly bilateral, but IFG activations are primarily in the left hemisphere. Sites activated more by reading are found in both right and left IFG. Reading-related activity is also evident in each temporal lobe, albeit more sparsely than listening activity. By contrast, reading-related activation in the occipital and parietal lobes is more extensive than that for speech perception.

Against the background of evoked activity to non-anomalous sentences, we investigated how the distribution of activity is modulated by sentence anomalies that pose challenges to syntactic or pragmatic processing. The difference between activity levels for anomalous sentences and non-anomalous ones isolates regions activated specifically by sentence processing from regions activated by lexical processing and characteristics of the task. Fig. 3 is a composite map for speech and print combined, also collapsing across anomaly type, showing locations of supra-threshold ($p < .05$, FDR corrected) contrast in activation between non-anomalous and anomalous sentences (yellow for regions activated more by anomaly than non-anomaly; blue for the reverse). The figure shows the spatial distribution of cortical responses to anomalous sentences in the context of an overt task ("plant" judgments) that is both irrelevant to the anomaly and orthogonal to it. Thus, while not the target of the semantic judgments, anomaly can be seen to activate some regions more strongly than the non-anomalous control sentences. The anomaly-sensitive sites (like their complexity-sensitive counterparts in Constable et al., 2004) are located chiefly in the left hemisphere, anteriorly within IFG and adjacent insula, the pre-central region, and the middle frontal gyrus (MFG). Posteriorly, they are located in STG, the inferior OT region (fusiform gyrus), and inferior parietal lobule (IPL). There are a few sites that were more responsive to non-anomalous sentences: inferior temporal, medial frontal, and posterior cingulate.

Whereas the main-effect analysis shown in Fig. 3 identified a set of areas that show an overall anomaly effect, the next step was to isolate effects specific to each type of anomaly in conjunction with modality. Accordingly, the maps in Fig. 4 depict the conjunction of speech and print modalities for anomaly minus non-anomaly, indicating areas more responsive to syntactically anomalous sentences than to non-anomalous sentences (Fig. 4a), or to pragmatically anomalous than to non-anomalous sentences (Fig. 4b). Voxels

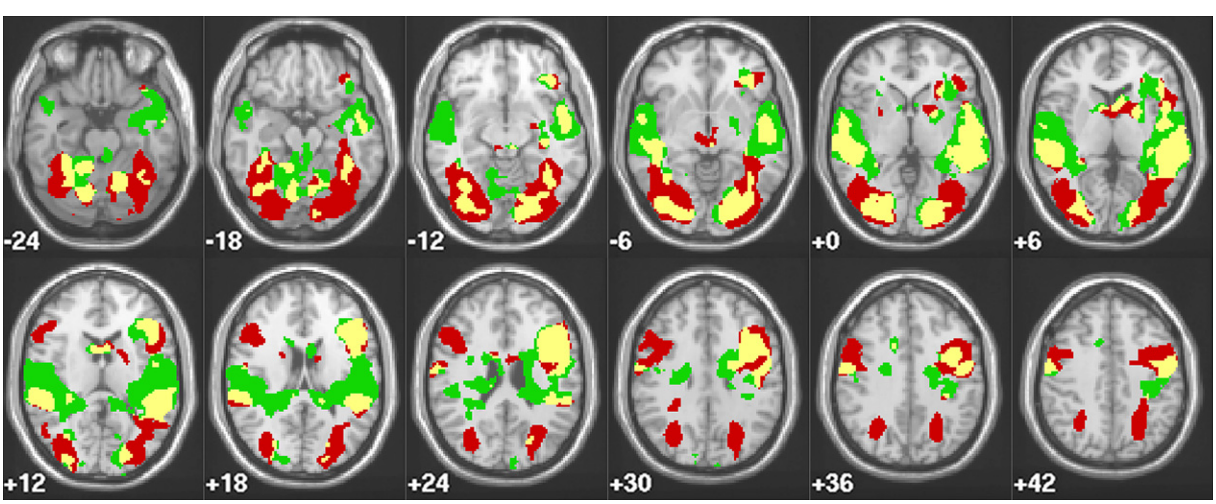

Fig. 2 – Intersection and differences in activation for evoked responses to non-anomalous sentences in each modality ($p < .00001$, uncorrected). Areas coded in green are activated above threshold in speech only, areas in red are activated in print only, and yellow indicates areas that are active in both modalities (conjoint probability $< 1.0e-10$). MNI z-coordinate is indicated on each slice.

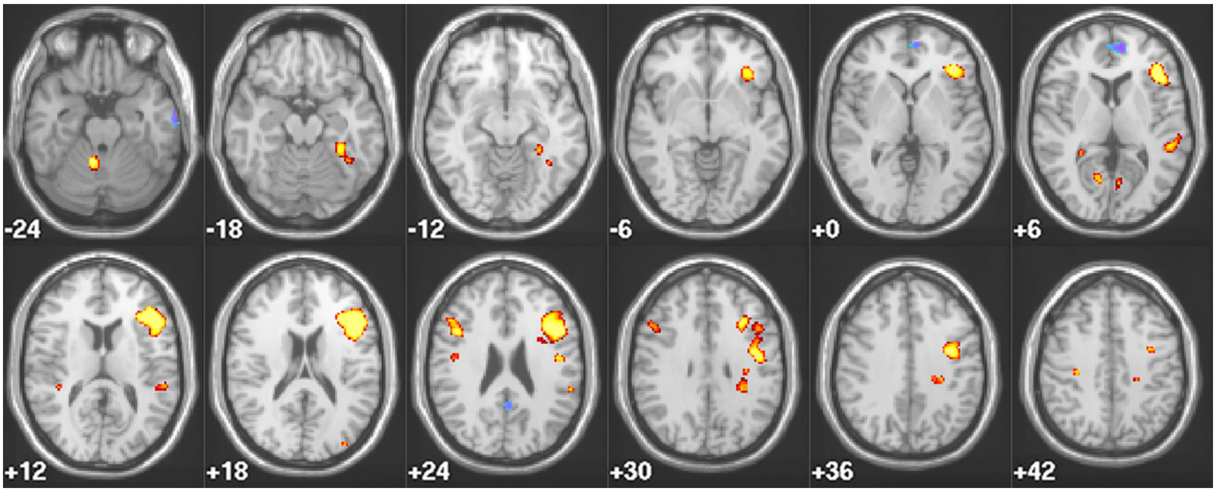

Fig. 3 – Map of standardized activations for the contrast between anomalous with non-anomalous sentences, collapsing across anomaly types and averaging over modality ($p < .05$, FDR corrected). Hot colors indicate regions more active for anomalous sentences; cold colors show areas more active for non-anomalous sentences. MNI z-coordinate is indicated on each slice.

activated above threshold for the given anomaly type in speech are shown in green and similarly for print in red ($p < .05$, FDR corrected). Voxels activated above threshold in both modalities are shown in yellow. The maps for syntactic anomaly (Fig. 4a) show modality overlap anteriorly in IFG and MFG, the pre-central gyrus, and posteriorly, in STG, and lingual gyrus. The maps for sentences containing pragmatic anomalies (Fig. 4b) show fewer regions of supra-threshold activity. But as was the case with syntactic anomaly, there is speech-print overlap, mainly at IFG, with a smaller overlapping site located inferiorly in the OT region. For each anomaly type, sites showing modality overlap are mainly within the left hemisphere.

3.3. *Concordant responses to anomaly, across modality*

To further examine the joint influence of modality and sentence characteristics and to connect them with benchmarks in the neuroimaging literature, we identified left-hemisphere ROI which in previous studies had shown effects contingent on sentence difficulty (Caplan, 2004; Indefrey, 2010). Within each of these areas we located the voxel most responsive to sentence anomalies in our own data; these locations were the centers of 6 spherical ROIs. These comprised two frontal sites in the dorsal and ventral IFG (dIFG, vIFG), three temporal sites in the posterior superior temporal, the posterior middle temporal and the OT regions, and one site in the inferior parietal region. The MNI coordinates corresponding to the centers of these ROIs are given in the caption to Fig. 5. See Methods for details of ROI selection. For each designated ROI we measured activity elicited by each sentence type in speech and print. Fig. 5 shows mean activity levels for each of the six combinations of modality and anomaly for each ROI. It should be appreciated that, by design, each ROI is differentially sensitive to anomaly as contrasted with non-anomalous control sentences. Our goal was to consider whether putative supramodal language regions are similarly sensitive to anomaly regardless of modality.

It is apparent that in each of the 6 ROIs, the pattern of activation across the three sentence types is qualitatively very similar in both modalities. However, in order to assess supramodal potential objectively across the entire brain, we implemented a novel method for determining which regions show a similar pattern of response to the various sentence types, regardless of input modality. For this purpose we computed the cosine of the angle between the print 3-vector and the speech 3-vector for each subject as a function of the activation levels within each ROI, a value which can vary from -1 to 1. See Method for details of the cosine metric. The mean cosine value based on evoked responses averaged within ROI and across subjects is high in five of the six regions, excepting MTG, consistent with the visually apparent similarity in BOLD activity level across modalities in each ROI shown in Fig. 5 (cosine in vIFG = .69; dIFG = .55; STG = .77; IPL = .69; MTG = .35; OT = .61). Regional cosine values computed individually for subjects and then averaged are shown in Table 4.

A central goal of this study was to explore the boundaries of the supramodal language system. Therefore, we wished to identify <u>all</u> brain regions in both hemispheres that showed a similar pattern of response to our three anomaly conditions, regardless of modality. The cosine similarity metric was employed for this purpose. In order to identify regions of highest similarity across the entire brain, we calculated the cosine value individually for each voxel in each subject, creating whole-brain subject maps of the similarity metric. We then averaged these subject maps to identify voxels that tend to show supramodal function across subjects. Fig. 6 shows a composite map of averaged cosine values across the brain, where the cosine measure exceeded .6. It is noteworthy that the areas of convergence identified by this measure overlap considerably with the 6 left-hemisphere ROIs just described. Right hemisphere cosine similarity clusters are also

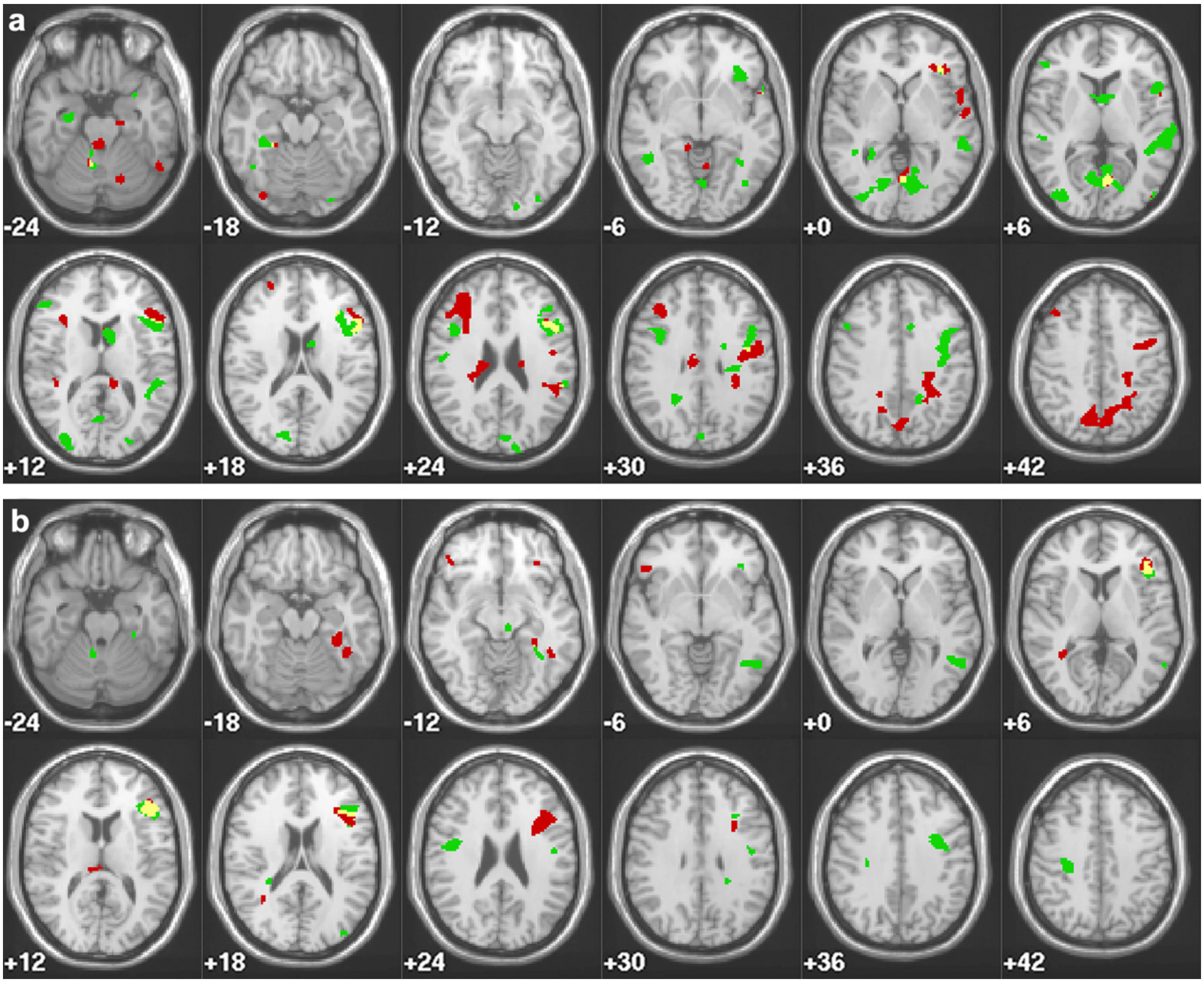

Fig. 4 – Conjunction map indicating areas more responsive ($p < .05$, uncorrected) to (a) syntactically anomalous sentences than to non-anomalous sentences or to (b) pragmatically anomalous sentences than to non-anomalous sentences, in speech (green), or print (red), or both (yellow; conjoint probability < .0025). MNI z-coordinate is indicated on each slice.

apparent. Table 5 lists all the areas in which the cosine measure was consistently greater than .6 over a volume of at least 80 mm^3.

The whole-brain survey based on the cosine vector analysis, like the activation maps shown in Figs. 3 and 4, shows a preponderance of left-hemisphere sites, although there are also reversals in some posterior regions. As may be seen from Table 5, a prominent single site that emerged only in the left hemisphere is in IFG. It includes portions of Brodmann areas 44 and 45, a region noted for its participation in language function, including syntactic processes (see meta-analysis by Vigneau et al., 2006). Although the size of this region is relatively small in each of the x–y planes shown in Fig. 6, it spans the inferior-superior axis contiguously across the IFG from $z = +8$ to $z = +26$, and was the fourth largest region identified by this analysis. We also observe large areas of high similarity in both right and left-hemisphere posterior STG; convergence of speech and print activations are especially strong in left STG, a region that has been found to be increasingly engaged as reading skill develops (Gabrielli, 2009). Notably, convergent portions of STG listed in Table 5 (both hemispheres) exclude the Transverse Temporal Gyri containing primary auditory cortex. There is a small activation in left IPL at slice $z = 24$ in Fig. 6, which is not listed in the table as it falls below the 80 mm^3 cutoff for inclusion; nonetheless, it is wholly contained within the spherical ROI whose activation pattern is depicted in the lower left panel of Fig. 5; functional differences in this region have been implicated in specific reading disability (e.g., Pugh et al., 2000b). We also find concordant patterns of activation in the OT regions, bilaterally. In left-hemisphere OT, this site of concordance approximates the so-called visual-word form area (VWFA; see Cohen and Dehaene, 2004). Activation 10 in Table 5 (not readily apparent in Fig. 6 due to slice selection) is slightly posterior to the OT ROI in Fig. 5 and, as noted, in close proximity to the conventionally acknowledged location of the VWFA. Although the lingual gyrus shows a larger convergent area on the left, the right fusiform gyrus shows a larger area of high cosine values than does the left. We also note high cosine values bilaterally in portions of extra-striate cortex, as well as the medial frontal and pre-central gyri and a large portion of right cerebellum.

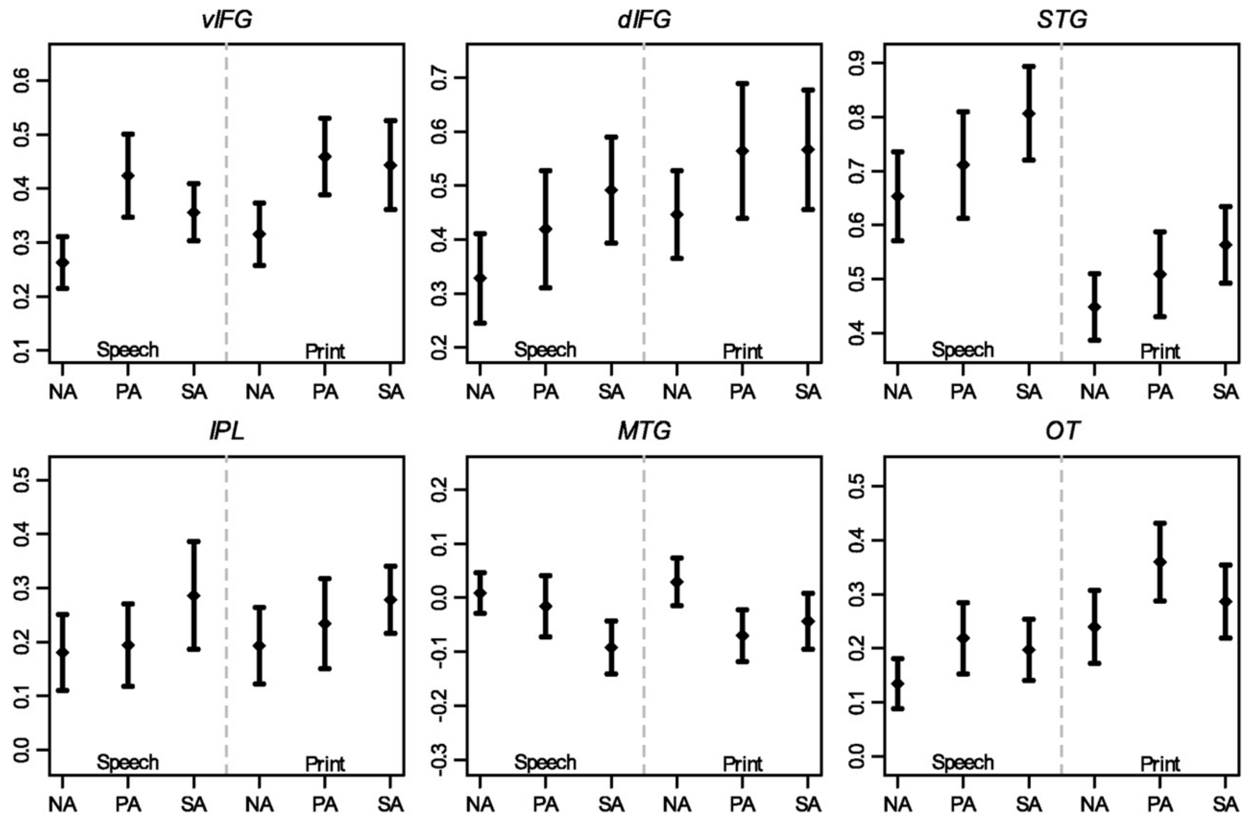

Fig. 5 – Mean standardized activation scores (±sem) for each of 6 sentence types in 6 empirically derived ROI (6 mm radius spheres, encompassing 123 voxels each). Note that y-axes are all on the same scale, although differently centered. ROIs are centered on the focal activation within anatomic regions known to respond to linguistically challenging material. ROI centers in MNI coordinates are: dIFG (−46, 16, 24); vIFG (−44, 26, 12); STG (−54, −36, 8); IPL (−58, −38, 24); MTG (−66, −10, −22); OT (−32, −40, −16).

In summary, we employed a novel application of cosine similarity to create unbiased whole-brain maps depicting the relative concordance of response to 3 sentence types, regardless of modality. Results arising from this analysis largely confirm the locations of regions presumed on other grounds to engage in supramodal language function.

4. Discussion

We have supposed that the language processing system of the human brain is essentially a supramodal system and that an important function of the system, in people who know how to read, is to establish a common currency across speech and print modalities. Accordingly, our goal in this project was to identify those cortical zones that prove sensitive to sentence comprehension challenges independent of input modality. We have proposed that these characteristics are integral features of the language comprehension network (see also Constable et al., 2004).

As a way to probe this hypothesis, we designed sentence materials that presented greater or lesser challenges to comprehension, enabling us to compare patterns of response to these differing sentence types across modalities. Accordingly, our materials included syntactically and pragmatically anomalous sentences as well as a non-anomalous baseline condition. We incorporated a neutral semantic category monitoring task because we wanted to ensure an active perceiver. At the same time, the monitoring task was designed to be irrelevant to the source of the comprehension challenge because we wanted to tap into preattentive, automatic processing of the anomalies, avoiding the metalinguistic mode of processing elicited by anomaly detection tasks. Analysis of the behavioral responses to the semantic judgment task showed that performance did not differ according to type of anomaly, and thus was neutral with respect to the anomalies, as we intended.

Table 4 – Peak and mean cosine values for the 6 ROIs whose activation patterns are depicted in Fig. 5.

	Name	MNI coordinate (center)			Cosine	
		x	y	z	Mean	Peak
1	vIFG	−44	26	12	.52	.64
2	dIFG	−46	16	24	.56	.65
3	STG	−54	−36	8	.59	.69
4	IPL	−58	−38	24	.46	.67
5	MTG	−66	−10	−22	.12	.36
6	OT	−32	−40	−15	.36	.51

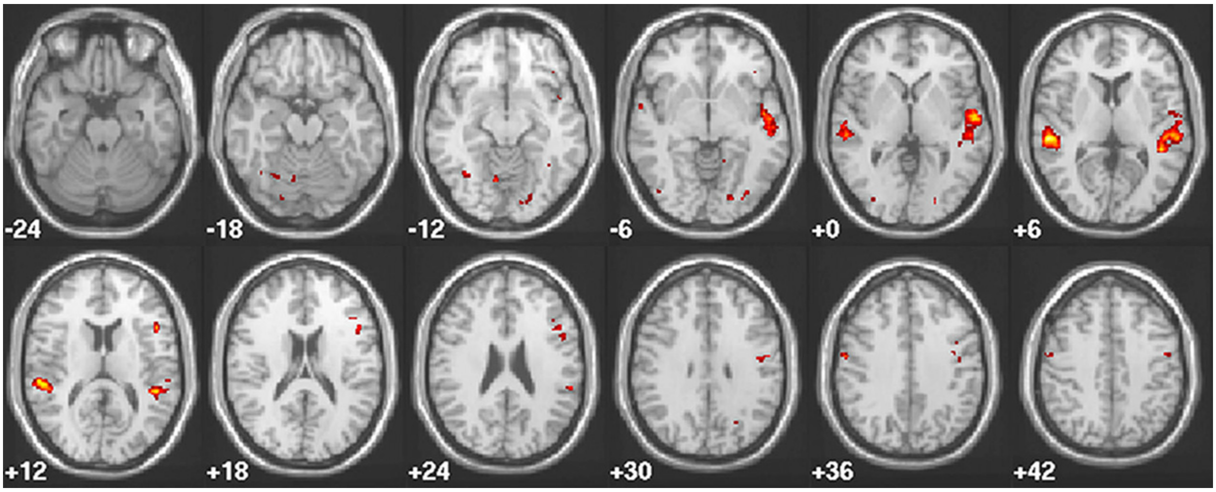

Fig. 6 – Results of applying the cosine similarity metric to the whole brain. Colored voxels indicate high similarity as determined by high cosine values (≥.6) for the angle between the speech vector, specified by values of evoked responses to three sentence conditions (pragmatic anomaly, syntactic anomaly, and no anomaly), and the corresponding print vector.

The imaging findings in their entirety, including evoked responses to non-anomalous sentences, show large zones of regional overlap in response to spoken and printed sentences as well as modality-specific sites. The evoked responses to the non-anomalous sentences in each modality, mapped in Fig. 2, show activity in perisylvian and extra-sylvian cortex, as well as visual and auditory sensory regions. Areas of overlap that reflect activity common to spoken language perception and reading are found most densely represented in frontal and temporal regions bilaterally, including Broca's and Wernicke's regions and their homologues. Responses to simple non-anomalous sentences in each modality provide a standard against which to gauge the effects of the challenging sentence anomaly conditions.

Subtraction of anomaly from non-anomaly isolates activity specific to sentence processing from activity associated with the task that is common to both sentence types (Fig. 3). This includes lower-level sensory activity stemming from visual and auditory stimulus conditions, motor-related activity elicited by the manual button press response, and activity evoked by the neutral, semantic monitoring task, all of which are balanced across anomaly conditions. When we contrasted activations due to non-anomalous sentences with those evoked by anomalous sentences, collapsing across anomaly type and modality, we found that the presence of anomaly heightens activity within some frontal and temporal regions, and that, in agreement with (Ni et al., 2000, Experiment 2), most of the specifically anomaly-sensitive sites are left-lateralized. Thus, despite the fact that the participants were not asked to attend to the anomaly, this manipulation of sentence type clearly produced an effect on brain activity that is consistent with prior work on language processing in the

Table 5 – Regions of cosine maxima (cosine ≥ .6) based on whole-brain analysis.

	Hemi.	Name	Volume mm3	MNI coordinate (peak)			Peak
				x	y	z	Cosine
1	L	IFG	1008	−48	18	14	.73
2	L & R	Medial frontal gyrus	392	0	8	50	.69
3	L & R	Medial frontal gyrus	1152	2	−2	64	.74
4	L	Pre-central gyrus	176	−48	−6	46	.70
5	R	Pre-central gyrus	288	58	−8	38	.72
6	L	Superior temporal gyrus	6584	−44	−40	8	.78
7	R	Superior temporal gyrus	3392	58	−30	8	.83
8	R	Middle temporal gyrus	104	62	−2	−4	.66
9	L	Postcentral gyrus	80	−42	−24	52	.64
10	L	Fusiform gyrus	80	−34	−54	−16	.62
11	R	Fusiform gyrus	648	38	−62	−14	.68
12	L	Lingual gyrus	392	−20	−84	−8	.68
13	R	Lingual gyrus	104	20	−84	−16	.67
14	L	Inferior occipital Gyrus	88	−34	−80	−6	.63
15	L	Inferior occipital Gyrus	80	−12	−88	−12	.63
16	R	Middle occipital gyrus	88	34	−84	4	.63
17	R	Culmen (cerebellum)	248	10	−68	−10	.69

brain. Residual activity associated with anomaly was detected at regions previously identified as portions of the language brain. Moreover, the anomaly-sensitive sites correspond approximately to the complexity-based contrasts reported by Carpentier et al. (2001), Michael et al. (2001), and Constable et al. (2004). Prominent sites are seen in peri-sylvian ventral IFG, STG, and extra-sylvian dorsal IFG, MTG, and OT. Despite differences in method, materials and task, we corroborate the indications of previous studies, which used relative clause complexity manipulations, regarding the location of sites sensitive to comprehension challenges in either modality.

In short, our findings parallel results reported by Carpentier (2001), Michael et al. (2001), and Constable et al. (2004), who examined the relation between sentence complexity and modality with quite sentence types (relative clauses). There is good agreement between our new findings with sentence anomaly and these earlier studies. In each case the effects are seemingly supramodal, implicating mainly inferior frontal and temporal regions.

4.1. *Supramodal potential*

Moving beyond simple identification of regions that respond to inputs in both modalities, a central goal of our research is to investigate the mechanism of the supramodal potential of the language brain. To this end, we implemented a novel application of a cosine similarity metric to identify areas in which the structure of processing is similar across modalities. As a preliminary evaluation of the metric, we chose six left-hemisphere areas, based on a review of the neurolinguistic literature, that are most frequently active during complex sentence processing tasks.[4] At each ROI, the cosine metric showed that, regardless of whether sentences were presented in printed or spoken form, these regions responded in a similar way to the comprehension challenges posed by morpho-syntactic and pragmatic anomalies. We then extended our approach based on the cosine vector analysis to evaluate the amodality of response to sentence anomaly across the entire brain. This unbiased whole-brain survey shows sites in both hemispheres, but with a preponderance of left-hemisphere sites and nearly double the total volume of supramodal cortex on the left than on the right (see Table 5). This is true in most frontal and temporal regions. Some posterior regions display greater bilaterality or, in the case of the fusiform gyrus, a larger region on the right. Overall, these results are in line with the general finding in neuroimaging studies that language tasks generate activity in both hemispheres, greater on the left. In terms of function, the principle of left-hemisphere language dominance is firmly established in the clinical literature, although there is also evidence for bilaterality in at least some language functions. In the case of reading, our findings are in keeping with evidence that typical reading development is characterized by decreased right hemisphere engagement and increased left-hemisphere engagement (Pugh et al., 2000a; Gabrielli, 2009).

We acknowledge that there is not complete agreement among the studies we reviewed regarding the locations of modality convergent sites. In view of the variety of tasks and stimulus materials employed in these studies, this is hardly surprising. For example, some studies have reported temporal and parietal sites, but no sites within frontal or prefrontal areas. Earlier we considered how task factors may have influenced these outcomes. First we noted that not all studies that addressed the issue of the supramodal language brain manipulated sentence difficulty and not all tested for comprehension during the neuroimaging session. Studies by Spitsyna et al. (2006) and Lindenberg and Scheef (2007) did not. These studies, which employed similar methodology using narrative material with passive listening or viewing, reported activity at temporal and temporo-parietal sites, but neither reported activity at frontal sites. It has long been observed that passive listening or reading tasks do not reliably engage inferior frontal sites (See Crinion et al., 2003). In contrast, Carpentier et al. (2001), Michael et al. (2001), and Homae et al. (2002) and Constable et al. (2004) each report prominent inferior frontal sites among the modality convergent zones. Each of these studies required explicit judgments about the grammatical or semantic acceptability of the test sentences, raising the possibility that recruitment of the inferior frontal region reflects the special demands of this task, not ordinary comprehension processes.

Our method, though incorporating anomalous sentence materials, did not solicit acceptability judgments, while the semantic category judgments required were balanced across anomaly condition. Thus, our findings imply that inclusion of IFG in the supramodal system is not necessarily a consequence of acceptability judgments. Another spurious factor that could lead to the participation of IFG and adjacent motor cortex is the manual button press response (see Crinion et al., 2003; Love et al., 2006). The present study required a button press, as did several of the studies we reviewed, except for Spitsyna et al. (2006) and Lindenberg and Scheef (2007). However, in the present study, as in Homae et al. (2002), button press is common both to the experimental condition and the baseline condition, hence its effects are removed from the contrasts of interest. Our findings and those of Homae point away from the engagement of IFG being an artifact of method assignable to acceptability judgments or to use of a manual response. On the contrary, IFG seems to be an integral part of the supramodal language system.[5]

It is apparent from Table 5 and Fig. 6 that modality convergence is found at other cortical regions than those we selected as ROIs. The whole-brain analysis revealed modality-independent sites in left IFG, left and right posterior STG, as well as the left OT region. Each of the left-hemisphere areas

[4] We acknowledge that activity engendered by sentence processing tasks is heavily bilateral. We initially focused on the left hemisphere because of the weight of evidence that the left is the dominant hemisphere in both speech and reading, not excluding the likelihood that the two hemispheres work cooperatively in language as in other functions, and not excluding the possibility that the right hemisphere may have distinctive functions in language processing. Note that the whole-brain analysis employing the cosine distance measure (Table 5, Fig. 6) is inherently unbiased with regard to hemispheric distribution.

[5] In a related study, we have shown that left IFG is a locus of literacy-related differences in modality convergence, which is a further reason for keeping this multifunction region in view (Shankweiler et al., 2008).

has been implicated in some aspect of language processing. IFG has confirmed relevance to syntactic processes (Binder et al., 1997; Cooke et al., 2006; Vigneau et al., 2006) and, arguably, to unification of meaning more generally (Hagoort, 2005). Left posterior STG (Wernicke's area) demonstrated especially strong and wide-spread convergence between speech and print activations (also noted by Jobard et al., 2007). Notably, the primary locus of convergence in STG did not include primary auditory cortex. In fact, Friederici et al. (2003) and Cooke et al. (2006) have each proposed wide-scale cortical networks with fronto-temporal components involved in the syntactic and semantic aspects of language processing. Right STG has been implicated in processing prosodic aspects of language (Friederici and Alter, 2004; for discussion see Bookheimer, 2002). The fact that our cosine metric indicates a high degree of concordance between print and speech activations in prosody-implicated right hemisphere regions is especially intriguing in light of recent indications from behavioral reading research that the apprehension of print may well engage prosodic processes (Ashby, 2006). Alignment of response to anomaly across modality in OT regions is consistent with the view that these regions subserve the interface between orthographic and phonological processes (Pugh et al., 2000b; Cohen and Dehaene, 2004), on the assumption that neural pathways activated by phonological (speech) inputs can feed back into regions that are putatively involved in orthographic-to-phonological mapping. Finally, we note that our cosine metric indicates concordance of response to anomaly regardless of modality in medial frontal and pre-central gyri. The first of these corresponds to the supplementary motor area, and the second with primary motor cortex. These areas have established connections to speech production, but there are also some indications in the literature that they, particularly supplementary motor area, may be involved in language comprehension (Zatorre et al., 1996; Murphy et al., 1997; Calvert and Campbell, 2003).

Though the discussion to this point has focused on the architecture of speech-print convergence, our findings, of course, also reveal modality-specific patterns of activity. As is apparent from the conjunction maps in Fig. 4, broken out by anomaly type, and confirmed by ROI analyses presented in Fig. 5, some sites activated by sentence anomalies also responded more vigorously to one or the other modality. Specifically, STG was slightly more responsive to speech than to print (as Spitsyna et al., 2006 also observed), while the OT site responded with greater vigor to printed sentences than to spoken ones and the more dorsal of the inferior frontal sites slightly so. These findings, particularly with respect to IFG and OT, are consistent with other indications in the literature (Poldrack et al., 1999; Constable et al., 2004).

5. Conclusion

A rigorous test of the hypothesis that the essential language brain is supramodal is that it responds similarly to differing sentence characteristics irrespective of whether the input was speech or print. New findings are presented delineating the neural architecture of the supramodal system for comprehension of language. This research examined the BOLD responses of young adults to spoken and printed sentences incorporating anomalies of morpho-syntax and pragmatics thereby extending to different kinds of linguistic material earlier findings based on relative clauses. The implicit effects of anomaly on the BOLD signal in the present study largely mirror the effects due to syntactic complexity manipulations used in other studies. Both kinds of comprehension challenges engage inferior frontal as well as posterior temporal and parietal sites. We identified six left-hemisphere ROIs, including both Broca's and Wernicke's regions, sensitive to comprehension challenges engendered by sentence anomalies. Across ROIs the pattern of response to sentence type is highly similar for each modality. Further, an unbiased survey of the whole-brain identified regions of high similarity in both hemispheres, but predominantly in the left, confirming that the supramodal language system is a distributed, asymmetrically organized system. Through our choice of method and baseline, we are able to shed light on a major inconsistency in earlier findings with respect to the contribution of the inferior frontal region. Our findings suggest that IFG is integral to the supramodal language system.

The cosine similarity measure that we used to identify regions of convergence across the whole brain can be extended to arbitrary numbers of conditions (that is, more than the three that we employ here). The analysis may be thought of as a way of asking about two regions, X and Y of brain, not only, "Do they constitute part of a subsystem with a particular functional purpose?" but also "Do they function in the same way within that subsystem?" This refinement of hypothesizing may help us move closer to the goal of using brain imaging data to address questions about process as well as questions about localization.

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PAPER

The *COMT* Val/Met polymorphism is associated with reading-related skills and consistent patterns of functional neural activation

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Abstract

In both children and adults there is large variability in reading skill, with approximately 5–10% of individuals characterized as having reading disability; these individuals struggle to learn to read despite adequate intelligence and opportunity. Although it is well established that a substantial portion of this variability is attributed to the genetic differences between individuals, specifics of the connections between reading and the genome are not understood. This article presents data that suggest that variation in the COMT *gene, which has previously been associated with variation in higher-order cognition, is associated with reading and reading-related skills, at the level of both brain and behavior. In particular, we found that the* COMT *Val/Met polymorphism at rs4680, which results in the substitution of the ancestral Valine (Val) by Methionine (Met), was associated with better performance on a number of critical reading measures and with patterns of functional neural activation that have been linked to better readers. We argue that this polymorphism, known for its broad effects on cognition, may modulate (likely through frontal lobe function) reading skill.*

Introduction

Reading disability (RD) has been characterized as a brain-based difficulty in acquiring fluent reading skills, typically associated with phonological deficits, that affects significant numbers of children (Lyon, Shaywitz & Shaywitz, 2003).[1] Evidence from epidemiological population studies suggests that RD symptomatology likely reflects normally distributed variation in behavior (Jorm, Share, Maclean & Matthews, 1986; Shaywitz, Escobar, Shaywitz, Fletcher & Makuch, 1992; Stevenson, 1988), and thus might be more accurately viewed as a dimensional, rather than a discrete developmental disorder (Fletcher, 2009). This evidence motivates the study of neural and genetic correlates of reading skill across a broad spectrum of levels rather than limiting our approach to extreme variation in reading skill (e.g. RD).

The acquisition of reading skill is likely to be influenced by multiple genes and gene–environment co-actions. Moreover, the psychological texture of reading skill is complex because it weaves in not only reading-specific processes (e.g. decoding) but also more generic cognitive characteristics of the reader (e.g. working memory). Given the role of *COMT* in dopamine regulation and the observed associations between *COMT* and a variety of skills important for reading (e.g. attention, working memory), we have chosen to focus on the variation in this gene and its putative association with reading skill. The *COMT* gene codes for the Catechol-*O*-methyltransferase enzyme, which metabolizes released dopamine in the prefrontal cortex and, as such, is a strong regulator of prefrontal dopamine levels. Moreover, multiple loci within the *COMT* intronic and promoter regions have been found to modify gene expression and function (e.g. Chen, Lipska, Halim, Quang, Matsumoto, Melhem, Kolachana, Hyde, Herman, Apud, Egan, Kleinman & Weinberger, 2004). Given the role of the variation in *COMT* in prefrontal functioning and skill, we suggest that variability in the *COMT* genotype may modulate

[1] This prevalence depends, in part, on definitional criteria applied (i.e. discrepancy–poor reading, usually bottom 25%, and 'normal' or above normal IQ; achievement–poor reading despite IQ; or Response to Intervention–poor reading despite adequate pedagogical treatment), thus prevalence estimates can vary from 5 to 20%.

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skilled reading development; that is, we suggest that variation in the *COMT* gene may be associated with reading skill acquisition through the connection between reading skills and higher-level cognitive skills, which, in turn, are connected to the activity in the prefrontal cortex.

Variation at codon 158 of the *COMT* gene (captured as rs4680) results in a valine (Val)-to-methionine (Met) substitution, which has been associated with increased performance on tasks that heavily recruit prefrontal regions and more efficient physiological response in prefrontal cortex (Egan, Goldberg, Kolachana, Callicott, Mazzanti, Straub, Goldman & Weinberger, 2001). Behaviorally, this polymorphism in adults and late adolescents has been associated with memory, executive function, attention, low-level auditory ERP response and reading comprehension (e.g. Chen *et al.*, 2004; Lebedeva, Korovaitseva, Lezheiko, Kaleda, Abramova, Barkhatova & Golimbet, 2009; Grigorenko, Deyoung, Getchell, Haeffel, Klinteberg, Koposov, Oreland, Pakstis, Ruchkin & Yrigollen, 2007). Extant research on *COMT* has largely focused on memory and/or executive function in typical and atypical (e.g. schizophrenic patients) individuals because of the role that prefrontal dopamine is thought to play in these functions and illnesses. Despite these positive associations, a recent meta-analysis (Barnett, Scoriels & Munafò, 2008) of this particular *COMT* polymorphism yielded mixed results, indicating that there may be little role for this polymorphism in cognitive behavior. However, meta-analytic approaches depend upon the quality and the validity of the individual studies included. In fact, Barnett *et al.* (2008) conclude that the *COMT* Val/Met polymorphism remains a viable candidate gene that may contribute to variation in cognitive function, and that continued investigation of the relationship between properly characterized complex cognitive phenotypes and the variation in the *COMT* gene is important.

Although the literature examining the effects of this *COMT* polymorphism on functional MRI (fMRI) activation is relatively small, and thus far largely limited to studies of adults, multiple studies have found that Val carriers produce greater prefrontal activation than Met carriers despite comparable levels of working memory performance, indicating that cognitive processing may be less efficient in these individuals (e.g. in schizophrenic patients during an N-back task, Egan *et al.*, 2001; in healthy adults in a verbal and spatial memory task, Bishop, Fossella, Croucher & Duncan, 2008; in healthy adults in a word recall task, Schott, Seidenbecher, Fenker, Lauer, Bunzeck, Bernstein, Tischmeyer, Gundelfinger, Heinze & Düzel, 2006; in healthy adults during mathematic and temporal transformations that tax working memory, Tan, Chen, Goldberg, Mattay, Meyer-Lindenberg, Weinberger & Callicot, 2007). However, other studies have found greater activity for Met carriers, including a recent study by Stokes, Rhodes, Grasby and Mehta (2011) who found reduced activation in the right posterior cingulate cortex for healthy adults with the Val/Val genotype relative to Val/Met and Met/Met genotypes during an N-back task and a go-no-go task (see also Stokes *et al.*, 2011 and Mier, Kirsh & Mayer-Lindenberg, 2010 for a summary of Val/Met, Met/Met and Val/Val patterns of activation across reports/tasks). Stokes and colleagues (2011) and Tan and colleagues (2007) suggest that the difference in findings reflects the use of tasks or subprocesses within tasks that have differential sensitivity to dopamine levels and/or function. Further, another recent meta-analysis of the neural substrates associated with *COMT* (Mier *et al.*, 2010) found that in general, executive cognition tasks favored Met carriers while emotional processing tasks favored Val carriers, further validating the pleiotropic effects of *COMT* variation.

Recently, our group established a complex association between variation in the *COMT* gene across multiple SNPs (using a haplotype analysis) and reading comprehension skill in incarcerated adolescents[2] (Grigorenko *et al.*, 2007). This relationship suggests that the action of the *COMT* gene is related to complex multi-layered tasks such as reading comprehension, which involves low-level skills such as pseudoword decoding, intermediate-level skills such as lexical-semantic processing, and high-level skills such as executive functioning that are required for maintaining coherent text representations (Locascio, Mahone, Eason & Cutting, 2010; Landi, 2010). This article presents data from a study that follows up on this work by examining whether variability in *COMT* is associated with multiple aspects of reading skill (word reading, pseudoword reading, passage comprehension) and reading-related tasks (phonological awareness [PA], spelling and oral language skills) in young children and/or brain activation measured with fMRI. Given that the *COMT* gene regulates dopamine in left frontal cortical regions that are altered in RD, particularly in beginning readers (Shaywitz, Shaywitz, Pugh, Mencl, Fulbright, Skudlarski, Constable, Marchione, Fletcher, Lyon & Gore, 2002), we hypothesize that variation in this gene may contribute to individual differences in reading skill and its acquisition. Specifically, we suggest that for young readers, learning to read should be viewed as acquiring a new expertise and, as such, prefrontal systems should play an important role. Therefore, we propose that the variation in *COMT* via its impact on prefrontal systems function will be associated with reading-related behavior indicators, and associated patterns of activation in brain.

[2] Note that this finding was obtained in the context of studying reading comprehension performance and self-reported characteristics of maternal upbringing; this was not a case-control study of reading comprehension.

Methods

Participants

Eighty-six individuals between the ages of 6 and 10, mean age = 8.28, were enrolled in this study; these participants were split into three groups based on *COMT* genotype (see Group details below). Mean ages and gender for the three groups are as follows: Met/Met, Mean age = 8.35 (11 males, 12 females); Val/Met, mean age = 8.06 (24 males, 18 females); Val/Val, mean age = 8.40 (15 males, 6 females). These individuals participated as part of an ongoing study of individual differences in behavioral, neurobiological and genetic contributions to reading skill. Our participants were selected from the larger sample because they had usable MRI data (see MRI analysis) and usable DNA (see DNA collection and analysis). All participants had normal or corrected-to-normal vision and had normal hearing, assessed by an audiometer to be between −20 and 20 dB. No participants had a history of neurobiological insult, psychiatric condition, or developmental disability other than RD (primary), ADHD and/or speech delay (secondary).

Behavioral assessments

Participants were all administered a standard battery of reading and language assessments as well as a screener for ADHD, and educational and neuropsychological history evaluations. Several assessments of reading, language and academic skills were used. Specifically, the three genetic groups (Val/Val, Val/Met, and Met/Met) were compared on several assessments from the Woodcock-Johnson Achievement battery (Woodcock, McGrew & Mather, 2001) including: *Word reading measures*: Word Attack (pseudoword reading, or pseudoword decoding) and Reading Comprehension. *Oral Language Measures*: the Oral Comprehension and Oral Expression composites. *Spelling* was measured with the Spelling subtest. We also administered a measure of *Phonological Awareness* from the Comprehensive test of Phonological Processing (CTOPP; Wagner, Torgesen & Rashotte, 1999), which includes measures of elision and blending. Finally, we also measured *IQ*, in both the Performance and Verbal domains (the latter serves as a measure of expressive vocabulary as well) using the WASI (Psychological Corporation, 1999).

fMRI task

All participants were administered a neuroimaging task that was designed to look at word–level print processing. Specifically, children viewed pictures of common objects and printed words or pseudowords that either matched or did not match the object (e.g. they saw an image of a dress and saw the word 'dress' or a similar pseudoword 'dreak'). Critically, pictures came on the screen before the words and remained on the screen for six trials; this was done to ensure that picture processing was not part of what was being measured during the trials of interest. Real words were high frequency, 4–5 letter words, pseudowords were also 4–5 letters long. Participants were asked to press one button when the word matched the image and another when the image did not match the word (see Frost, Landi, Mencl, Sandak, Fulbright, Tejada, Jacobsen, Grigorenko, Constable & Pugh, 2009; Preston, Frost, Mencl, Fulbright, Landi, Grigorenko, Jacobsen & Pugh, 2010; Preston, Felsenfeld, Frost, Mencl, Fulbright, Grigorenko, Landi & Pugh, in press, for a more detailed task description). Behavioral accuracy in this task was greater than 80% (M = 84%), which is consistent with performance reported in other analyses with this sample (see Frost *et al.*, 2009). This task has been previously shown to discriminate good from poor readers as well as children with more general language problems (Frost *et al.*, 2009; Preston *et al.*, 2010; Preston *et al.*, in press).

fMRI data processing and analysis

Twenty axial-oblique anatomic images were acquired, parallel to the intercommissural line based on sagittal localizer images. At these same 20 slice locations, activation images were acquired using single shot, gradient echo, echo-planar acquisitions. High-resolution anatomical images were collected for 3D reconstruction. Images were sinc-interpolated to correct for slice acquisition time, motion-corrected with SPM2 (Friston, Ashburner, Frith, Poline, Heather & Frackowiak, 1995) and spatially smoothed with a 5.15-mm FWHM Gaussian filter. Images were excluded if they exceeded a tolerance of 2 mm displacement or 2^{o} rotation from the first image in the functional series, or if they exceeded an image-to-image change of 1 mm displacement or 1^{o} rotation. Regression-based estimation was used for the hemodynamic response at each voxel and for each condition, without prior specification of a reference function (Miezin, Maccotta, Ollinger, Petersen & Buckner, 2000). These parameters estimated the mean response for each condition from −3 to + 15 s relative to stimulus onset, and individual activation maps were created to estimate the mean difference between a baseline (0–3 sec before onset) and an activation period (3–8 sec post-onset). Prior to across-subjects analysis, participants' data were transformed to standardized reference space defined by the Montreal Neurological Institute (MNI) by mapping to the high-resolution anatomic to the 'Colin' brain, using linear and nonlinear registration parameters obtained with BioImage Suite (www.bioimagesuite.org; Papademetris, Jackowski, Schultz, Staib & Duncan, 2003).

The three genotype groups were compared on indicators of behavioral performance and initially across three fMRI conditions (printed words [match and non-match] and pseudowords) in a repeated-measures ANOVA;

patterns of activation between the two groups did not differ between word and pseudoword conditions and thus these three conditions were collapsed. Planned contrasts within this ANOVA were used to compare groups for the main effect of print processing conditions (collapsed across words and pseudowords) at each voxel separately. The univariate *p*-values from this ANOVA then corrected for multiple comparisons using the False Discovery Rate [FDR] correction with q = 0.001, effectively thresholding the univariate *p*-values at .01, corrected for multiple comparisons (Genovese, Lazar & Nichols, 2002). No cluster threshold was applied in this analysis or for display purposes. We also ran an omnibus ANOVA to examine which regions overlapped for the overall effect of *COMT* and the individual group comparisons. For the most part regions that showed significant activation differences in the individual group comparisons were also significantly active in the Omnibus ANOVA (Appendix Table A4 and Appendix figure 1).

DNA collection and analysis

DNA was extracted from saliva samples collected using sterile Oragene kits (DNA Genotek) during behavioral testing sessions with participants using DNA Genotek's protocol. After extraction of DNA from samples we used the Applied Biosystems Inc. (ABI) Taqman protocol for SNP genotyping. Specifically, the Assays-on-Demand SNP Genotyping Product containing forward and reverse primers as well as the probe for the SNP of interest was utilized. Taqman polymerase chain reaction (PCR) was used to amplify the region of DNA contained in the genomic region (*COMT* rs4680) under investigation. PCR was carried out using MJ Research Tetrad Thermocycler on a 384-well plate format. Taqman reactions include 50 ng of genomic DNA, 2.5 μl of ABI Taqman® Universal PCR Master Mix, 0.2 μl of ABI 40X Assays-on-Demand SNP Genotyping Assay Mix (assay ID C__25746809_50), 2.0 ul of sterile H_2O and 0.5 μl of Bovine Serum Albumin (BSA). The call rate for genotype identification was 87% (i.e. 28/209 from the entire study sample failed due to the quality of DNA).

Group details

Participants were genotyped (see details above) and grouped into three genotype groups: Val/ Val (n = 23), Val/Met (n = 42), and Met /Met (n = 21). There were no significant differences in age $F(2, 83) = .915$, $p = .405$ or gender ($X^2 = 2.09$, $p = .351$) between the three *COMT* groups. With respect to race, almost all participants were of European Caucasian ancestry with the two African-American participants in the Met/Met group and one in the Val/Met and only Caucasian participants in the Val/Val group.[3] With respect to handedness across the groups, the majority of participants were right handed with 27% left handed in the Met/Met group; 11% left handed in the Val/Met group and 9% in the Val/Val group ($X^2 = 5.103$, $p = .277$).

[3] Behavioral assessments and fMRI analyses were run with and without the two African-American participants in the Met carrier groups, and the pattern of significant findings remained the same.

Results

Behavioral

Performance on behavioral assessments was first analyzed using a MANOVA with group as a fixed factor, followed by pair-wise comparisons for each assessment. The MANOVA was significant $F(2, 75)$, $p = .03$. Because of a few missing cells in the phonological awareness and IQ subtests, the group *N*s for the MANOVA were Met/Met = 20; Val/Met = 40; and Val/ Val = 19; findings reported in Table 1 show means and standard deviations for the two groups on each of the behavioral assessments (means are based on the full sample for most assessments, Ns are provided for each test). Table 2 shows statistical results from the MANOVA including F values, *p* values and effect sizes for the group comparisons, and Table 3 shows the pairwise comparisons for each group relative to the other group in order to distinguish which group comparisons are driving the overall group effect. For both Met/Met vs. Val/Val and Val/Met vs. Val/Val we observed significant differences for Phonological Awareness and Spelling, and a marginal effect for Decoding. There were no significant differences between Met/Met

Table 1 *Means and standard deviations for the two groups on our behavioral assessments*

Test	Group	*N*	Mean	*SD*
WordAttack	Met/Met	23	110.17	13.90
	Val/Met	42	110.60	13.71
	Val/Val	21	103.71	11.93
PassageComp	Met/Met	23	106.39	16.98
	Val/Met	42	106.52	13.88
	Val/Val	21	100.71	13.40
OralComprehension	Met/Met	23	117.17	14.10
	Val/Met	42	115.98	12.24
	Val/Val	21	116.81	11.89
OralExpression	Met/Met	23	113.52	14.38
	Val/Met	42	114.41	10.61
	Val/Val	21	116.48	11.80
PhonoAwareness	Met/Met	23	114.32	17.80
	Val/Met	42	108.49	13.94
	Val/ Val	21	99.05	9.95
Spelling	Met/Met	23	110.39	19.67
	Val/Met	42	108.71	19.92
	Val/Val	21	96.29	16.52
PIQ	Met/Met	22	104.77	14.82
	Val/Met	42	110.81	17.81
	Val/Val	21	108.81	15.19
VIQ	Met/Met	22	106.77	16.32
	Val/Met	42	112.29	14.84
	Val/Val	21	107.57	15.37

Table 2 *F-values, p-values and effect sizes (r) for the three group comparison (MANOVA) on our behavioral assessments. Significant and marginal effects (based on effect size are bolded)*

Test	*F*	*p*	*R*
WordAttack	2.070	**0.133**	**0.412**
PassageComp	0.994	0.375	0.212
OralComprehension	0.115	0.681	0.067
OralExpression	0.386	0.681	0.110
PhonoAwareness	5.818	**0.004**	**0.859**
Spelling	3.953	**0.023**	**0.694**
PIQ	0.983	0.379	0.215
VIQ	0.848	0.432	0.191

Table 3 *Pairwise t-values from the three group comparisons (MANOVA) on our behavioral assessments. Significant and marginal effects (based on p-value, are bolded)*

Test	Group	*p*
WordAttack	Met/Met vs. Val /Met	.999
	Met/Met vs. Val/Val	**.092**
	Val/Met vs. Val/Val	**.059**
PassageComp	Met/Met vs. Val /Met	.946
	Met/Met vs. Val/Val	.257
	Val/Met vs. Val/Val	.181
OralComprehension	Met/Met vs. Val /Met	.874
	Met/Met vs. Val/Val	.772
	Val/Met vs. Val/Val	.633
OralExpression	Met/Met vs. Val /Met	.661
	Met/Met vs. Val/Val	.383
	Val/Met vs. Val/Val	.573
PhonoAwareness	Met/Met vs. Val /Met	.141
	Met/Met vs. Val/Val	**.001**
	Val/Met vs. Val/Val	**.020**
Spelling	Met/Met vs. Val /Met	.752
	Met/Met vs. Val/Val	**.014**
	Val/Met vs. Val/Val	**.014**
PIQ	Met/Met vs. Val /Met	.170
	Met/Met vs. Val/Val	.573
	Val/Met vs. Val/Val	.497
VIQ	Met/Met vs. Val /Met	.206
	Met/Met vs. Val/Val	.631
	Val/Met vs. Val/Val	.502

and Val/Met groups, though for some of our tasks there was a trend for means to be higher for Met/Met in the reading and reading-related tasks. There were no significant differences between any of the groups in Oral Language skills, Passage Comprehension, Performance IQ or Verbal IQ. These findings suggest that Met/Met and Val/Met carriers had superior performance relative to Val/Val carriers on reading-related skills (PA, Spelling), and marginally better performance for Decoding but not on more general language skills (Oral Language, Comprehension) or IQ. Note that superior performance for the individuals possessing Met/Met relative to Val/Val is consistent with previous behavioral data as noted above, though none of these studies examined reading or reading-related skills; this study is the first to use this approach to investigate reading and language skills and their relationship to *COMT*.

fMRI

Met/Met vs. Val/Val

Comparisons of the two homozygous groups revealed many regions of differential brain activation, with the Met/Met group showing several regions of greater activation relative to the Val/Val group. Moreover, the pattern of neural activation observed for Met/Met was more consistent with previously identified patterns of neural activity in good readers relative to poor readers (e.g. Landi, Mencl, Frost, Sandak, Chen & Pugh, 2010; Pugh, Mencl, Jenner, Katz, Frost, Lee, Shaywitz & Shaywitz, 2000; Pugh, Frost, Sandak, Landi, Rueckl, Constable, Seidenberg, Fulbright, Katz & Mencl, 2008). Specifically, individuals in the Met/Met group showed greater activation in a large region covering the left occipitotemporal junction (OT) and fusiform gyrus, sometimes referred to as the visual word form area (VWFA) and the left middle temporal gyrus (MTG). In addition, they also showed greater activation in a region of right frontal cortex and right parietal cortex, consistent with the idea that the frontal cortex may be involved in the relationship between *COMT* and reading (Figure 1; Appendix Table A1).

Met/Met vs. Val/Met

Likewise, as shown in Figure 1, the comparison of Met/Met and Val/Met groups indicated several regions of differential brain activation, in this case with Met/Met carriers showing significantly greater activation relative to individuals with the Val/Met genotype. The areas of greater activation for Met/Met relative to Val/Met overlap with those observed to be more active for Met/Met relative to Val/Val. In particular, greater activation in many of these regions is typically observed in relative to less skilled readers, including left OT, left STG and left MTG, (Figure 1; Appendix Table A2).

Val/Met vs. Val/Val

The comparison of Val/Met with Val/Val revealed many fewer regions of differential activation and the pattern of regional activation differences is primarily isolated to the left precentral gyrus and right occipital temporal gyrus with additional differences in extrastriate regions. Val/Val carriers also showed several areas of greater activity relative to Val/Met carriers, including in the parahippocampal gyrus and in several small regions of the frontal cortex and in the cerebellum.

Covariate analysis

Because *COMT* regulates dopamine levels and the degree to which these levels are modulated varies by gender, we chose to include gender as a covariate. Similarly, because the *COMT* Val/Met polymorphism has been associated

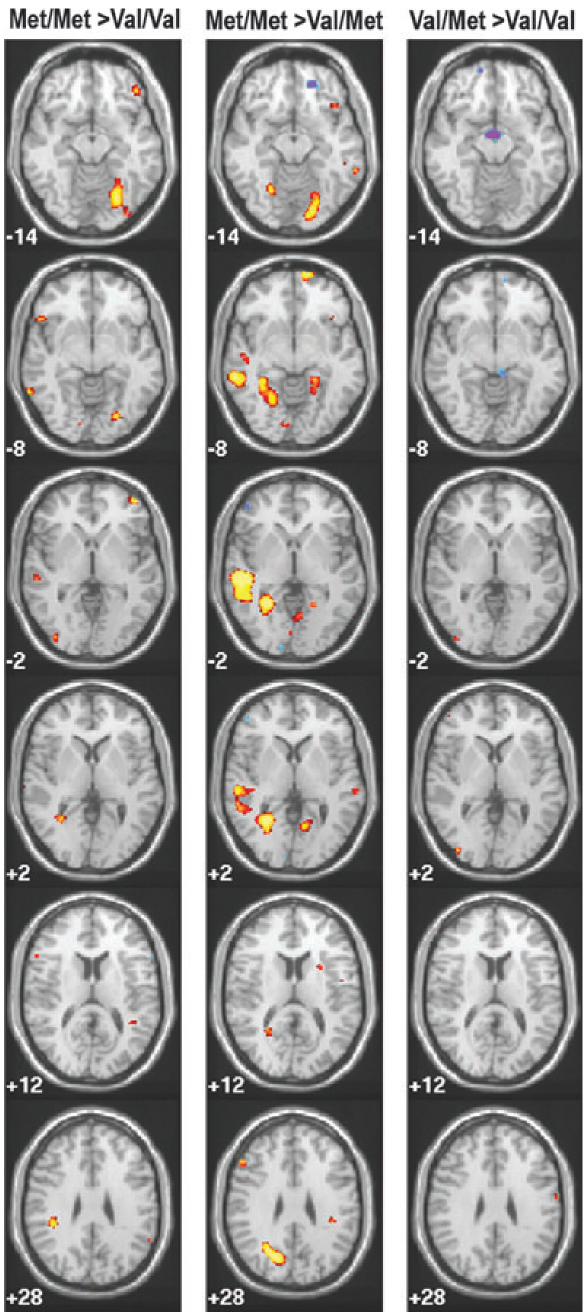

Figure 1 *Patterns of activation are shown for Met/Met > Val/Val, Met/Met > Val/Val and Val/Met > Val/Val in response to printed stimuli. Areas in yellow show greater activity for genotype listed first, Areas in purple show greater activity for the genotype listed second Z coordinates are listed in the bottom left corner, and pictures are presented in radiological convention (left, right reversed).*

with ADHD (Gothelf, Michaelovsky, Frisch, Zohar, Presburger, Burg, Aviram-Goldring, Frydman, Yeshaya, Shohat, Korostishevsky, Apter & Weizman, 2006), diagnosis of ADHD was included as a covariate as well. In addition, because of its known effect on hemispheric laterality, handedness was also included as a covariate. Finally, because of the relatively large age range in our study we also included age. To examine the role that gender, handedness, ADHD and age might play in our behavioral and/or our fMRI findings, we conducted two ANCOVAs, the first on all of our statistically significant behavioral variables, the second on our regions of interest (all regions in which group activations significantly differed). We first conducted the analysis with all covariates at once and if a significant effect for any covariate was identified or if the effect of group became non-significant we ran each covariate separately to determine which covariate was modifying our results. For the behavioral data, none of the covariates modified our effects (either entered in combination or independently). For the MRI data, we found small effects in two regions for one of our group comparisons; specifically, for the comparison of Val/Met > Val/Val the inclusion of all of the covariates made the middle occipital effect marginal ($p = .07$). This was also true for each of the covariates entered on their own (p-values for the effect of *COMT* group ranged from $p = .07$ to .09) except handedness, which did not modify observed effects of interest. Thus the middle occipital effect in this contrast may not be robust.

Discussion

We present an initial report on the relationship between a relatively common genetic mutation, the *COMT* Val/Met polymorphism found at SNP rs4680, and reading and reading-related skills. Associations were found between variation in the *COMT* gene and performance on behavioral measures; specifically, pairwise comparisons of each genotype revealed significantly better performance for Met/Met relative to Val/Val and Val/Met relative to Val/Val on several reading related skills, namely phonological awareness and spelling as well as a marginal effect of better performance on decoding (Word Attack), but no significant effects or trends for other skills we measured (e.g. comprehension, oral language, IQ). We suggest that these particular skills were more strongly associated with frontal lobe function (relative to the other skills measured) because these skills, which emphasize phonological processing, decoding and orthographic awareness, are of particular importance for children in this age range who are just beginning to acquire these skills. Moreover, we also observed strong associations between *COMT* and patterns of brain activation (BOLD); specifically, we found that Met/Met relative to Val/Val and Met/Met relative to Val/Met carriers presented more like better readers (identified in our previous work, e.g. Pugh *et al.*, 2000; Landi *et al.*, 2010). That is, in both cases the Met/Met carriers had greater activation in the OT region and in temporal regions of the left hemisphere. Moreover, Met/

Met carriers had greater activation in left prefrontal regions, consistent with the role of *COMT* in modulating prefrontal function. The comparison of Val/Met to Val/Val revealed fewer regions that distinguished the groups, and although the Val/Met carriers showed greater activation in some reading-related regions, they did not show the same global pattern of 'looking like better readers'. This is somewhat in conflict with the behavioral findings, which demonstrated behavioral differences between these groups. However, upon further inspection at a lower threshold ($p < .05$, FDR corrected) many more regions associated with reading including the OT were indeed more strongly activated for the Val/Met relative to the Val/ Val group.

It is noteworthy that many previous fMRI studies of this *COMT* Val/Met genotype have often identified greater activation for Val/Val carriers particularly in frontal regions, which has been associated with decreased efficiency (Bertolino, Rubino, Sambataro, Blasi, Latorre, Fazio, Caforio, Petruzzella, Kolachana, Hariri, Meyer-Lindenberg, Nardini, Weinberger & Scarabino, 2006; Bishop *et al*., 2008; Blasi Mattay, V.S., Bertolino, A., Elvevag, B., Callicott, J.H., Das, S., Kolachana, Egan, Goldberg & Weinberger, 2005; Caldu, Vendrell, Bartres-Faz, Clemente, Bargallo, Jurado, Serra- Grabulosa & Junqué, 2007; Egan *et al*., 2001; Kempton, Haldane, Jogia, Christodoulou, Powell, Collier, Williams & Frangou, 2008; Mattay, Goldberg, Fera, Hariri, Tessitore, Egan, Kolachana, Callicott & Weinberger, 2003). In our study the Val/Val group generally showed reduced activation, particularly in areas of interest for reading, including a left frontal region; however, as discussed above, several studies have also found greater activity for Met carriers, in a variety of regions including frontal sites (Drabant, Hariri, Meyer-Lindenberg, Munoz, Mattay, Kolachana, Egan & Weinberger, 2006; Smolka, Bühler, Schumann, Klein, Hu, Moayer, Zimmer, Wrase, Flor, Mann, Braus, Goldman & Heinz, 2007; Smolka, Schumann, Wrase, Grusser, Flor, Mann, Braus, Goldman, Büchel & Heinz, 2005; Stokes *et al*., 2011). This discrepancy from the literature might be explained by two factors: first, the nature of our task (reading) and second the regions involved. The existing work that has identified greater activation for Val/Val has been focused on executive function (EF), attention and memory; these tasks and their associated patterns of regional activations are quite different from our assessments and in-scanner tasks, which primarily involve word reading. In particular, work on memory and EF routinely identifies increased activation in prefrontal regions as indicating reduced efficiency; however, in studies of reading, increased activity in reading and language-related areas is associated with superior performance. The second factor may be the age of our participants; the majority of the imaging work investigating *COMT* variation has been done with adults and not with young children. Although it is difficult to predict how exactly this would affect the data, it is known that tonic and phasic levels of dopamine in the cortex change throughout the aging process. Indeed, Wahlstrom, White, Hooper, Vrshek-Schallhorn, Oetting, Brott and Luciana (2007) found that superior performance in children and adolescents was associated with the heterozygous Val/Met genotype in contrast to most of the work on adults which has demonstrated superior performance for individuals with the Met/Met genotype (see also Wahlstrom, White & Luciana, 2010, for a review on the this work and related findings). Moreover, two existing studies of effects of *COMT* genotype on brain in children (though not on reading) indicate that 11–12-year-old children with the Met/Met genotype have increased gray matter volume and increased functional activity in the hippocampus during and emotional processing task (Mechelli, Tognin, McGuire, Prata, Sartori, Fusar-Poli, De Brito, Hariri & Viding, 2009) and that children between the ages of 9 and 16 who are Met/Met carriers have greater regional perfusion (measured by arterial spin-labeling) than Val/Val homozygotes in both cortical and sub-cortical regions, including frontal and temporal cortices, insula, caudate, brainstem, and lateral cerebellum. Although these tasks and methods are different from those used in the current study, these findings suggest that patterns of activation for Met/Met vs. Val/Met and Val/Val carriers may differ based on task, regions being explored, and participant age.

With regard to the association between this polymorphism and our behavioral data, we argue that, based on the literature, this polymorphism has broad cognitive effects and may modulate both acquisition and realization of reading skill via its impact on frontal lobe function. More specifically, we believe that the link to frontal lobe function may be via the metacognitive skill of phonological awareness (PA), which is strongly predictive of reading skill in the early grades (see Frost *et al*., 2009); this hypothesis is supported by our behavioral data which show that Met carriers have better PA. An alternative hypothesis is that polymorphism affects reading via fronto-striatal networks; recent work from our lab (Preston *et al*., 2010; Pugh, Landi, Preston, Mencl, Austin, Sibley, Fulbright, Seidenberg, Grigorenko, Constable, Molfese & Frost, in press) implicates the thalamus and putamen as important in reading and related skills (and these regions are apparent in the data presented here as well; Appendix Tables A1–A3). In our earlier work, we have further hypothesized that these regions are critical because of the sensori-motor procedural learning that takes place when children acquire phonological awareness and then reading (cf. Ullman & Pierpont, 2005). Specific mechanisms aside, because the Val/Met polymorphism represents a common variant in the population, it may account for a meaningful amount of the variability in reading and other domain-specific abilities (again, via domain-general mechanisms associated with cognition) in the general population. Thus, we suggest that *COMT* may be more relevant in the general population and associated distribution of reading skill than any single rare mutation, which can be a powerful causal factor in a single family or a few families, but is unlikely to be generalizable to the general population.

Despite its limitations (i.e. sample size in particular), this study contributes to a growing literature that stresses the importance of considering common genetic variants in understanding the etiology of cognitive differences, especially in samples drawn from the general population. Although such variants might not target a particular cognitive skill or process, because of their critical role in brain function, they appear to be pleiotropic in their impact, affecting multiple skills or components of these skills. While these findings should be viewed with caution, they contribute to the literature by demonstrating the complexity of the *COMT* Val/Met polymorphism in its relationship to multiple cognitive skills. To understand this complexity, it is important to carry out multi-level modeling, bringing genetic, brain, and behavior data into vertical structures allowing investigations of the direct and indirect effects of genetic variants on characteristics of brain and behavior functions. Although such modeling cannot be carried out in this work due to sample size limitations, the current results provide evidence for the importance of such multi-level investigations.

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Appendix

Table A1 *For all regions showing significant differences between the two groups (Met/Met > Val/Met), Brodman Area (BA), volume in mm³, MNI coordinates at peak, p-value for peak activation. The sign of the p value indicates directionality of the observed effect*

Region	BA	Vol.	X	Y	Z	*p*-value
Precuneus	7	12616	28	−54	16	<.0001
Superior Temporal Gyrus	21/22	6400	56	−28	−1	<.0001
Parahippocampa Gyrus	19	5080	28	−51	−2	.0002
Middle Occipital Gyrus	18	1496	−18	−86	−15	.001
Parahippocampa Gyrus	30	1048	−22	−42	−6	.0017
Lingual Gyrus	18	952	−10	−64	2	.0023
Precentral Gyrus	6	944	−34	−14	44	.0006
Superior Temporal Gyrus	42	664	70	−24	10	.0005
Superior Parietal Lobule	7	584	−44	−62	54	.0002
Insula	13	584	−42	−36	24	.0028
Superior Frontal Gyrus	10	504	−10	68	−6	.0007
Culmen		480	24	−60	−30	.0011
Precuneus	7	408	−20	−82	50	.0018
Middle Frontal Gyrus	46	376	52	29	30	.0008
Postcentral Gyrus	43	368	70	−14	20	.0029
Lingual Gyrus	18	328	6	−86	−6	.0034
Culmen		296	12	−42	−24	.0035
Middle Temporal Gyrus	20	272	−64	−46	−16	.0012
Inferior Frontal Gyrus	47	216	−42	22	−14	.005
Middle Temporal Gyrus	21	144	−64	−30	0	.0049
Precentral Gyrus	6	120	20	−16	54	.0042
Superior Frontal Gyrus	10	112	30	62	−4	.0067
Culmen	36	104	−12	−46	−24	.0064
Angular Gyrus	39	88	−54	−62	36	.0051
Lentiform Nucleus		80	30	−16	−6	.0037
Inferior Frontal Gyrus	11	1416	12	36	−22	−.0002
Middle Frontal Gyrus	11	520	−20	44	−12	−.0005
Cuneus	19	296	12	−96	24	−.0003
Inferior Frontal Gyrus	10	168	48	48	0	−.0013
Cuneus	17	88	10	−98	0	−.0068

Table A2 *For all regions showing significant differences between the two groups (Met/Met > Val/Val), Brodman Area (BA), volume in mm³, MNI coordinates at peak, p-value for peak activation. The sign of the p value indicates directionality of the observed effect*

Region	BA	Vol.	X	Y	Z	*p*-value
Fusiform Gyrus	19	2048	−24	−70	−14	.0008
Cerebellar Tonsil	19	1664	6	−56	−43	.0004
Inferior Parietal Lobule	40	1480	40	−36	32	.0001
Medial Frontal Gyrus	6	1040	18	−16	54	.0006
Precentral Gyrus	4	992	−32	−20	46	.0002
Parahippocampa Gyrus	30	480	32	−56	2	.0029
Precuneus	7	344	16	−46	54	.0023
Inferior Occipital Gyrus	18	328	40	−86	−3	.0039
Paracentral Lobule	6	320	−6	−30	54	.0044
Middle Temporal Gyrus	37	312	64	−58	−6	.0008
Superior Temporal Gyrus	22	288	30	−54	16	.0011
Inferior Frontal Gyrus	47	280	−46	38	−15	.0029
Middle Frontal Gyrus	10	280	−44	54	−2	.0006
Fusiform Gyrus	37	248	38	−52	−20	.0047
Inferior Occipital Gyrus	18	208	−38	−88	−16	.0034
Precuneus	7	208	24	−60	56	.0041
Superior Temporal Gyrus		160	56	−28	−1	.0048
Declive	18	144	4	−64	−30	.0045
Precuneus	7	136	−20	−70	40	.0046
Fusiform Gyrus	37	136	36	−40	−9	.0048
Inferior Frontal Gyrus	47	120	52	22	−8	.0036
Inferior Frontal Gyrus	45	112	58	20	10	.0041
Superior Frontal Gyrus	8	96	8	50	44	.0055
Superior Temporal Gyrus	38	88	−24	22	−34	.0017
Fusiform Gyrus	19	80	24	−62	−12	.0059
Inferior Frontal Gyrus	47	520	−34	14	−19	−.0001
Uncus		512	2	−8	−40	−.0004
Inferior Frontal Gyrus	47	376	20	10	−22	−.0017
Uncus		288	−4	−8	−20	−.0031
Inferior Frontal Gyrus	11	264	20	38	−24	−.001
Caudate		240	−22	−32	24	−.0025
Caudate		104	24	−36	22	−.004

Table A3 *For all regions showing significant differences between the two groups (Val/Met> Val/Val), Brodman Area (BA), volume in mm^3, MNI coordinates at peak, p-value for peak activation. The sign of the p value indicates directionality of the observed effect*

Region	BA	Vol.	X	Y	Z	*p*-value
Precentral Gyrus	6	1104	−32	−16	64	.001
Fusiform Gyrus	19	272	10	−58	−44	.003
Middle Occipital Gyrus	18	256	40	−88	0	.0023
Uncus		1544	−2	−10	−18	<.0001
Inferior Frontal Gyrus	47	704	20	12	−24	−.0003
Uncus		384	−4	−12	−36	−.0028
Insula	13	352	−32	−38	18	−.0013
Insula	13	192	34	−8	24	−.0039
Inferior Frontal Gyrus	47	168	−34	16	−18	−.0026
Superior Frontal Gyrus	10	152	−10	60	−6	−.0025
Parahippocampal Gyrus	30	144	−8	−34	−8	−.0053
Superior Frontal Gyrus	11	136	16	58	−15	−.0022
Thalamus		96	−12	−28	20	−.0072

Table A4 *For all regions showing significant differences between among the groups (omnibus ANOVA), Brodman Area (BA), volume in mm^3, MNI coordinates at peak, and the p-value for peak activation*

Region	BA	Vol.	X	Y	Z	*p*-value
Superior Temporal Gyrus		3240	56	−28	−1	.0001
Parahippocampa Gyrus	19	1800	32	−50	−4	.0006
Precuneus	7	1448	22	−56	54	.0015
Precuneus	7	1352	18	−70	30	.0005
Lingual Gyrus	18	1200	−24	−74	−14	.002
Uncus		1016	−2	−10	−18	.0002
Culmen		832	28	−54	16	.0001
Declive		808	6	−56	−43	.0012
Precentral Gyrus	4	680	−32	−18	46	.0005
Inferior Frontal Gyrus	11	648	12	36	−22	.0011
Inferior Parietal Lobule	40	632	40	−36	32	.0005
Precuneus	7	544	−20	−70	40	.0017
Uncus	34	488	20	10	−24	.001
Fusiform Gyrus	19	416	24	−62	−12	.0013
Superior Frontal Gyrus	10	384	−10	66	−6	.0007
Insula	13	320	−34	−38	18	.0016
Inferior Frontal Gyrus	47	312	−34	14	−19	.0004
Superior Parietal Lobule	7	304	−44	−62	54	.0005
Uncus		296	2	−8	−40	.0016
Precentral Gyrus	6	256	−32	−16	64	.0041
Precentral Gyrus	6	240	20	−16	54	.0017
Middle Frontal Gyrus	11	200	−20	44	−12	.0019
Superior Temporal Gyrus	42	168	70	−24	10	.0021
Declive		136	24	−60	−30	.0046
Middle Temporal Gyrus	37	112	64	−58	−6	.0024
Cuneus	19	104	12	−96	24	.0014
Insula	13	104	−42	−34	24	.0062
Middle Frontal Gyrus	46	88	52	29	30	.0033

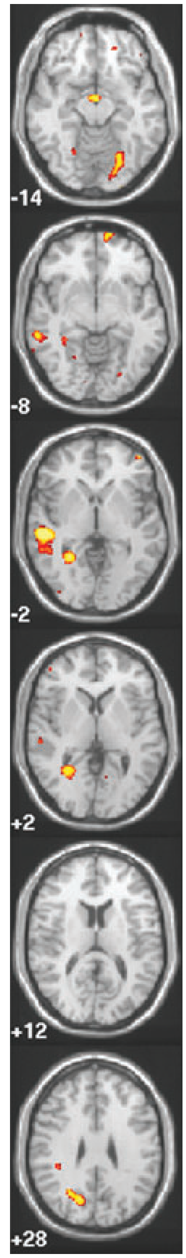

Figure A1 *Omnibus ANOVA: overall effect of COMT.*

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Inferior Frontal Regions Underlie the Perception of Phonetic Category Invariance

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Abstract

The problem of mapping differing sensory stimuli onto a common category is fundamental to human cognition. Listeners perceive stable phonetic categories despite many sources of acoustic variability. At issue is identifying those neural mechanisms underlying this perceptual stability. A short-interval habituation fMRI paradigm was used to investigate neural sensitivity to within and between phonetic category acoustic changes. A region in the left inferior frontal sulcus showed an invariant pattern of activation: insensitivity to acoustic changes within a phonetic category in the context of sensitivity to changes between phonetic categories. Left superior temporal regions, in contrast, showed graded sensitivity to both within- and between-phonetic category changes. These results suggest that perceptual insensitivity to changes within a phonetic category may arise from decision-related mechanisms in the left prefrontal cortex and add to a growing body of literature suggesting that the inferior prefrontal cortex plays a domain-general role in computing category representations.

1. Introduction

Mapping differing sensory stimuli onto a common category is fundamental to human cognition. For instance, multiple views of a given face are mapped to a common identity, visually distinct objects such as cups are mapped to the same object category, and acoustically-distinct speech tokens are resolved to the same phonetic category. Within each of these domains there is variability in the sensory input. The challenge for the perceiver is to determine which attributes are relevant to category membership and which are not in order to arrive at a stable percept of the category. This many-to-one mapping problem has been termed the ‘invariance problem.’ A core issue in cognitive neuroscience is how the neural system solves this problem.

The subject of the current investigation is the invariance problem in the speech domain. The speech signal contains multiple sources of variability. For instance, the acoustics of a given speech sound vary as a function of the vocal characteristics of different speakers (Peterson & Barney, 1952), speech rate (Miller, 1981), and coarticulation effects from adjacent speech sounds (Liberman et al., 1967). Despite these sources of variability, listeners perceive a stable phonetic percept.

Results from the neuroimaging literature have shown that the neural systems involved in phonetic processing are sensitive to the acoustic variability inherent in phonetic categories.

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Both anterior (left inferior frontal gyrus, [IFG]) and posterior (left superior temporal gyrus, [STG], and superior temporal sulcus, [STS]) structures show sensitivity to acoustic variation within a phonetic category (Blumstein et al., 2005; Liebenthal et al., 2005), and temporo-parietal structures (left STS, left middle temporal gyrus [MTG], left angular gyrus [AG], and left supramarginal gyrus [SMG]) show sensitivity to acoustic variations that distinguish phonetic categories (Celsis et al., 1999; Joanisse et al., 2006; Zevin & McCandliss, 2005). Thus, the neural system shows sensitivity to differences within as well as between phonetic categories. At issue is identifying areas of the brain which reflect listeners' 'invariant' percept of a phonetic category despite variability in the signal.

Within the speech literature, four hypotheses have been proposed to address how the perceptual system solves the invariance problem, each implicating different candidate neural areas as sources of phonetic category invariance. While each of these theories proposes that phonetic categories are abstract, the crucial issue and the one that is the focus of this paper is determining how different acoustic inputs are treated as functionally equivalent. The first hypothesis proposes that phonetic invariance is acoustically based with the acoustic input transformed to more generalized spectral-temporal patterns shared by the variants within a phonetic category (Blumstein & Stevens, 1981; Stevens & Blumstein, 1978). If this is the case, invariant neural responses should emerge in the STG and/or STS, areas involved in processing the acoustic properties of speech (Belin et al., 2002; Liebenthal et al., 2005; Scott & Johnsrude, 2003). A second hypothesis proposes that invariance is motor or gesturally-based with the acoustic input mapped onto motor patterns or gestures used in producing speech (Fowler, 1986; Liberman et al., 1967). If this is the case, invariant neural responses would be expected in motor planning areas including the pars opercularis (BA44 of the IFG), the supplementary motor area (SMA), as well as ventral premotor areas (BA6), and possibly primary motor cortex (BA4) (Pulvermuller et al., 2006; Wilson et al., 2004). These two hypotheses share the assumption that the basis of invariance resides in higher-order properties of the input.

The two other alternatives suggest that phonetic constancy emerges at a level abstracted from the input. One hypothesis is that invariant percepts arise from decision mechanisms acting upon multiple sources of information (Magnuson & Nusbaum, 2007). In this case, invariant neural responses should emerge in frontal areas involved in executive processing such as the IFG (Badre & Wagner, 2004; Miller & Cohen, 2001; Petrides, 2005). Alternatively, invariant percepts might arise from mapping the speech input to higher-order abstract phonological representations. Under this view, invariant neural responses would emerge in parietal areas such as the left AG or SMG which have been implicated in phonological processes (Caplan et al., 1995) and phonological working memory (Paulesu et al., 1993).

In the current experiment, a short interval habituation (SIH) paradigm was utilized to investigate neural sensitivity to within and between phonetic category acoustic changes along a voice-onset time (VOT) acoustic-phonetic series ranging from [da] to [ta] (Celsis et al., 1999; Joanisse et al., 2006; Zevin & McCandliss, 2005). In this paradigm, repeated presentation of a stimulus (e.g. 'ta') results in a reduction or 'adaptation' of the neural response (Grill-Spector & Malach, 2001). The subsequent presentation of a token at a different point along the acoustic series should cause a release from adaptation (and a concomitant increase in the BOLD signal) if that neural area is sensitive to the acoustic difference between the repeated token and the change token. The question is whether there are neural areas that fail to show a release from adaptation for within-category changes while showing a release from adaptation for between-category acoustic changes.

Methods

Participants

Eighteen healthy subjects from the Brown University community (13 females) received modest monetary compensation for their participation. Subjects ranged in age from 19 to 29 (mean age = 23.13± 3.46). All were strongly right-handed (Oldfield, 1971) (mean score 16 ± 2.42) and were screened for MR compatibility. Subjects gave informed consent in accordance with the Human Subjects policies of Brown University.

Stimuli

Stimuli were tokens varying in 25-ms VOT steps, i.e. −15 and 10 (both 'da'), and 35 and 60 (both 'ta') ms VOT. These stimuli were from a larger series created using a parallel synthesizer at Haskins Laboratory. Each 230-ms stimulus contained five formants. Formant frequencies were 40-ms starting at 200 Hz (F1), 1350 Hz (F2), and 3100 Hz (F3) and ending at steady-state frequencies of 720, 1250, and 2500 Hz, respectively. F4 and F5 remained steady throughout at 3600 and 4500 Hz. Stimuli had an average fundamental frequency of 119 Hz. High-pitched target tokens were created by raising the pitch contour of the test stimuli by 100 Hz (Boersma, 2001).

Each trial consisted of five speech tokens separated by a 50-ms ISI in which: all stimuli were identical (Repeat trials), four repeated stimuli were followed by a different stimulus from the same phonetic category (Within trials) or from a different phonetic category (Between trials). The VOT interval between stimuli in both Within-category and Between-category trials was always 25-ms. Repeat, Within, and Between conditions were distributed equally across four runs (32 trials per condition). There were 36 Target trials in which one of the stimuli in the trial was replaced by its high-pitched version. Target stimuli occurred in every position within a trial and in trials of each experimental type.

Behavioral Procedure and Apparatus

A discrimination pretest was conducted to confirm that subjects were sensitive to the 25-ms VOT steps. Twenty-two subjects discriminated pairs of stimuli that were either identical (Repeat), within the same phonetic category (Within) or from two phonetic categories (Between). Subjects were included if they exhibited sensitivity to Within compared to Repeat stimuli. "Sensitivity" was defined as either longer reaction time (RT) for Within pairs than Repeat pairs or more correct "different" judgments for Within pairs than Repeat pairs. On this basis, four subjects were excluded, leaving 18 subjects. Paired t-tests (N = 18) showed significant differences in error rate between Within-category and Repeat pairs: (mean percent 'different' responses: Within=8.78%, SD=5.9%; Repeat =3.67%, SD=4.15%; $t(17)=4.273$, $p_{rep}=0.992$, $d=1.007$). Despite discriminating Within-Category pairs below chance, subjects showed sensitivity to Within-category contrasts. Between-category pairs were discriminated at near-ceiling rates (mean percent 'different' responses =93.8%, SD=8.44%). RT differences between Within and Repeat approached significance (Within mean RT=848.8 ms SD=134.2 ms, Repeat mean RT= 817.4 ms SD=127.9 ms; $t(17)=1.532$, $p_{rep}=0.849$, $d=0.361$,)

Participants in the scanner listened to each trial, and pressed a button when they heard the high-pitched target syllable. Ten practice trials were presented during the anatomical scan.

FMRI Data Acquisition

Functional and anatomical brain images were acquired with a 3T Siemens Trio scanner. High-resolution 3D T1-weighted anatomical images were acquired for anatomical co-registration (TR=1900 ms, TE=4.15 ms, TI=1100 ms, 1mm^3 isotropic voxels, 256 × 256 matrix). Functional images consisted of 15 5mm-thick echo planar (EPI) axial slices with a 3mm isotropic in-plane resolution, acquired in an ascending, interleaved order. Functional slabs were positioned to image peri-sylvian cortex (TR=1 sec, TE=30 ms, flip angle = 90 degrees, FOV=192mm3, 64×64 matrix). Each functional volume was acquired with a 1-second TR. Auditory stimuli were presented during a 2-second silent interval after every 12^{th} EPI volume. The first trial began 12 volumes into each run to avoid saturation effects. An auditory trial occurred in each successive silent gap (see Figure 1). A total of 33 trials and 408 functional volumes were collected in each run.

Functional Data Analysis

Image Preprocessing—MR data analysis was performed using AFNI (Cox, 1996). In order to accurately interpret the time-course of functional volume acquisition, two dummy volumes were inserted in place of each silent gap. These volumes were censored from further analysis, as were the first two volumes of each block of 12 volumes due to T1 saturation effects. Functional datasets were corrected for slice acquisition time, and runs were concatenated and motion-corrected using a six-parameter rigid-body transform (Cox & Jesmanowicz, 1999). Functional datasets were resampled to $3mm^3$, transformed to Talairach and Tournoux space, spatially smoothed with a 6mm Gaussian kernel, and converted to percent signal change units.

Statistical Analysis—Each subject's preprocessed functional data was submitted to a regression analysis by creating a vector for each stimulus type (Between, Within, Repeat, Target) in which the start time of each stimulus was convolved with a gamma-variate function. The Target trials were not further analyzed. Each subject's mean whole-brain time-course was included as a nuisance regressor to account for potential effects of signal destabilization due to the clustered acquisition design. The six parameters output by the motion-correction process were also included as nuisance regressors. By-run mean and linear trends were removed from the data. The 3dDeconvolve analysis returned by-voxel fit coefficients for each condition.

A mixed-factor ANOVA was performed on the fit coefficients with subjects as a random factor and stimulus condition as a fixed factor. Planned comparisons were performed: Between vs. Repeat, Between vs. Within, and Within vs. Repeat. Statistical maps for each comparison were thresholded at $p<0.05$, corrected for multiple comparisons (56 contiguous voxels at a $p<0.025$). Within functionally-defined regions of interest the mean percent signal change for each subject was calculated for each condition, and these data were submitted to paired t-tests (Bonferroni-corrected alpha=0.0167, critical t=2.655). Group statistical maps were displayed on a canonical inflated brain surface in Talairach space (Holmes et al., 1998) (http://afni.nimh.nih.gov/afni/suma).

Results

Table 1 shows the clusters that emerged in each planned comparison. A significant temporal lobe cluster in the left STG posterior to Heschl's Gyrus and extending into the STS emerged in the Between vs. Repeat condition indicating that this area showed sensitivity to phonetic category changes (see Figure 2, Table 1). Analysis of the patterns of activation across the three trial types in this cluster showed significant differences between all conditions (see Figure 2), with Between-category trials resulting in the greatest activation, Within-category trials with less activation, and Repeat trials with the least activation (Between-Repeat, $t(17)=6.480$, $p_{rep}=0.999$, $d=1.527$; Between-Within, $t(17)=2.993$, $p_{rep}=0.908$, $d=0.706$; Within-Repeat, $t(17)=3.053$, $p_{rep}=0.970$, $d=0.720$). This graded activation pattern suggests that the pSTG is not only sensitive to between category differences (Joanisse et al., 2006)

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but also to within category differences. No other significant clusters emerged in the temporal areas.

Several frontal clusters emerged in the comparisons across conditions (see Table 1). The Between vs. Repeat comparison yielded a large cluster in left inferior frontal regions (Figure 2). Two separate clusters emerged within this larger inferior frontal region in the comparisons of the Between vs. Within and Within vs. Repeat conditions (see Figure 3, Table 1). Overlap between these two clusters was minimal (18 voxels). Projection of the functional maps on to a canonical inflated brain surface showed that the Between vs. Within cluster fell primarily within the inferior frontal sulcus and the Within vs. Repeat cluster lay principally on the lateral surface of the pars opercularis (BA44, Figure 3).

Further analysis examined the patterns of activation within these two functional clusters. The Between vs. Within cluster located in the inferior frontal sulcus contained voxels showing greater activation to between phonetic category changes than to within phonetic category changes. To determine if the pattern of activation in this cluster reflected phonetic category invariance, potential differences in activation between Within-category and Repeat trials were examined. Results revealed a pattern consistent with phonetic category invariance; Between-category trials showed significantly greater activation than either the Within-category or Repeat trials (Between-Within, $t(17)=3.522$, $p_{rep}=0.983$, $d=0.830$; Between-Repeat, $t(17)=5.127$, $p_{rep} = 0.997$, $d=1.209$), but Within-category trials were not significantly different from Repeat trials ($t(17)=1.877$). Thus, this area showed a release from adaptation only for those trials in which there was a change in phonetic category membership.

The cluster that emerged in the Within vs. Repeat comparison showed sensitivity to acoustic changes within a phonetic category. To determine whether this area also showed greater activation for between category changes than within category changes, comparisons were made between the stimulus conditions. Both Between-category and Within-category trials showed significantly more activation than Repeat trials (Between-Repeat $t(17)=4.913$, $p_{rep}=0.996$, $d=1.158$; Within-Repeat $t(17)=3.991$, $p_{rep}=0.990$, $d=0.941$); however, Between-category and Within-category trials were not significantly different from each other ($t(17)=2.071$). Thus, this area in BA 44 showed sensitivity to acoustic changes irrespective of their phonetic relevance.

In addition to the left hemisphere clusters, clusters emerged in the right STG and the right IFG. The right STG cluster emerged in the Within vs. Repeat comparison, but showed no significant difference between phonetically-relevant vs. non-relevant changes (Between vs. Within, $t(17)=2.643$). Two clusters emerged in the right IFG (pars opercularis, see Table 1, Figures 1 and 2), one in the Between vs. Repeat comparison and the other in the Within vs. Repeat comparison. Examination of the patterns of activation within these clusters revealed significant differences only as a function of acoustic changes irrespective of their phonetic relevance. There was significantly greater activation in both Between-category trials and Within-category trials compared to Repeat trials (Between-Repeat cluster $t(17)\geq 2.881$, $prep\geq 0.964$, $d\geq 0.679$; Within-Repeat cluster $t(17) \geq 4.534$, $prep\geq 0.994$ $d\geq 1.069$). However, no significant differences emerged in either cluster in the Between-category compared to the Within-category trials ($t(17)\leq 1.175$).

Discussion

Role of inferior frontal areas in computing phonetic category invariance

The goal of the current study was to investigate the neural correlates of phonetic category invariance. An invariant pattern of activation emerged in the left inferior frontal sulcus. This cluster showed release from adaptation for stimuli which crossed the phonetic category boundary and no release from adaptation for stimuli drawn from the same phonetic category. This pattern of response suggests that this neural area is involved in subjects' perceptual experience of functional equivalence for different sensory inputs consistent with category invariance.

Supporting evidence for these findings comes from a study by Hasson and colleagues (2007). In this study, subjects were exposed to stimuli containing conflicting auditory and visual cues. Such stimuli are subject to the McGurk effect (McGurk & MacDonald, 1976) in which the presentation of a visual stimulus of a speaker saying 'ka', coupled with an auditory stimulus of the speaker saying 'pa', is typically perceived as 'ta'. Hasson et al. showed that when the McGurk stimulus was preceded by an auditory examplar of 'ta,' repetition suppression was seen in the left pars opercularis which was equivalent to that observed when this stimulus was preceded by itself. Of importance, there was no sensory overlap in either the auditory or visual domain between the adapting and target stimulus. These results suggest that invariance emerges in inferior frontal cortex as a function of perceptual rather than sensory overlap, i.e. between stimuli that are perceived as belonging to a common category 't'.

A role for the inferior frontal lobes in computing categorical representations has been suggested by work in non-human primates (Freedman et al., 2001, 2003). This work has implicated inferior frontal areas in computing decisions necessary for action (Petrides, 2005). For example, using single-cell recordings, Freedman and colleagues (2001) showed invariant responses in lateral pre-frontal cortex of monkeys to exemplars from a learned visual category. Of interest, Freedman et al. also showed individual cells in the same region that were sensitive to within-category variation. Similarly, in the current study, posterior prefrontal cortex also showed functional heterogeneity in its responsiveness to category representations – within this region, a cluster in the inferior frontal sulcus failed to show sensitivity to within category variation and hence showed phonetic category invariance, and another cluster in the pars opercularis, BA 44, showed sensitivity to within phonetic category variation. The fact that analogous results are shown for speech categories in humans as well as learned visual categories in non-human primates suggests that this region plays a domain-general role in computing category representations.

In contrast to the frontal clusters, the left STG cluster showed graded sensitivity to phonetic category membership, showing a significant release from adaptation for within category differences and an even greater release from adaptation for between category differences. This finding would appear to be at odds with those of Joanisse et al (2006) who showed that the left STS was sensitive to between phonetic category differences but not to within phonetic category differences. Several important differences between the Joanisse et al. study and the current one might account for these differences. First, it is unclear from the behavioral data in Joanisse et al. whether their subjects showed perceptual sensitivity to within phonetic category stimuli. A failure to show any cortical regions that showed sensitivity to within-category changes could reflect subjects' inability to perceptually resolve differences among these stimuli. In contrast, in the current study, subjects showed perceptual sensitivity to within phonetic category stimuli, a fact which is reflected by a significant release from adaptation for these stimuli in the STG, and confirmed by a behavioral pre-test. Second, because the focus of their study was the pre-attentive processing of phonetic category information, Joanisse and colleagues did not require their subjects to attend to the speech stimuli or even to the auditory stream. Rather, subjects watched a subtitled movie while the speech stimuli were being presented. This lack of attention to the auditory input may have attenuated responses to phonetic category information. Consistent with this view, a recent study using a bimodal (auditory, visual) selective attention task

(Sabri et al., 2008) showed reduced activation to speech and nonspeech stimuli in the STG when subjects performed a demanding visual task and were not required to attend to the auditory stream. In the current study, although participants did not have to explicitly process the speech stimuli, they were required to attend to the auditory stream in order to perform the low-level pitch detection task. Differences between the findings of these two studies highlight the importance of attention to the auditory stream in processing the acoustic-phonetic details of speech.

The fact that invariant patterns of activation were seen in frontal areas, but not in areas involved in acoustic processing (i.e. temporal areas) suggests that perceptual invariance for speech categories does not arise through a set of shared acoustic patterns (Stevens & Blumstein, 1981), but instead emerges through higher-order computations on graded input, presumably from temporal areas. The failure to find invariant patterns of activation in primary motor areas involved in the articulatory implementation (i.e. BA4, M1) argues against gestural theories of phonetic invariance (Fowler, 1986). Taken together, the failure to show invariant patterns of activation in either the STG or motor areas suggests that phonetic invariance does not arise from invariant acoustic/motor properties but instead arises from higher order computations on that input.

Nonetheless, while the results of the current study suggests that perceptual invariance does not rely on activation of a motor code, two clusters were activated in left inferior frontal areas (inferior frontal sulcus/precentral gyrus and pars opercularis) which have been suggested to contain mirror neurons (Craighero et al., 2007; Rizzolatti & Craighero, 2004). Some have speculated that mirror neurons, by providing a neural substrate for modeling the motor gestures necessary for speech, also provide a route to perceptual stability of phonetic category percepts across multiple types of variance. This claim cannot be either confirmed or ruled out by the results of the present study. However, pertinent to this question is recent research suggesting that BA6 and not BA44 (pars opercularis) is most similar to F5 of the macaque brain where mirror neurons have been found. In particular, BA6 responds consistently to goal-directed actions whereas BA44 does not (Morin & Grezes, 2008). As such, the cluster falling in the inferior frontal sulcus/precentral gyrus which showed an “invariant” pattern of activation is more likely to reflect the existence of putative mirror neuron activity.

A number of recent studies have implicated temporoparietal areas such as the SMG and AG in phonetic category processing (Blumstein et al., 2005; Caplan et al., 1995; Hasson et al., 2007; Raizada & Poldrack, 2007; Zevin & McCandliss, 2005) In addition, there appears to be a tight link between the IFG and SMG in phonological processing (Gold & Buckner, 2002). In view of these results, it is perhaps surprising that no clusters emerged in the SMG in the current study. In order to explore the possibility that temporoparietal areas play a potential role in phonetic category invariance, further analysis was undertaken to investigate activation in the SMG and AG. At a much reduced threshold ($p< 0.025$ voxel-level threshold, 25 contiguous voxels), a cluster did emerge in the SMG for the Between-Category vs. Within comparison (peak, $x=-62$, $y=-29$, $z=27$). This cluster showed an invariant pattern with no release from adaptation for within category stimuli and a release from adaptation for those stimuli which were from two different categories. While these results should be interpreted with caution, such a pattern suggests that there may be dual routes to phonetic invariance: one that emerges due to probabilistic decisions on graded acoustic data, and one which involves a mapping to abstract phonological codes. Alternatively, phonetic category invariance may arise through the interaction of decision-related mechanisms in the frontal lobes with a phonological code in the SMG (Gold & Buckner, 2002).

Much research suggests that one of the basic functions of the prefrontal cortex is in the service of goals and hence this area plays a critical role in mediating the transformation of perception into action (Freedman et al., 2002; Miller & Cohen, 2001). The ability to group a set of stimuli into categories facilitates this transformation by providing a means of segmenting the world into meaningful units and ultimately acting on them. In the case of speech, phonetic categorization provides the basic building blocks used for language communication. Nonetheless, the data from the current study indicates that category membership may be computed even when not required by the task. In particular, phonetic invariance was shown in the current experiment in a task which required subjects to attend to the auditory stream, but not to make an overt decision about the phonetic category to which a stimulus belonged. The implicit nature of phonetic categorization has been shown even in infants who clearly are not responding to the stimuli in the service of an explicit goal (Eimas et al., 1971). Thus, it appears that an explicit categorization or decision about speech stimuli is unnecessary for categorical-like neural responses in the context of speech sounds. What is of interest is whether similar categorical-like neural responses would be found in the implicit processing of learned non-language categories or whether such have evolved as part of the biological substrates of language because of its functional importance for humans.

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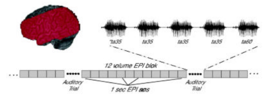

Figure 1.
Diagram of stimulus presentation during functional data acquisition. Red area on the left indicates the extent of EPI coverage for a typical subject.

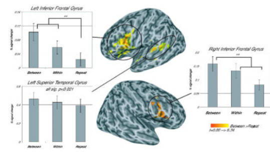

Figure 2.
Areas showing greater activation for Between-category than Repeat trials. All clusters are significant at a corrected threshold of $p<0.05$ ($p<0.025$ voxel-wise threshold, minimum cluster size 56 voxels), activation displayed on a canonical inflated brain surface (Holmes et al., 1998), with left (top) and right hemispheres (bottom) shown separately.

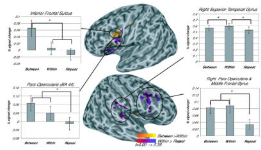

Figure 3.
Areas showing greater activation for Between-category than Within-category trials (purples) and greater activation for Within-category than Repeat trials (oranges). All clusters are significant at a corrected threshold of p<0.05 (p<0.025 voxel-wise threshold, minimum cluster size 56 voxels), activation displayed on a canonical inflated brain surface (Holmes et al., 1998), with left (top) and right hemispheres (bottom) shown separately.

Table 1

Clusters revealed in planned comparisons of syllable types. All clusters are significant at p<0.05, corrected (voxel-wise p<0.025, minimum 56 contiguous voxels per cluster).

		Coordinates of Maximum t value		
Area	**# Voxels**	**[x,y,z]**	**max t-stat**	**P value**
Between > Repeat				
LIFG (pars opercularis, pars triangularis)	465	[47, −5, 15]	6.3410	p<0.00001
RIFG (pars opercularis)	138	[−47, −5, 6]	4.7640	p<0.0005
L post STG, MTG	92	[62, 29, 12]	5.3400	p<0.001
Between < Repeat				
R Fusiform, R Lingual Gyrus	62	[−29, 53, −1]	−5.4150	p<0.025
Between > Within				
LIFG (pars opercularis)	105	[41, 8, 27]	4.0090	p<0.0012
Between < Within				
R Mid Orbital Gyrus, ACC	138	[−5, −29, −1]	−4.2000	p<0.0005
Within > Repeat				
R IFG (pars Opercularis), R Precentral	149	[−47, −5, 30]	5.1940	p<0.0003
R STG, R SMG	72	[−47, 32, 30]	3.7960	p<0.007
L Insula	60	[26, −23, 3]	3.7750	p<0.033
LIFG (pars Opercularis), L Precentral	59	[47, −5, 21]	3.8210	p<0.036
Within < Repeat				
L Fusiform, L Inferior Occipital	57	[38, 56, −16]	−5.0680	p<0.046
R Thalamus, Putamen	120	[−8, 20, 9]	−5.3760	p<0.0042

Effects of Stimulus Difficulty and Repetition on Printed Word Identification: An fMRI Comparison of Nonimpaired and Reading-disabled Adolescent Cohorts

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Abstract

■ Functional neuroimaging studies indicate that a primary marker of specific reading disability (RD) is reduced activation of left hemisphere (LH) posterior regions during performance of reading tasks. However, the severity of this disruption, and the extent to which these LH systems might be available for reading under any circumstances, is unclear at present. Experiment 1 examined the cortical effects of stimulus manipulations (frequency, imageability, consistency) that have known facilitative effects on reading performance for both nonimpaired (NI) and RD readers. Experiment 2 examined stimulus repetition, another facilitative variable, in an additional sample of adolescent NI and RD readers. For NI readers, factors that made words easier to process were associated with relatively reduced activation. For RD readers, facilitative factors resulted in increased activation in these same reading-related sites, suggesting that the LH reading circuitry in adolescent RD is poorly trained but not wholly disrupted. ■

INTRODUCTION

Converging evidence from functional neuroimaging studies indicates that a primary neurobiological marker of specific reading disability (RD) is reduced activation of left hemisphere (LH) posterior regions relative to activation levels for nonimpaired (NI) readers during tasks that make demands on language and printed word processing. Together with the failure to reliably engage LH temporo-parietal and occipito-temporal regions, RD readers tend also to show heightened activation of right hemisphere (RH) posterior and bilateral frontal regions (see Sarkari et al., 2002; Pugh, Mencl, Jenner, et al., 2000 for reviews); the tendency to hyperengage these regions may serve to compensate for deficient linguistic processing in the LH. Although this RD profile appears to be reasonably stable across different ages, tasks, and languages (Paulesu et al., 2001), the question still remains as to the severity of this LH disruption (Pugh, Mencl, Shaywitz, et al., 2000). Evidence from recent intervention studies suggests that compromised LH systems appear to be responsive to intensive training in young RD populations (Shaywitz et al., 2004; Temple et al., 2003; Simos et al., 2002). That is, many LH regions that are critically involved in reading and are not activated during reading tasks in young RD readers prior to an intervention period show increased activation after intervention. However, the extent to which these LH systems are available for reading in older children whose reading difficulties have persisted is less studied. Recently, Cao, Bitan, Chou, Burman, and Booth (2006) contrasted NI and RD children in a rhyming task with easy versus hard trials. The often-observed diminished activation of key LH regions in RD was obtained only on hard trials, suggesting that stimulus difficulty is an important variable in making group contrasts. Hoeft et al. (2007) used reading age (RA) and chronological age (CA) controls to assess performance effects on group contrasts, and concluded that hyperactivation in frontal areas in RD is experience and effort-related whereas hypoactivation in RD at LH posterior regions (particularly LH temporo-parietal sites) is more fundamental to the syndrome (indeed, structural imaging reinforced this conclusion; with reliably reduced gray matter volume in temporo-parietal areas in RD). The current experiments were designed to examine learning and difficulty effects in NI and RD more directly by focusing on learning differences as a window on latent functionality

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in RD. Addressing this issue is of high priority for predicting likely neurobiological and behavioral outcomes of systematic reading intervention and remediation in older children. As a first step, it is critical that we begin to examine whether adolescent RD readers demonstrate reading-related functionality in these LH systems under any conditions.

The current study examines the cortical effects of stimulus manipulations that have known facilitative effects on word reading latencies and accuracy in adolescent RD readers. In Experiment 1, we focus specifically on the ways in which stimulus familiarity (frequency) and semantic features (imageability) modulate processing of words that vary with regard to complexity of orthographic-to-phonological mappings (consistency). This experiment provides a window into how top–down, semantic, facilitative features are able to affect the altered neural circuitry for reading in RD readers. In Experiment 2, we examine stimulus repetition (a highly salient facilitative variable in RD performance) to characterize on-line learning processes in RD readers. By examining on-line learning, we can begin to move beyond first-generation questions of where in the brain activation levels differ in these groups in general, to a more systems-level account of the ways in which readers with very different skill levels modulate activation patterns in the context of learning. We predict that this more dynamic approach will provide a better model for clinical contrast than one that simply looks for regional differences in a more static manner.

EXPERIMENT 1

One of the most often used indices of the influence of phonology on printed word naming is the spelling-to-sound consistency effect. This refers to the finding that identification is faster and more accurate for words that have consistent (1:1) correspondences between the orthographic body and phonological rime (e.g., –ill only corresponds to /Il/ as in *pill*, *mill*) than for inconsistent words that have multiple body–rime correspondences (e.g., –int corresponds to /Int/ as in *mint* and /aInt/ as in *pint*). Behavioral studies have shown that frequency modulates this effect such that consistency effects are most robust for low-frequency words (Jared, McRae, & Seidenberg, 1990; Seidenberg, Waters, Barnes, & Tanenhaus, 1984). Further work by Strain, Patterson, and Seidenberg (1995, 2002) demonstrated that the typically obtained interaction of consistency and frequency during printed word naming is modulated by a semantic variable, imageability. Consistency effects were observed primarily on words that are both low in frequency and imageability; consistency effects for high-imageable, low-frequency words were either attenuated or not significant across experiments. These findings reveal that semantics can attenuate the difficulties associated with reading words that have inconsistent orthographic-to-phonological mappings.

Research on phonology and lexico-semantics in RD readers has shown that they are particularly challenged by spelling-to-sound inconsistent words and particularly benefited by frequency and imageability. That is, RD readers demonstrate amplified consistency effects relative to NI readers (Bruck, 1992) and greater advantages than skilled readers for high-frequency words relative to low-frequency words in both accuracy and latency (Shaywitz et al., 2003). Moreover, with regard to the top–down influence of semantics (Strain et al., 1995, 2002), poor readers show even greater benefit from imageability than skilled readers on the processing of difficult-to-decode inconsistent words (Strain & Herdman, 1999). Thus, for all reading levels, performance on difficult-to-decode inconsistent words is facilitated when tokens are high frequency and/or highly imageable, but this effect is amplified for poor readers. In summary, these semantic factors can, at least to some degree, offset problematic phonological assembly skills in RD readers. Identification of the neurobiological correlates of this type of top–down modulation in RD will allow us to address changing activation profiles as demands on core processes are systematically manipulated, in order to assess potential functionality in LH reading-related systems in RD.

Experiment 1 examines go/no-go naming responses for words while manipulating frequency, consistency, and imageability. Go/no-go naming (in which participants are required to name the token if it is a real English word but not if it is a pseudoword) was chosen because this overt naming paradigm strongly engages phonological processing, while also accentuating the influences of lexico-semantics (Frost et al., 2005).

We predict that our behavioral findings will follow those of previous studies: Consistency effects will be greater for RD relative to NI readers, and frequency and/or imageability will facilitate naming latencies and accuracy on difficult-to-decode inconsistent words for all participants, but with a much larger effect in RD. With respect to anticipated brain activation patterns, for NI readers, previous research indicates that stimuli that are easier to process should be associated with reduced blood oxygenation level-dependent (BOLD) signal at reading-related regions in the LH, reflecting increased processing efficiency within these regions (Frost et al., 2005; Katz et al., 2005; Sandak, Mencl, Frost, & Pugh, 2004; Sandak, Mencl, Frost, Rueckl, et al., 2004; Poldrack & Gabrieli, 2001). For RD readers in this age range, the predictions are less clear. As we stated earlier, adolescent RD, for whom altered reading circuitry has been established, may exhibit complete dysfunctionality in LH systems for reading. If so, we would anticipate that words that are easier to process will be associated only with modulated activation of the compensatory RH and frontal circuitry. However, if LH posterior regions are less stable but not wholly dysfunctional, we would predict that words that are easier to process should reveal greater engagement of reading-related LH posterior regions for RD readers. That is, whereas inconsistent words in general should be associated with diminished LH posterior responses in RD, the facilitative influences of frequency and imageability might be associated with increased LH posterior responsiveness (and possibly with reduced reliance on RH posterior and bilateral anterior compensatory circuits).

Methods

Participants

Forty-four native English speakers (27 males, 17 females) ranging from 11.0 years in age to 19.0 years participated in exchange for payment: 24 NI and 20 RD. NI readers had averaged standard scores >100 (mean = 116) on a composite of the following three assessments: (1) Woodcock Johnson basic reading (mean = 115), (2) Woodcock Johnson spelling (mean = 124), and (3) TOWRE total word reading (mean = 108) measures. Twenty met our criteria for RD of averaged standard scores <90 on a composite of these reading tests [Woodcock Johnson basic reading (mean = 90), Woodcock Johnson spelling (mean = 87), and TOWRE total word reading (mean = 75) measures], and/or averaged standard score <100 with RD history. Groups did not differ on age (RD = 14.94; NI = 15.32, $t < 1$) or WASI performance IQ (RD = 105; NI = 109, $t < 1$). All reported normal or corrected-to-normal vision and no history of known neurological impairments. The experiment was conducted with the understanding and the written consent of each participant and all procedures were approved by the Yale University Institutional Review Board.

Stimuli and Design

Word stimuli represented the crossing of frequency (low, high), imageability (low, high), and spelling-to-sound consistency (consistent, inconsistent) with 40 words per condition, yielding a total of 320 ''go'' trials. Nonword trials were made up of 80 pseudowords matched on factors including length, bigram frequency, and initial phoneme, which served as ''no-go'' trials. Because we were unable to obtain naming latencies during functional scanning, behavioral data were collected in a separate session. In order to assess the behavioral profiles for each group, we asked participants to return to the lab on a day subsequent to functional magnetic resonance imaging (fMRI) scanning and perform the go/no-go task with the same materials in order to record behavioral data. Thirty (16 NI, 14 RD) subjects returned for the out-of-scanner session (fMRI analyses include the full cohort of 44).

Procedure

For the fMRI session, a go/no-go naming paradigm was employed in a block design. Each 20-sec experimental block consisted of five 4-sec trials in which participants were presented with a letter string for 1 sec that either made a real English word or not and were instructed to name it aloud if it was a real English word (''go trial'') and to do nothing if it was not a word (''no-go trial''). The proportion of go and no-go trials was equivalent across conditions. During baseline blocks, participants passively viewed displays of intermixed hash marks and asterisks.

fMRI Image Acquisition and Analysis

Functional imaging runs consisted of eight 20-sec experimental blocks (one for each stimulus condition) of four word trials and one pseudoword trial, and five 20-sec baseline blocks. A total of 1300 full-brain functional images were acquired across 10 imaging runs; 100 images for each experimental condition and 500 images in the baseline condition. Each subject received the same pseudorandom order of runs. The order of activation block types was counterbalanced across runs.

Functional imaging was performed on GE Signa 1.5-Tesla and Siemens Sonata 1.5-Tesla MR systems. Participants' heads were immobilized within a circularly polarized head coil using a neck support, foam wedges, and a restraining band drawn tightly around the forehead. Prior to functional imaging, 20 axial–oblique anatomic images (TE = 11 msec; TR = 500 msec; FOV = 200 mm; 6 mm slice thickness, no gap; 256 × 256 × 2 NEX) were prescribed parallel to the intercommissural line based on sagittal localizer images (TE = 11; TR = 600 msec; FOV = 240 mm; 23 slices, 5 mm slice thickness, no gap; 256 × 256 × 1 NEX). Activation images were collected using single-shot, gradient-echo echo-planar acquisitions (flip angle = 80°; TE = 50 msec; TR = 2000 msec; FOV = 200 mm; 6 mm slice thickness, no gap; 64 × 64 × 1 NEX) at the same 20 slice locations used for anatomic images.

Functional images were first sinc-interpolated to correct for slice acquisition time, corrected for motion (Friston et al., 1995), and spatially smoothed with a Gaussian filter of size 3.125 mm full width at half maximum. For each subject, an affine transformation to the standardized space defined by the Montreal Neurological Institute (MNI) was obtained using BioImageSuite (Papademetris, Jackowski, Schultz, Staib, & Duncan, 2003; www.bioimagesuite.org), mapping between the subject-space T1 anatomic and the MNI space ''Colin'' brain (available at www.bic.mni.mcgill.ca). Prior to across-subjects analysis, this transformation was applied to the single-subject activation maps, with trilinear interpolation, into 2-mm isotropic MNI space. For each subject and voxel, linear regression was used to compare the mean signal during each experimental condition to the baseline condition, and these differences were converted to standardized activation values by dividing them by the square root of the error mean square for the model. Across subjects, these values were entered into a mixed-model or repeated measures analysis of variance (ANOVA; Holmes & Friston, 1998; Woods, 1996; Kirk, 1982) with planned comparisons for main effects, frequency, imageability, and consistency, and their interactions, conducted on a voxelwise basis.

Region-of-interest (ROI) coordinates were defined by peak activation sites within the Group by Stimulus difficulty interaction analysis (see below). From this analysis, we identified seven LH regions that (1) have been previously implicated in reading (cf., Price, 2000; Pugh, Mencl, Jenner, et al., 2000; Pugh, Mencl, Shaywitz, et al., 2000; Posner, Abdullaev, McCandliss, & Sereno, 1999) and (2) showed a significant Group by Stimulus difficulty interaction. Table 1 presents the MNI coordinates and significance levels for peak activation as well as the volume for the following regions: LH fusiform/occipitotemporal (OT), middle temporal gyrus (MTG), thalamus (THAL), superior temporal gyrus (STG), insula (INS), inferior frontal gyrus (IFG), and supramarginal gyrus (SMG). RH regions were examined based on previous studies implicating RD differences and the presence of a Group by Stimulus difficulty interaction (Pugh, Mencl, Jenner, et al., 2000; Pugh, Mencl, Shaywitz, et al., 2000).

Results

Behavioral Analysis

Separate 2 × 2 × 2 × 2 mixed-factors ANOVA were conducted on latencies to correct responses and on errors. Frequency (low/high), imageability (low/high), and consistency (consistent/inconsistent) served as within-subjects factors and reader group (NI/RD) served as a between-subjects factor. Overall, naming latencies were slower [$F(1, 28) = 13.05, p < .01$] and less accurate [$F(1, 28) = 8.15, p < .01$] for RD relative to NI participants. The Group by Imageability interaction was marginal for naming latency [$F(1, 28) = 3.46, p = .07$] and significant for accuracy [$F(1, 28) = 6.91, p < .05$], revealing heightened effects of imageability (faster and more accurate responses for high imageable relative to low imageable words) in RD readers. There were also reliable Group by Frequency interactions on both naming latency [$F(1, 28) = 12.27, p < .01$] and accuracy [$F(1, 28) = 6.44, p < .05$], indicating heightened effects of frequency (faster and more accurate responses for high-frequency relative to low-frequency words) in RD. These interactions were further qualified by a three-way interaction of Group × Frequency × Imageability on accuracy [$F(1, 28) = 4.81, p < .05$], such that frequency effects were greater for low-imageable relative to high-imageable words and this difference was greater for RD readers (3%) than for NI readers (4%). A reliable four-way interaction of Group × Frequency × Imageability × Consistency was also observed [$F(1, 28) = 7.01, p < .05$, driven by a maximum drop in proportion correct to 0.86 for RD on low-frequency, low-imageable, inconsistent words, as anticipated from previous research].

Given that both frequency and imageability had a heightened facilitative influence on naming inconsistent words for RD participants, a targeted stimulus difficulty analysis of extreme conditions contrasting low-frequency/low-imageable/inconsistent words (henceforth LF–LI–INC) with high-frequency/high-imageable/inconsistent words (HF–HI–INC) was performed in order to compare the reader groups on difficult-to-decode words that differ systematically with regard to familiarity and semantic features. This extreme contrast allows us to directly examine purported top–down effects on problematic decoding in RD with maximal power. A group interaction was obtained for both accuracy [$F(1, 28) = 5.87, p < .025$] and latencies [$F(1, 28) = 8.73, p < .01$] (shown in Figure 1A and B, respectively). As predicted, whereas both groups were faster and more accurate on HF–HI–INC than on LF–LI–INC words, this advantage was amplified for RD participants.

Table 1. Regions of Interest (ROIs) Showing Reader Group × Stimulus Difficulty Interaction

Region	*x*	*y*	*z*	*p*	*Volume (mm^3)*
L. Occipito-temporal/fusiform	−48	−46	−18	.0031	184
L. Middle temporal	−44	−48	−6	.0004	304
L. Thalamus	−18	−30	−2	.0056	248
L. Superior temporal	−44	−44	10	.0002	384
L. Insula	−38	0	4	.0003	408
L. Inferior frontal	−42	6	24	.0007	664
L. Supramarginal	−50	−34	32	.0001	320

fMRI Analysis

Naming engaged a broad bi-hemispheric circuitry in general, and overall, activation during the go/no-go task (collapsed across stimulus type) was reliably higher in a large number of regions for NI, relative to RD, participants, as seen in previous studies (see Figure 2A). Of more acute interest in the current experiment, however, is how group differences in activation were qualified by stimulus characteristics.

Stimulus Difficulty

The behavioral data indicate that RD readers benefited from high frequency and high imageability when reading difficult-to-decode inconsistent words. Therefore, to

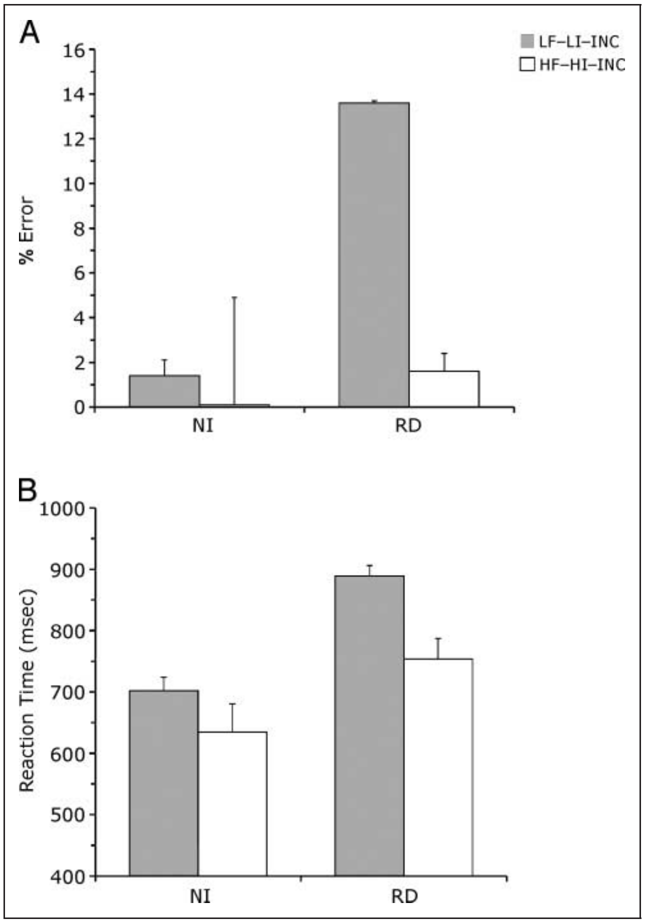

Figure 1. Mean percent error (A) and reaction time (B) for NI and RD readers on the contrast of low-frequency, low-imageable, inconsistent (LF–LI–INC) versus high-frequency, high-imageable, inconsistent (HF–HI–INC) words.

examine the maximum benefit from our stimulus manipulations, we conducted an analysis of extreme conditions (LF–LI–INC vs. HF–HI–INC words) that paralleled the analysis conducted on the behavioral data. Regions showing this Group by Stimulus difficulty interaction are shown in Figure 2B. For NI, the easier HF–HI–INC items were associated with relatively reduced activation at virtually all of these regions. For RD, by contrast, these

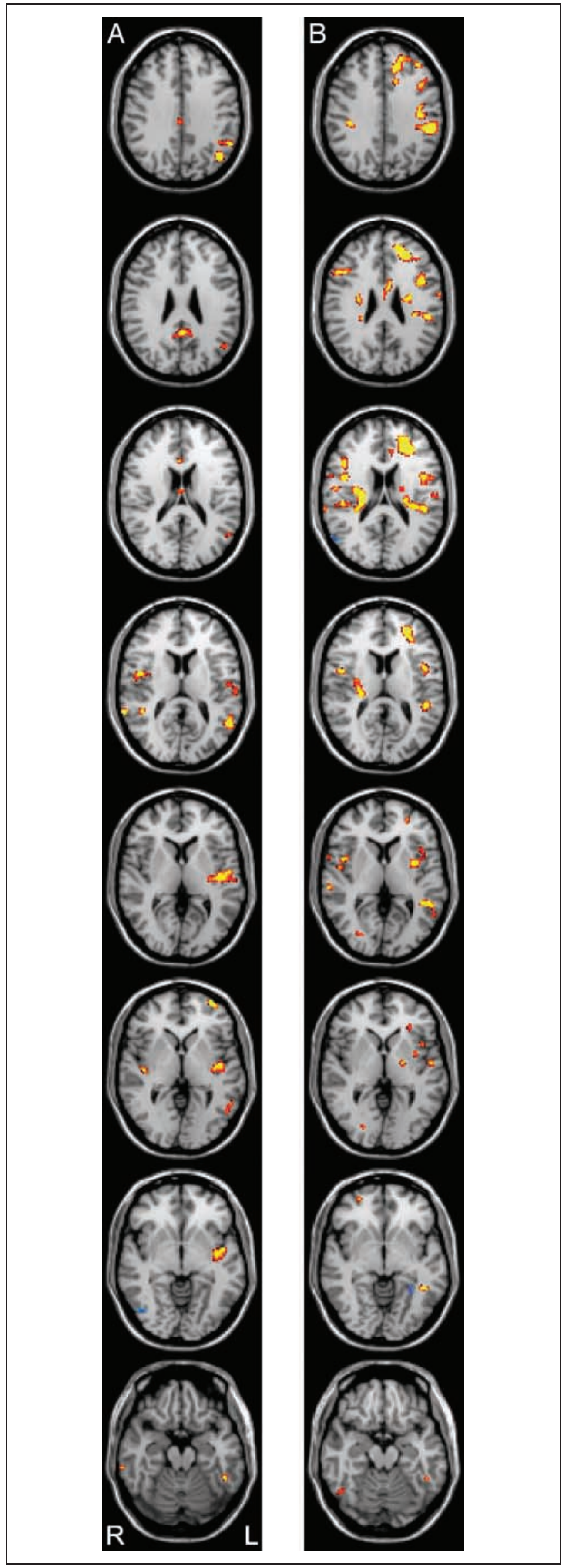

Figure 2. Omnibus group differences indicate regions where activation for NI is greater than RD (yellow/red) or where RD is greater than NI (blue/purple) (A). Group difference on the contrast of low-frequency, low-imageable, inconsistent (LF–LI–INC) versus high-frequency, high-imageable, inconsistent (HF–HI–INC) words (B). In yellow/red are those regions where NI show decreases in activation for HF–HI–INC words relative to LF–LI–INC words and RD showed increases. Images are presented at a univariate threshold of $p < .01$, corrected for mapwise false discovery rate (FDR; Genovese, Lazar, & Nichols, 2002). Images from top to bottom correspond to the following position along the z-axis in MNI space: +34, +26, +18, +12, +4, +0, −6, and −20, respectively, with the LH on the right side of the images.

easier words were associated primarily with heightened activation at key, LH reading-related regions.

Regions of Interest

To more fully investigate stimulus-qualified reader group interactions across the set of a priori defined regions previously implicated as reading-relevant, we conducted ROI analyses. We isolated those clusters of voxels in these regions that were associated with reliable a Group × Stimulus Difficulty (LF–LI–INC vs. HF–HI–INC) interaction (see Figure 2B and Table 1). A striking pattern was observed at several regions, particularly temporo-parietal areas, including STG and SMG (see Figure 3) For NI, the easier, HF–HI–INC words were associated with reduced activation at every ROI, whereas for RD, the opposite pattern was observed (increased activation for easier tokens). Thus, although activation of key LH regions was low for inconsistent words in general for RD readers, when these difficult-to-decode words were of both high frequency and high imageability, activation levels increased modestly.

Discussion

The findings from Experiment 1 suggest latent functionality in LH regions in RD including the IFG and the STG: RD readers increased engagement of the LH reading systems for easier stimuli. However, two important points should be noted with respect to whether activation in these reading systems may be ''normalized.'' First, despite reliable increases in major reading-related areas for HF–HI–INC stimuli relative to LF–LI–INC stimuli (see Figure 2B), activation levels were still relatively weak for RD readers compared with typical levels for NI readers. Second, the commonly seen RD compensatory response in RH posterior and bilateral IFG was still evident even on easy tokens (higher activation for RD readers), implying limits on normalization of response for this type of manipulation.

EXPERIMENT 2

In order to further examine the limits on normalization of function, we employed a second experimental manipulation—repetition. The frequency-related activation effects in Experiment 1 indirectly suggest that the number of exposures is a critical variable in increased LH responses in RD. In Experiment 2, we conduct a direct test of this notion by manipulating the number of exposures to a given token in the short term with a repetition paradigm (Katz et al., 2005; Poldrack & Gabrieli, 2001). In addition to being one of the strongest behavioral manipulations, repetition allows us to more precisely examine learning-dependent brain activation changes because we directly control short-term experience in both groups by manipulating how frequently a token is encountered. By employing an animacy judgment (living/nonliving) using a button press, we also measure latency and accuracy, which allows for a more precise comparison of coordinated behavioral and neurobiological changes in NI and RD groups than in Experiment 1. The goal of this repetition manipulation was to bring RD readers to a point of overlearning for repeated tokens (Adams, 1994) in order to examine whether LH systems are robustly engaged with higher learning levels.

Methods

Participants

Thirty native English speakers (17 males, 13 females) ranging from 9 years in age to 20 years (mean = 13 years) participated in exchange for payment: 16 NI and 14 RD. Of the 16 NI readers, 14 averaged standard scores >100 on the composite of the reading tests described in Experiment 1 [overall mean = 115, Woodcock Johnson basic reading (mean = 113), Woodcock Johnson spelling (mean = 119), and TOWRE total word reading (mean = 112) measures].[1] Fourteen participants met our criteria for RD with averaged standard scores <90 on a composite of these reading tests, and/or averaged standard score <100 with RD history [overall mean = 86, Woodcock Johnson basic reading (mean = 88), Woodcock Johnson spelling (mean = 88), and TOWRE total word reading (mean = 80)]. Groups did not differ on age (RD = 12.89; NI = 13.84, $t < 1.5$) or WASI performance IQ (RD = 108; NI = 111, $t < 1$). All reported normal or corrected-to-normal vision and no history of known neurological impairments. The experiment was conducted with the understanding and the written consent of each participant and all procedures were approved by the Yale University Institutional Review Board.

Stimuli and Design

Two hundred eight mid-frequency nouns were selected for the study. All words were four or five letters in length and all had regular spelling-to-sound mappings. Sixty-five percent of the items were ''nonliving'' and 35% were ''living.'' Repeated and novel conditions were matched for mean frequency, length in letters, and proportion of living/nonliving trials within each imaging run. Two lists were created for counterbalancing purposes such that a subset of the novel words in the first list served as repeated words in the second list and vice versa. Participants were randomly assigned to one of the two lists.

Procedure

Eight functional imaging runs in an event-related animacy judgment (living/nonliving) paradigm employed (a) interleaved acquisition to increase the effective

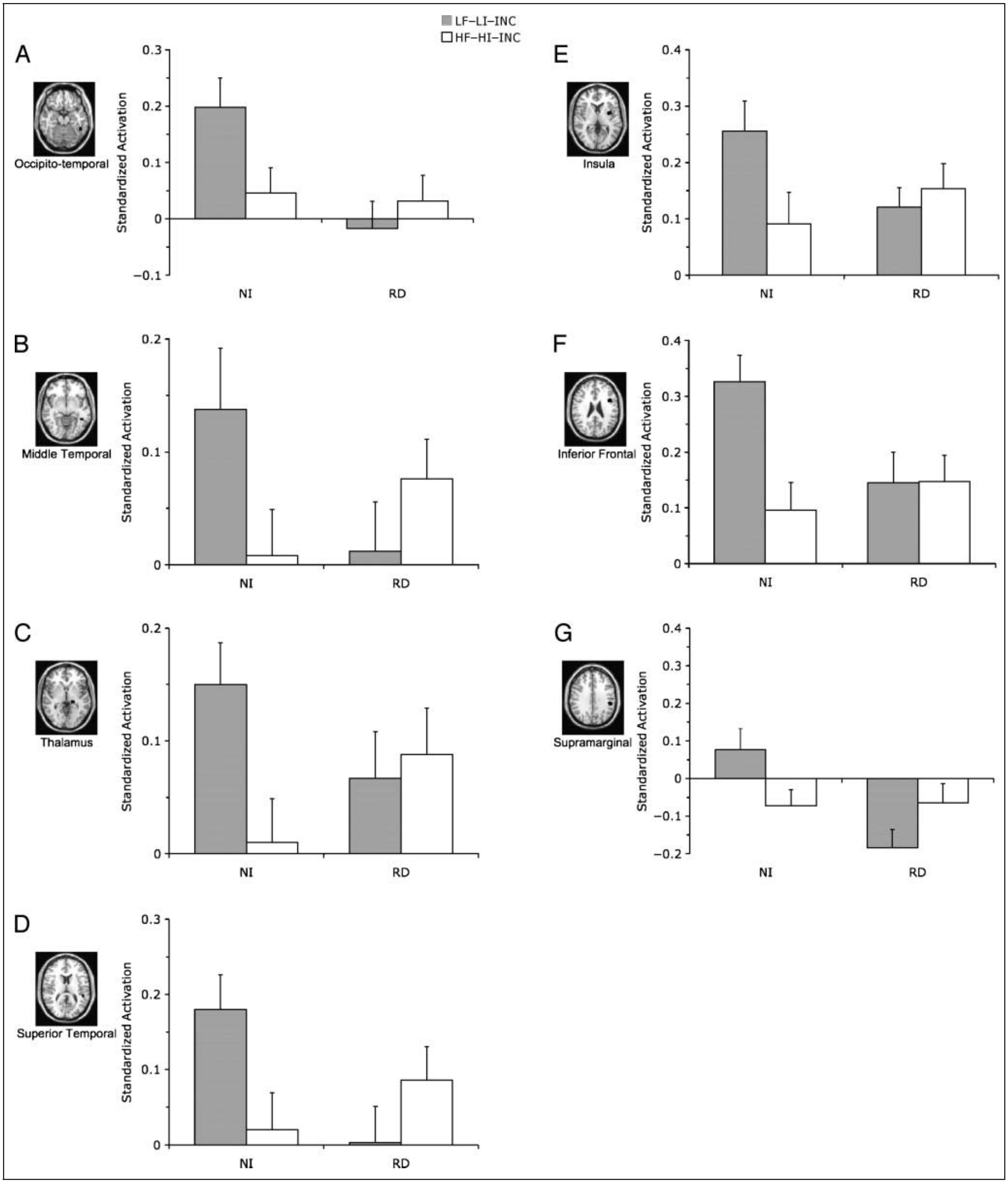

Figure 3. Standardized activation values for the reader group by stimulus difficulty contrasts of LF–LI–INC versus HF–HI–INC words in the seven LH ROIs: OT/fusiform (A), MTG (B), thalamus (C), STG (D), insula (E), IFG (F), and SMG (G).

sampling rate of the hemodynamic response (Josephs, Turner, & Friston, 1997), (b) multiple randomized or "jittered" trial durations (4–7 sec) (Miezin, Maccotta, Ollinger, Petersen, & Buckner, 2000), and (c) and six "null" trials (Friston et al., 1995) to improve our estimate of baseline activation. Each 6:18 minute run consisted of 56 trials in which six words were presented six times in a pseudorandom fashion with 20 intermixed tokens serving as unrepeated control words. All participants completed at least six runs, for a minimum of 216 repetition trials and 120 novel trials across runs. On each trial, a word appeared in the center of screen for 2500 msec and participants were instructed to indicate, as quickly as possible, whether the word came from the category of living or nonliving objects via a right-hand button press. Participants pressed buttons on a response pad with the middle finger for ''living'' responses and the index finger for ''nonliving'' responses. In-scanner behavioral measures (i.e., reaction time and accuracy) were collected for all subjects using PsyScope (Cohen, MacWhinney, Flatt, & Provost, 1993). Response timing started at the onset of the stimulus presentation and continued until the end of the trial. Participants received 16 practice trials before functional scanning began in order to familiarize themselves with the task and setup.

fMRI Image Acquisition and Analysis

Image acquisition and preprocessing were conducted as described in Experiment 1 except that high-resolution anatomical images were obtained for 3-D reconstruction (sagittal MPRAGE acquisition, FA = 45°; TE = 4.66 msec; TR = 2000 msec; FOV = 25.6 × 25.6 cm; 1 mm slice thickness, no gap; 256 × 256 × 1 NEX; 28 slices total). For each subject, a nonlinear transformation was then obtained using BioImageSuite (Papademetris et al., 2003; www.bioimagesuite.org), mapping between the subject-space high-resolution anatomic and the standard brain space defined by the MNI ''Colin'' brain. Prior to across-subjects analysis, this transformation was applied to the single-subject activation maps (described below), with trilinear interpolation, into 2 mm isotropic MNI space.

For single-subject event-related analysis, a regression-based method was utilized, allowing for direct estimation of the hemodynamic response for each trial type, at each voxel separately, without prior specification of a reference function (Miezin et al., 2000). Parameters from this regression model were then used to uniquely estimate the mean response for each condition from −3 to +15 sec relative to stimulus onset. Subject activation maps were then created for each condition using the regression estimates to calculate the mean difference in activity for an activation period (3–8 sec post trial onset) relative to a baseline period (0–3 sec prior to trial onset). Linear contrasts for effects of interest, including the evoked response of each trial type, simple subtractions among trial types, main effects, and interactions, were applied to these regression estimates to obtain contrast images for each subject. Across subjects, each voxel in these contrast images was tested versus zero with an *F* test, implementing a mixed-model or repeated measures ANOVA (Holmes & Friston, 1998; Woods, 1996; Kirk, 1982).

ROI coordinates were defined by peak activation sites within a Group by Linear trend analysis performed to isolate voxels where there was a linear trend across the six presentations that differed by reader group. From this analysis, we identified sites in the seven LH regions that have been previously implicated in reading (cf., Price, 2000; Pugh, Mencl, Jenner, et al., 2000; Pugh, Mencl, Shaywitz, et al., 2000; Posner et al., 1999) and were examined in Experiment 1. For the thalamus, STG, and SMG, including voxels that passed the threshold of $p < .01$, FDR corrected, yielded a volume of less than 100 mm^3; thus we adjusted the threshold to include voxels that passed $p < .05$, FDR, to obtain a more stable descriptor of activation of these regions. MNI coordinates and significance levels for peak activation, as well as the volume for the seven regions, are presented in Table 2. RH regions were examined based on previous studies implicating RD differences and the presence of a Group by Linear trend interaction (Pugh, Mencl, Jenner, et al., 2000; Pugh, Mencl, Shaywitz, et al., 2000).

Results

Behavioral Analysis

Separate ANOVAs were performed on both accuracy and latencies to correct responses. Reading group was the sole between-subjects factor and repetition was the within-subject factor. Due to the relatively small number of stimuli in each exposure condition, we collapsed the six exposures into three periods: early (first and second exposures), middle (third and fourth exposures), and late (fifth and sixth exposures). This three-level coding is employed for both behavioral and fMRI ROI analyses. Accuracy analyses (Figure 4A) revealed a main effect of reader group [$F(1, 28) = 4.61, p < .05$], a marginal effect of repetition ($p < .10$), and no interaction. Latency analyses shown in Figure 4B revealed main effects of reading group [$F(1, 28) = 7.01, p < .05$] and repetition [$F(2, 56) = 36.6, p < .001$]. The Reading group by Repetition interaction was not significant ($F < 1$). These data indicate that effects of repetition were facilitative as expected and were of similar magnitude for both NI and

Table 2. Regions of Interest (ROIs) Showing Reader Group × Linear Trend Interaction

Region	*x*	*y*	*z*	*p*	*Volume (mm^3)*
L. Occipito-temporal/fusiform	−46	−44	−20	.0002	112
L. Middle temporal	−58	−34	−6	.0002	880
Thalamus	−26	−32	8	.0024	216
L. Superior temporal	−66	−14	10	.0002	432
L. Insula	−44	2	−2	.0011	248
L. Inferior frontal	−56	18	24	.0002	216
L. Supramarginal	−34	−64	56	.0042	560

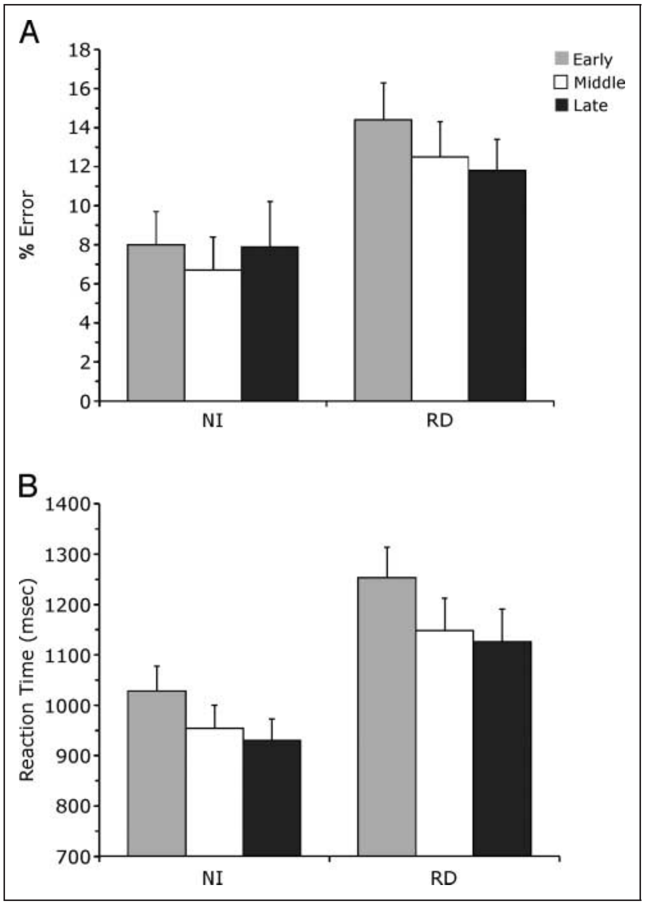

Figure 4. Mean percent error (A) and reaction time (B) for NI and RD readers for early, middle, and late exposures to words.

RD groups. A general advantage for NI was observed but performance in RD was, nonetheless, quite good on this task.

fMRI Analysis

The main effect analysis for group differences revealed the commonly seen underactivation of wide numbers of regions in RD relative to NI readers (see Figure 5A). The Reading group by Linear repetition comparison revealed reading group differences in the direction of the repetition effect in a number of regions, including the LH OT, MTG, thalamus, STG, insula, IFG, and SMG (see Figure 5B).

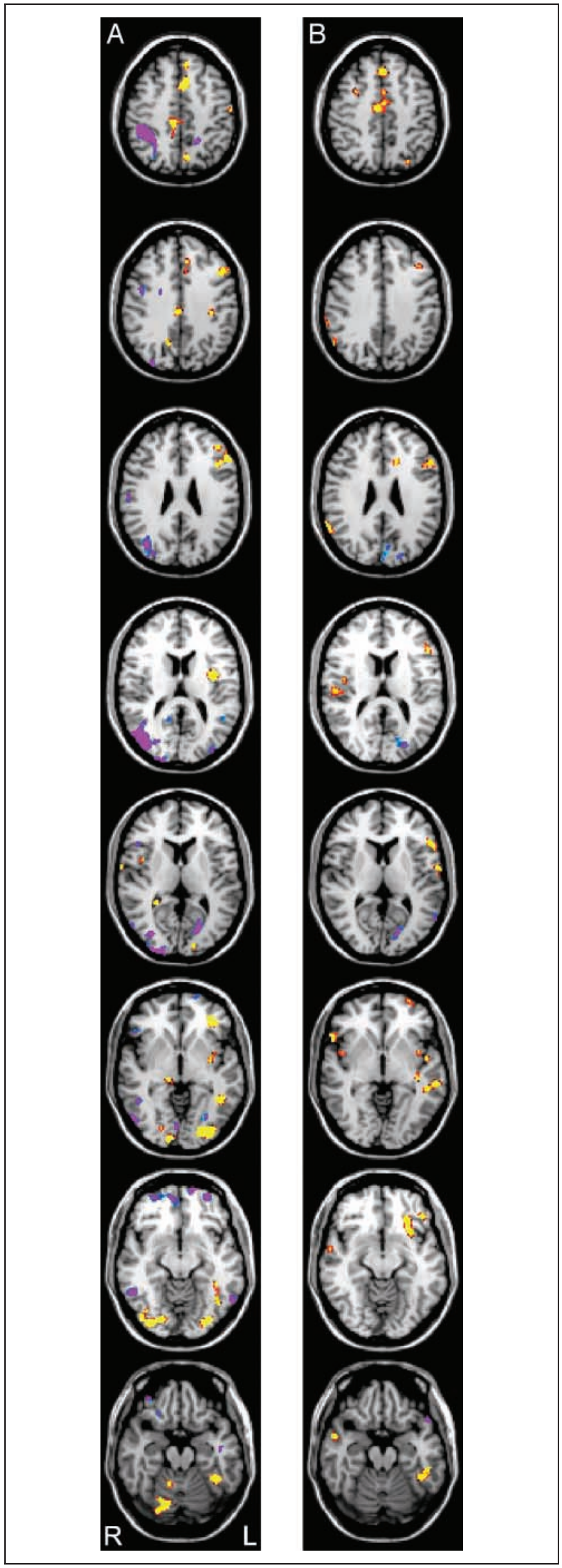

Figure 5. The group difference on unrepeated words (A) shows regions where activation for NI is greater than RD (yellow/red) or where RD is greater than NI (blue/purple) ($p < .001$, FDR corrected). The Group by Linear repetition interaction shows regions where NI decreased activation across the six exposures to a word (yellow/red) and RD increased activation across exposures ($p < .01$, FDR corrected). Images from top to bottom correspond to the following position along the z-axis in MNI space: +46, +36, +26, +14, +8, −4, −12, −12, and −20, respectively, with the LH on the right side of the images.

These interactions, shown in more detail in the following ROI Analyses section, indicate differential effects of repetition on activation for the two groups in these regions. On early trials, increased activation for NI relative to RD is seen at multiple regions, including the LH OT, STG, insula, IFG, MFG, cerebellum, and thalamus, along with RH sites including the OT, IFG, and MTG. On late trials, the differences are more circumscribed and limited to the OT, extrastriate, and LH insula. Heightened RH activation for RD is apparent at OT and MTG sites, and LH prefrontal increases in RD are seen. Critically, activation differences in several reading-related sites such as the STG and the IFG are no longer apparent on late trials.

Regions of Interest

Figure 6 presents the activation levels for each of the seven ROIs described earlier at each exposure period for the two reader groups. The pattern in most of these regions is such that, for NI readers, reduction in activation from early to middle to late was seen, whereas for RD the opposite pattern was observed. Indeed, for the RD readers, each region exhibits significant activation on late trials (fifth and sixth exposures combined). Note that in the SMG, STG, and insula, a shift from deactivation to activation in RD is seen by the middle trials, whereas in the OT the shift occurs by the late trials. Moreover, in most regions, we observed activation decreases for NI but with some sustained activity even on late trials, whereas the IFG shows deactivation on late trials. This is consistent with our previous study (Katz et al., 2005) suggesting that premotor activation is eliminated in silent reading tasks with multiple repetitions (and increased efficiency) for skilled readers. Of note is the activation pattern in the MTG that is uniformly low for NI but increases dramatically across repetitions in RD.

Discussion

The findings from Experiment 2 demonstrate that repetition has a similar, facilitative effect on reaction time and accuracy for both NI and RD readers, but has an opposite effect on BOLD activation. In crucial LH regions, RD readers show the often-reported deactivation early but show reliable increases between three and six exposures, whereas NI readers demonstrated continued reduction in activation with increased exposure. The current findings reinforce our conclusion from Experiment 1 that the LH systems in RD are poorly tuned but can respond when processing words is made easier. Of note, although there are still some residual differences in LH regions such as the insula, and slightly elevated RH response in posterior ventral areas for RD even with multiple exposures, the overall activation in several LH regions appears to be robust and not reliably different as performance improves.

The similar pattern of findings in the two experiments suggests that these learning-related increases in RD generalize to both overt naming tasks (Experiment 1) and silent reading tasks (Experiment 2). Note that the regions of maximum activation tend to differ somewhat within the broadly defined ROIs but this is not surprising given the differing demands of naming and silent lexical access. In order to identify those voxels which showed reliable group interactions with the stimulus manipulations in both experiments, presumably task invariant reading sites, we conducted an intersect analysis (Hadjikhani & Roland, 1998), which identified those voxels for NI that reduced activation across stimulus difficulty (Experiment 1), repetition (Experiment 2), and increased activation across stimulus difficulty and repetition for RD. As seen in Figure 7, overlapping sites are found at the IFG, insula, STG, and MTG that show this pattern in each experiment. Thus, despite rather varied response demands, a core set of areas, mainly in LH cortex, showed opposite activation changes in NI and RD as a function of stimulus difficulty.

GENERAL DISCUSSION

The current findings suggest a degree of latent functionality in LH neurocircuitry for reading in RD readers. The behavioral results from Experiment 1 (on both naming latencies and accuracy) demonstrate that factors such as frequency and imageability enhance performance for RD and NI readers on difficult-to-decode (inconsistent) words. Similarly, repetition of tokens in Experiment 2 facilitated processing on repeated tokens for both groups of readers. This work extends recent studies examining stimulus difficulty and effort effects on activation differences (Hoeft et al., 2007; Cao et al., 2006), by demonstrating significant increases in neural activity in LH systems for adolescent RD as a consequence of learning and experience.

More striking was the differential pattern of brain activation across both experiments. In Experiment 1, the often-reported group differences in activation (lower BOLD signal across the LH reading-related circuitry in RD relative to NI) were qualified by stimulus difficulty. Specifically, on the most difficult words (LF–LI–INC), RD readers demonstrated reduced activation relative to NI across almost all reading-relevant zones; indeed, for these items, no reliable activation was seen in key temporo-parietal sites including the STG and the SMG. For easier stimulus types (e.g., HF–HI–INC words), RD readers demonstrated *increased* activation relative to the hardest stimuli at these same LH regions, suggesting that these cortical networks are poorly trained in RD but not wholly unavailable during reading performance (Pugh, Mencl, Shaywitz, et al., 2000). Although NI readers showed stable activation of these regions for all stimulus types, when compared to RD readers, the NI group showed the opposite pattern of modulation for

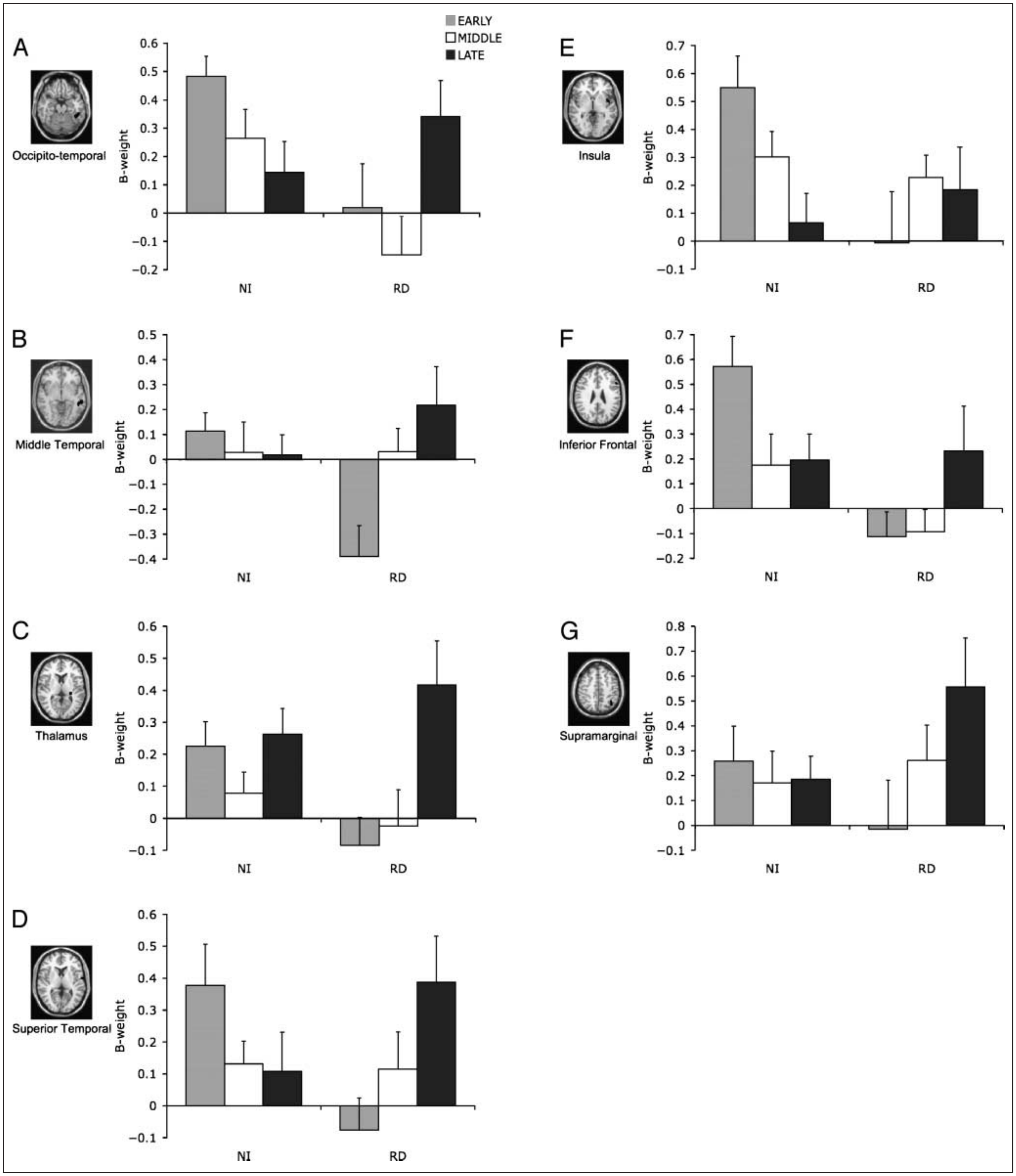

Figure 6. Activation values for the Reader group by Linear repetition interaction in the seven LH ROIs: OT/fusiform (A), MTG (B), thalamus (C), STG (D), insula (E), IFG (F), and SMG (G).

easier-to-process words with relatively *reduced* activation apparent across the LH reading circuit—presumably reflecting increased processing efficiency (Katz et al., 2005; Sandak, Mencl, Frost, & Pugh, 2004; Sandak, Mencl, Frost, Rueckl, et al., 2004; Poldrack & Gabrieli, 2001). Although the data indicate that RD readers increased engagement of the LH reading systems for easier stimuli, Experiment 1 was not definitive regarding whether activation in these reading systems may be "normalized." Despite modest increases in major reading-related areas for HF–HI–INC stimuli (see Figure 2B), activation levels were still relatively weak for RD readers compared with typical levels for NI readers. Moreover, the commonly seen RD compensatory response in the RH posterior and bilateral IFG was evident even on easy tokens, implying limits on normalization of response.

Experiment 2 provided clear evidence for a shift from deactivation to robust activation of most key LH regions with repetition in RD readers. We can conclude from these experiments that many important reading-related regions are capable of engaging in print processing for stimuli that are made easier to process either through repetition-induced learning or increased top–down support from imageability or frequency manipulations.

Given that phonologically sensitive subregions of the LH (i.e., IFG, SMG, STG) are generally found to be underengaged in RD (including in the current study for more difficult stimuli), the increased responsiveness in RD for high-frequency/high-imageable inconsistent tokens relative to low-frequency/low-imageable inconsistent tokens in naming at each of the key phonologically tuned areas (Pugh et al., 1996) may reflect increased communication or resonance with semantically tuned networks; that is, stabilization of a poorly tuned phonological coding system via support from nonphonological systems. Experiment 2 is empirically straightforward with regard to increased activation in phonologically tuned regions, but whether this reflects semantic reinforcement (given that the task involves animacy judgment), orthographic/phonological reinforcement, or both of these things is not fully answerable. One possible answer is suggested by the pattern of activation in the MTG (see Figure 6), a region strongly associated with lexical–semantic processing (Frost et al., 2005; Sandak, Mencl, Frost, Rueckl, et al., 2004; Price, 2000; Pugh, Mencl, Jenner, et al., 2000). In the MTG, NI readers showed minimal and unchanging activation whereas RD demonstrated initial deactivation and then robust activation by middle to late trials. This might reflect differential sensitivity to semantic support in RD readers. In general though, we see that relatively poorly tuned phonologically sensitive regions are positively affected by ameliorative factors for RD in both Experiments 1 and 2.

The current results suggest a neurobiological learning curve wherein NI and RD readers start at very different points on an inverted U-shaped relationship between learning and neural activation. Neuroimaging studies of perceptual and motor skill learning in nonimpaired populations have demonstrated that initial skill acquisition (unskilled performance) is associated with increased

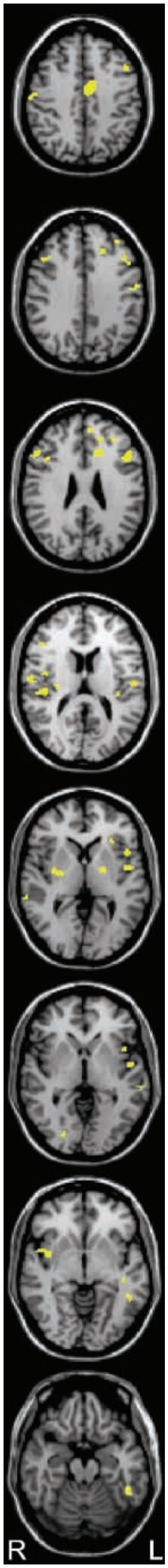

Figure 7. Intersect analysis showing voxels that showed a Reader group by Stimulus difficulty effect and a Reader group by Repetition effect ($p < .05$, FDR corrected in each; conjoint threshold of $p < .0025$). Images from top to bottom correspond to the following position along the z-axis in MNI space: +42, +34, +26, +14, +2, −2, −6, and −20, respectively, with the LH on the right side of the images.

activation in task-specific cortical areas, whereas continued practice of an acquired skill tends to be associated with task-specific decreases in activation in the same cortical regions. (e.g., Katz et al., 2005; Poldrack & Gabrieli, 2001). Other studies of skilled reading have also shown different patterns of learning-related changes in brain activation as a function of item familiarity. For example, Henson, Price, Rugg, Turner, and Friston (2002) found that repetition of familiar real words was associated with decreases in cortical activation, whereas repetition of (initially unfamiliar) pseudowords was associated with increased activation in the same regions. Thus, this *learning-curve* hypothesis suggests that whether learning is associated with increased or decreased activation depends upon the degree to which processing is overlearned and automatic (how far along the learning curve it is). With regard to developmental trajectories, our cross-sectional studies have suggested that beginning readers show low activation of LH posterior regions, particularly the occipito-temporal region, but increase with experience (Shaywitz et al., 2002). However, once these systems are in place, increased routinization for stimuli (such as the repetition effect in the current Experiment 2) results in drops in activation (thus, a nonmonotonic relation between activation and experience in nonimpaired readers).

In the current study, RD readers appear to start at a very low point on this curve but repetition and learning result in increases. This does not necessarily imply a simple developmental delay account of specific RD because these regions are clearly less than ideally organized even after many years of reading experience in our adolescent RD readers, and this suggests some degree of compromise in the neural circuitry. But the robust activation seen after multiple exposures in Experiment 2 does lend itself to speculation that these systems are trainable (indeed, it will be critical in future studies to push these systems further to test limits on learning effects).

One question that the data from Experiment 2 raise is why the initial (first exposure) activation response in LH is so low given that RD readers have certainly seen the words used in this experiment thousands of times. The most straightforward hypothesis, and one that would point to a very specific learning problem in RD, is that these readers fail to consolidate the learning experience into longer-term neural changes in processing and organization. Thus, the system might be available for processing but might fail to demonstrate savings with longer-term modulation of connections. If this turns out to be the case (for all or some subtypes of RD), then this would shift focus away from exclusive focus on simple mapping deficits toward more systematic investigation of the mechanisms of explicit or implicit learning. There is, nonetheless, some indication of neural consolidation in Experiment 1, where both frequency and imageability (a semantic variable) were associated with a heightened LH response even without local repetition. However, the increases for HF–HI–INC tokens in that experiment were modest. In any event, the mechanisms underlying an apparent consolidation deficit in RD will require us to explore a new line of dynamic learning paradigms to measure long-term learning under varied training conditions (e.g., Sandak, Mencl, Frost, & Pugh, 2004; Sandak, Mencl, Frost, Rueckl, et al., 2004).

The current results, along with our previous work that has shown nonuniformity in hemodynamic effects of learning as a function of stimulus type (Sandak, Mencl, Frost, Rueckl, et al., 2004), have some important methodological and design implications as well. These findings reveal the importance of controlling stimulus factors in order to derive a more precise understanding of brain–behavior relations in RD. Although most published reports show lower LH posterior activation in RD, the results of these experiments indicate that the extent of this difference is dependent on stimulus difficulty. From a design consideration, we argue that dynamic designs, which parametrically examine the ways in which learning modulates relative activation across distributed systems, will allow for the development of a more detailed theory of the neurobiological mechanisms of reading and provide a framework for examining systems-level differences in RD. Indeed, it seems plausible that in searching for biomarkers that are diagnostic in this condition, response patterning to tasks (measuring dynamic changes with learning) will prove more substantive than static group differences.

The current results provide some constraint on the sort of hypotheses we entertain regarding neurobiological mechanisms in RD. Whatever the biologic mechanism (or mechanisms) that engender risk for RD, this mechanism must be of the sort that results in a neurocircuitry that is relatively disrupted in general, but is, nonetheless, not so fundamentally compromised that a more typical reading response cannot be induced. Indeed, recent intervention studies with at-risk or RD children indicate increased engagement of all these LH areas following intensive remediation (Shaywitz et al., 2004; Temple et al., 2003; Simos et al., 2002).

Various biological accounts have been proposed to explain this LH dysfunction, including a suggestion of a higher numbers of cortical dysplasias or ectopias (Galaburda, 1992), reduced myelination in white matter tracts (Klingberg et al., 2000) connecting anterior and posterior language zones, or abnormalities in gray matter development (Miller, Sanchez, & Hynd, 2003). Obviously, the current findings do not directly assess any of these speculations but they do suggest a clear biologic constraint: The systems are weakened but not wholly dysfunctional in even severe older RD readers. The general notion of a "developmental lesion" at critical LH systems in RD (cf., Eden & Zeffiro, 1998) would appear to be inconsistent with data suggesting functional activation of these systems under certain conditions (see

Pugh, Mencl, Shaywitz, et al., 2000 for similar conclusions with functional connectivity analyses). Speculatively, these findings seem most consistent with accounts that posit ''noisy'' or unstable neural systems (Sperling, Lu, Manis, & Seidenberg, 2005).

Summary

In Experiment 1, effects of imageability and frequency on behavioral performance in NI and RD participants were similar. Both groups show facilitation but, as predicted, the benefit was larger for RD. Effects of imageability and frequency on brain activation in phonologically tuned subsystems in NI and RD were wholly dissimilar. For NI readers, easier words were associated with relatively reduced activation. For RD readers, easier words resulted in increased activation. Experiment 2 replicated this pattern with a simple and direct manipulation of on-line learning through stimulus repetition. Thus, the phonologically tuned subsystems in adolescent RD readers appear to be poorly trained but not wholly disrupted. Further studies will be required to test the limits on learning in these LH systems in RD.

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Note

1. Two of the 16 readers were unavailable for testing, but their overall performance on the in-scanner task was 97% and 98% correct and they had no history of reading difficulties.

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The neural underpinnings of prosody in autism

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This study examines the processing of prosodic cues to linguistic structure and to affect, drawing on fMRI and behavioral data from 16 high-functioning adolescents with autism spectrum disorders (ASD) and 11 typically developing controls. Stimuli were carefully matched on pitch, intensity, and duration, while varying systematically in conditions of affective prosody (angry versus neutral speech) and grammatical prosody (questions versus statement). To avoid conscious attention to prosody, which normalizes responses in young people with ASD, the implicit comprehension task directed attention to semantic aspects of the stimuli. Results showed that when perceiving prosodic cues, both affective and grammatical, activation of neural regions was more generalized in ASD than in typical development, and areas recruited reflect heightened reliance on cognitive control, reading of intentions, attentional management, and visualization. This broader recruitment of executive and "mind-reading" brain areas for a relative simple language-processing task may be interpreted to suggest that speakers with high-functioning autism (HFA) have developed less automaticity in language processing and may also suggest that "mind-reading" or theory of mind deficits are intricately bound up in language processing. Data provide support for both a right-lateralized as well as a bilateral model of prosodic processing in typical individuals, depending upon the function of the prosodic information.

Keywords: Autism; Prosody; Language; fMRI; Theory of mind.

While it is well known that individuals with autism spectrum disorders (ASD) have significant deficits in language abilities, there is ongoing debate about the nature of these deficits. In some of the earliest descriptions of ASD (Hermelin & O'Connor, 1970; Rutter, 1970, 1979), language was described as the primary domain of impairment, to which social impairments were secondary. Subsequent research reversed this emphasis, such that social impairments were conceptualized as primary and causally related to language impairments

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(e.g., Baron-Cohen, 1988; Mundy, Sigman, & Kasari, 1990). Prosody is an important aspect of language that may inform this debate, as it is centrally involved in both social and language functions. Unfortunately, behavioral studies of prosody in ASD are few in number and have yielded results that are generally at odds with clinical impressions. The current study focuses on the neural underpinnings of prosodic comprehension in ASD, examining the responses of adolescents with high-functioning ASD to both relatively social and relatively linguistic forms of prosody.

Prosody refers to the *pitch* (fundamental frequency), *intensity* (amplitude), and *durational* qualities of speech. Prosody has several functions, all of which make use of these same kinds of acoustic forms. *Grammatical prosodic cues* signal syntactic information, such as whether an utterance has a declarative (statement) or an interrogative (question) function. *Affective prosodic cues* signal the speaker's affective state (e.g., happy versus angry). As "suprasegmental" signals, these prosodic signals can be independent of the speaker's specific utterances (word choices or sentence structures); that is, an interrogative prosody can be uttered with a parallel interrogative linguistic structure (movement of an auxiliary verb to the start of the utterance, as in "Can I help you with that?") or with a declarative structure (as in, "Perhaps you need some help with that?"). Similarly, affective prosodic valances can be superimposed upon semantic meanings that might otherwise convey no particular emotion. In addition to differing forms of prosody, individuals must both produce and comprehend prosodic information; links between these two aspects of prosody are, to date, unclear.

Prosody in ASD

Since the first delineation of the autistic syndrome (Kanner, 1943), abnormal prosody production has been frequently identified as a core feature of the syndrome for individuals with autism who speak (Baltaxe & D'Angiola, 1992; Baltaxe & Simmons, 1975; Fay & Schuler, 1980; Ornitz & Ritvo, 1976; Paul, 1987; Pronovost, Wakstein, & Wakstein, 1966; Rutter & Lockyer, 1967; Tager-Flusberg, 1981). Differences noted in early observations of ASD included monotonic or machine-like intonation, deficits in the use of pitch and control of volume, deficiencies in vocal quality, and use of aberrant stress patterns. Speakers with high-functioning autism (HFA) demonstrate these difficulties (Ghaziuddin & Gerstein, 1996; Shriberg et al., 2001). Prosodic deficits have not been universally reported, however. Simmons and Baltaxe (1975), for example, found that only four out of the seven adolescents with autism they studied had notable suprasegmental differences in their speech. Paul, Shriberg, et al. (2005) reported abnormal prosody in 47% of the 30 speakers with ASD studied. When such behaviors are present, however, the prosody characteristics of a person with autism constitute one of the most significant obstacles to his or her social integration and vocational acceptance. Prosodic differences have been found to be persistent and to show little change over time, even when other aspects of language improve (DeMyer et al., 1973; Kanner, 1971; Rutter & Lockyer, 1967; Simmons & Baltaxe, 1975). Paul et al. (2005) report that prosodic differences are significantly related to ratings of ASD speakers' social and communicative competence. Moreover, Mesibov (1992) and Van Bourgondien and Woods (1992) reported that it is the vocal presentation of individuals with autism that most immediately creates an impression of oddness.

Given the salience of emotional and social deficits in ASD, most empirical research on prosody in ASD has focused on affective prosody, showing that prosodic deficits are linked to broader social emotional impairments. The research, in general, suggests the presence of deficits in comprehending affective prosody when individuals are asked to label those emotions, or to match them to facial expressions of emotions (Boucher, Lewis, & Collis, 1998; Hall, Szechtman, & Nahmias, 2003; Schultz, 2005).

Studies of grammatical prosody, in contrast, have been somewhat less consistent. Individuals with autism show no particular impairments in the production (timing, length) or the comprehension of pauses (Fine, Bartolucci, Ginsberg, & Szatmari, 1991; Thurber & Tager-Flusberg, 1993), the production or comprehension of stress (Fine, et al., 1991; Paul, Bianchi, Augustyn, Klin, & Volkmar, 2008), the comprehension of utterance-final prosody (Fine et al., 1991), the production of pauses at grammatical boundaries in speech (Fine et al., 1991; Thurber & Tager-Flusberg, 1993), the use of unmarked (grammatical) stress placement (Fine et al., 1991), and the comprehension of stress and timing cues to grammatical phrase structure (e.g., "*chocolate cake* and cookies" versus "*chocolate*, *cake*, and cookies"; Paul, Augustyn, et al., 2005).

In contrast, however, some research *has* demonstrated significant impairments in prosodic or stress production in ASD (Baltaxe, 1984; Paul et al., 2008; Shriberg et al., 2001), particularly for speech that is more grammatically or semantically complex. Studies have revealed impairments in prosody for assigning contrastive stress (Baltaxe, 1984), grammatical placement of stress (Baltaxe & Guthrie, 1987), terminal pitch contours (Baltaxe, Simmons, & Zee, 1984), marking "chunks" of connected words during imitation (Fosnot & Jun, 1999), and comprehension of prosodic cues to phrase structure (Diehl, Bennetto, Watson, Gunlogson, & McDonough, 2008). A recent fMRI study of prosody in ASD indicated that processing of prosodic cues involved a failure of inhibition of the "default network" (Hesling et al., 2010), suggesting that individuals with ASD may be activating a distinct set of brain networks in comprehension.

While there have been a number of studies of prosodic comprehension and production in ASD, much of this literature is characterized by conflicting results, small sample sizes, and controls that are unmatched for age or IQ. In addition, many studies have relied upon explicit assessments. This is a significant methodological issue; data from a number of studies indicate that individuals with ASD often perform more similarly to controls when given explicit instructions, relative to spontaneous behavior. For example, the timing of spontaneous but *not* explicitly instructed facial mimicry is delayed in ASD (Charlop, Schreibman, & Thibodeau, 1985).

While studies of prosody in ASD have been inconclusive, it is clear that aspects of prosodic production and comprehension, particularly affective prosody, are perturbed in a significant proportion of individuals with ASD. Research making use of brain imaging may identify the neural processes underlying these aberrant behavioral patterns and may help to explain some of the phenotypic heterogeneity. In typical individuals, prosody is thought to depend on the recruitment of a large, complex, distributed network of brain regions (Robins, Hunyadi, & Schultz, 2009; Sidtis & Van Lancker Sidtis, 2003). In ASD, because prior studies suggest affective but potentially not grammatical prosodic impairments, we can ask whether this hinges upon difference in affective qualities. Alternatively, it may be the case that grammatical impairments are more difficult to characterize in sensitive tasks; thus, this approach offers the possibility of identifying important and salient clinical impairments in subtle linguistic skills in ASD.

Neural Bases of Prosody

Early research on the neural underpinnings of prosody drew on lesion studies and consistently demonstrated a right lateralization of emotional prosody and a left pattern of lateralization for grammatical prosody (Heilman, Leon, & Rosenbek, 2004; Van Lancker, 1980). More recent neuroimaging work in typically developing individuals has suggested three alternative hypotheses (Hesling, Clement, Bordessoules, & Allard, 2005). First, prosodic processes may draw heavily on subcortical regions (Cancelliere & Kertesz, 1990). Consistent with this suggestion, participants presented with filtered speech (containing no semantic information) display bilateral basal ganglia activation (Kotz et al., 2003). Second, prosody may be generally right-lateralized, with linguistic information processed in left hemisphere (Klouda, Robin, Graff-Radford, & Cooper, 1988). For example, fMRI studies that present participants with emotional valence versus phonological contrast decisions indicate bilateral involvement in both kinds of judgments, but relatively greater recruitment of right hemisphere for the emotion judgments, especially inferior frontal lobe (Buchanan et al., 2000). Third, prosodic processing may simply depend on specific acoustic cues (Van Lancker & Sidtis, 1992) and specific task demands (Luks, Nusbaum, & Levy, 1998). In general, posterior superior temporal regions are particularly important in prosodic processing and have also been highlighted as atypical across a variety of functional and anatomical studies of ASD (Just, Cherkassky, Keller, & Minshew, 2004).

In the present study, we used functional imaging to examine the processing of grammatical and affective prosody in youth (9–17) with HFA. In order to avoid conscious attention to prosody, which is likely to normalize responses in young people with HFA (Wang, Lee, Sigman, & Dapretto, 2006), we designed a task that focused attention on semantic aspects, while systematically varying the prosody of the stimuli. In this way, we aimed to investigate which brain areas would be recruited for prosodic processing when conscious attention was diverted. This approach will provide an opportunity both to evaluate the alternative hypotheses discussed by Hesling et al. as well as to look for ways in which this processing diverges from the normal pattern in speakers with HFA.

METHOD

Participants

High-functioning youth with and without ASD took part in a study of pragmatic and prosodic ability. Diagnostic assignment was made based on clinical consensus by a multidisciplinary team of experienced clinicians, using *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (*DSM-IV*, APA, 1994) criteria and making use of data from the Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter, & LeCouteur, 1994), the Autism Diagnostic Observation Schedule-Generic (ADOS-G; Lord et al., 1994), and clinical observation. Interrater reliability between these clinicians for diagnostic assignment was high, with kappa values ranging from .80 to .95 in related research projects. All participants were native, monolingual speakers of English, with normal hearing. Typically developing (TD) participants were included only if they had no history of learning or psychiatric disorders, based on parent report in the Childhood/Adolescent Symptom Inventory (Gadow & Sprafkin, 1997). They were between 9 and 17 years of age and had a Verbal IQ greater than 70 (on the Differential Abilities Scale [Elliott, 1990] for the ASD group or the Wechsler Abbreviated Scale of Intelligence [Wechsler, 1999] for the TD group). In addition, participants completed the Clinical Evaluation of Language Fundamentals (CELF), a standardized assessment of language skills (Semel, Wiig, & Secord, 2003), to determine overall language level.

Table 1 Demographic Information for Participants with Autism Spectrum Disorders (ASD) and Typically Developing (TD) Control Participants.

	ASD ($n = 16$, 14 boys)	TD ($n = 11$, 7 boys)
Age (years)	13.7 (2.8); 9 − 17	13.7 (2.6); 9 − 17
ADOS S+C[a]***	12.2 (5.7); 4 − 24	0.0 (0.0)
Full-scale IQ**	96.7 (14.9); 74 − 125	111.9 (10.9); 89 − 133
Verbal IQ	103.5 (22.2); 77 − 146	112.9 (9.8); 98 − 127
Performance IQ*	96.8 (15.7); 68 − 126	109.6 (14.5); 72 − 131
Handedness (R:L)	10:1	8:1
CELF Core Language (SS)*	97.4 (15.7); 69 − 120	110.1 (6.1); 100 − 123
CELF Expressive*	96.6 (15.0); 71 − 120	107.4 (6.3); 96 − 122
Behavioral prosody production and perception (accuracy)**	92.1 (4.7); 82 − 97	96.5 (1.9); 93 − 100

Note. Data presented as *M* (*SD*); range. Handedness was assessed using the PANESS inventory (Denckla, 1985). Not all participants completed a handedness assessment, due to experimenter error; data were missing for 5 participants in the ASD group and 2 in the TD group.

[a]ADOS S+C = Sum of scores on the ADOS Social and Communication domains (Modules 3 and 4); cutoff for ASD Diagnosis is 7.

TD > ASD: $^*p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Sixteen children and adolescents with autism spectrum disorders (ASD; including 7 with Pervasive Developmental Disorder/Not Otherwise Specified (PDD/NOS), 5 with high-functioning autism, and 4 with Asperger syndrome) and 11 typically developing controls participated in this study. Typically developing controls were matched as a group to the ASD participants on the basis of chronological age and verbal IQ (all Fs < 1.7, all ps $> .20$). Groups were also matched for gender, $\chi^2(1) = 2.15$, $p = .14$, and handedness, χ^2 $(1) = 0.117$, $p = .73$. Demographic data are summarized in Table 1. In addition, participants completed a behavioral assessment of prosody comprehension and production across four tasks; data are reported in a separate publication (Diehl & Paul, in press). While there were statistically significant differences between the ASD and TD groups on affective prosody perception, the participants with ASD were, nonetheless, correct on more than 87% of the items, indicating that they were able to comprehend and produce auditory cues relevant to prosody. All participants and caregivers gave informed consent.

Experimental Task

After training in a mock scanner and with the fMRI task, followed by screening to ensure safety, participants were placed on the bed of the scanner and provided with the button box. The head was stabilized with foam cushions placed inside the head coil. Participants wore MRI-compatible earphones and viewed the task through a mirror mounted on the head coil.

In the scanner, participants were presented with a series of sentences. The sentences (e.g., *It is five o'clock*; *She is typing fast*) were declarative statements, three to five words in length, consisting of high-frequency words (based on standard norms; Gilhooly & Logie, 1980; Kucera, 1967) and spoken by a female native speaker of English. Sentences fell into one of two affective conditions (Neutral or Angry emotion) and one of two grammatical

Table 2 Characteristics of Experimental Prosodic Stimuli by Condition.

	Pitch Pattern	Pitch Range
Neutral Statements	falling pitch	108.8–302.4
Neutral Questions	rising pitch	165.5–486.4
Angry Statements	falling pitch	127.7–338.5
Angry Questions	rising pitch	270.0–506.0

conditions (Statement or Question intonation), forming a two-by-two design. Across conditions, stimuli were matched on pitch, intensity, and duration, using Praat for manipulation of the acoustic signal, as shown in Table 2. Importantly, participants were *never* explicitly instructed to attend to the prosody of the sentences they heard. To maintain (and permit monitoring of) attention and to decrease explicit attention to the prosodic contrasts, participants were asked to report whether each stimulus sentence was about a living creature. The proportion of "yes" answers was set at 50%. To validate perception of the intended prosodic functions, university undergraduates rated audio recordings of the stimuli for the contrast between question and statement intonation ($n = 24$) and the contrast between angry and neutral ($n = 13$). Stimuli were only included when the ratings were at the appropriate endpoints of the continua (either 4–5, or 1–2, along a 5-point continuum). The average affect rating (on a scale of 1 to 5, where 1 is completely neutral and 5 is completely angry) was 1.9 for the neutral sentences and 3.7 for the angry sentences. The average grammatical prosody rating (on a scale of 1 to 5, where 1 was clearly declarative and 5 was clearly interrogative) was 1.4 for the declarative sentences and 4.5 for the interrogative sentences.

Stimuli were presented in six runs with four different conditions (blocked) in a 2 (emotion prosody) $\times$ 2 (grammatical prosody) design—(a) Neutral Statements; (b) Neutral Questions; (c) Angry Statements; (d) Angry Questions—in which emotional prosody was fully crossed with grammatical prosody by block. Each run included two blocks of each of the four experimental conditions (e.g., eight blocks), one block of an auditory attention control task (detecting a beep in noise) and a silent 10-second rest condition, for 11 blocks total in a pseudo-random order that maximized variability. There were 54 trials per run. Each block contained four 3-second trials with an intertrial interval of either one or two seconds (counterbalanced across trial types), and each block was followed by a 12-second rest trial.

Neuroimaging Data

MRI data were collected on a 3.0 Tesla Siemens Trio scanner at the Yale University School of Medicine Magnetic Resonance Research Center, with a standard birdcage head coil. Following localizer scans, 2D anatomical scans were acquired for in-plane coregistration with functional data (T1 flash, axial oblique plane through the AC-PC, 32 slices, 4 mm^3 isotropic voxels with no gap between slices; TR/TE = 300/2.47, flip angle = 60°) with full cortex coverage and the first slice prescribed at "one slice above vertex" (top of brain). Six functional runs were acquired in the axial AC/PC plane, using a gradient echo, single-shot echoplanar sequence (TR/TE = 2000/20, flip angle = 80°, 32 slices, 4 mm^3 isotropic voxels with no gap between slices). The final scan consisted of a 3D MPRAGE 1 mm^3 anatomical image, also used for functional localization (176 slices,

$1\ mm^3$ isotropic voxels, TR/TE = 2530/3.66, flip angle = 7°). BrainVoyager QX 1.9 (Brain Innovation, Maastricht, The Netherlands) was used to analyze the recorded MRI data (Goebel, Esposito, & Formisano, 2006).

Preprocessing included intrasession alignment, motion correction, 7 mm FWHM Gaussian spatial smoothing, and linear trend removal. Five initial volumes per run were discarded. The functional image was coregistered to the 3D anatomical image, and the 3D image was then transformed into standard Talairach space using piecewise linear transformation. The Talairach and coregistration transformations were applied to the functional data to interpolate it into standard a 3D $3\ mm^3$ space. All images are shown using radiological convention (e.g., the left hemisphere is on the right side of the image). Parametric maps were obtained using a general linear model (GLM) with multiple conditions. Analyses examined specific task contrasts using the t statistic. For whole-brain analyses, a conservative threshold of $p < .001$ was used to account for multiple comparisons. We examined activations as a function of grammatical prosody (question versus statement blocks, collapsing emotional prosody conditions) and emotional prosody (angry versus neutral blocks, collapsing grammatical prosody). Across subjects, random effects analyses of covariance (ANCOVAs) with CELF Core Language scores as a covariate tested differences in response to these stimulus types by group (ASD vs. TD).

RESULTS

Behavioral Analyses

Analyses of the behavioral task revealed that the ASD and control groups performed similarly in regards to correct performance on the explicit semantic task of determining whether each stimulus contained a living creature. A repeated-measures analysis of variance (ANOVA) on Condition × Group indicated no group differences in accuracy across four prosody conditions, $F(1, 26) = 1.78$, $p = .19$, (ASD group: $M = 0.733$, $SD = 0.04$; TD group: $M = 0.814$, $SD = 0.05$). Similarly, groups did not differ in reaction time across conditions, $F(1, 26) = 1.39$, $p = .25$ (overall ASD group: $M = 1927$, $SD = 178$; TD group: $M = 2009$, $SD = 186$). Because of significant or near-significant differences in fundamental language abilities as a function of group, CELF Core Language scores were included as a covariate in all analyses.

MRI Results

In order to determine the neural regions involved in perception of prosody, we contrasted activations in response to the four prosody conditions, collapsing over group, using a random effects ANCOVA with Core Language scores as a covariate. There were multiple regions of activation, indicating that the prosodic contrasts recruited topographically distinct brain structures. To map out regions of activation more specifically, a series of analyses examined the main effect of emotional prosody on brain responses (angry versus neutral conditions) and the main effect of grammatical prosody (questions versus statements), collapsed across group. First, the Angry-Neutral contrast was reflected by significant regions of activation, including medial frontal gyrus (X, Y, Z = 6, 38, 38); left inferior frontal gyrus; and right precuneus (12, −61, 29). The Question-Statement contrast was reflected by significant activation in left superior temporal gyrus (−53, 8, −2). There was a significant interaction between group status and condition, reflecting regions

Table 3 Brain Regions of Significant Activation Induced by Affective Prosodic Contrasts in Participants with ASD and TD.

Type of analysis of variance and contrast	Brain region	Brodmann area	Talairach X,Y,Z coordinates
Between-group comparison			
Greater activation in TD than ASD (Angry Statements+Questions)	L IFG	47	−54, 23, −8
	Bilat parahippocampal gyrus		16, −8, −19
Greater activation in ASD than TD (Angry Statements+Questions)	L globus pallidus		−14, −6, −6
	R MFG		5, 45, 37
	R STG	6	30, 10, −20
	R Precentral Gyrus	4	54, −12, 41
Within-group comparison			
Activation reflecting emotional prosodic contrast in ASD (Angry – Neutral)	R MFG	10, 6	3, 52, 1 and − 3, 37, 37
	L IFG	46	−46, 35, 11
Activation reflecting emotional prosodic contrast in TD (Angry – Neutral)	R STG	38	42, 10, −27

Table 4 Brain Regions of Significant Activation Induced by Grammatical Prosodic Contrasts in Participants with ASD and TD.

Type of analysis of variance and contrast	Brain region	Brodmann area	Talairach coordinates X,Y,Z
Between-group comparison			
Greater activation in TD than ASD (Questions)	R STG	22	46, −6, −6
Greater activation in ASD than TD (Questions)	Bilat Mid FG	10, 6	39,50,10; −26,2,47
	R ACG		2, 37, 29
	R SFG	6	15, 21, 53
Within-group comparison			
Activation reflecting grammatical prosodic contrast in ASD (Quest – Statement)	R Mid FG	10	43, 47, 13
	L STG	–	−39, 9, −13
	L ACG (decrease)	32	−5, 32, −4
Activation reflecting grammatical prosodic contrast in TD (Quest – Statement)	L Mid FG	46	−48, 30, 21
	L STG	22	−50, −7, −2
	L Fusiform	19	−39, −79, −12

of differences in activation, including right medial frontal gyrus (37, 49, 11), right inferior temporal gyrus (62, −16, −16), right parietal postcentral gyrus (5, −39, 63), right middle temporal gyrus (62, −41, 2), and left middle temporal gyrus (−44, −61, 27). Results, broken down by group, are presented in Tables 3 and 4.

Affective Prosody Results

To test the interaction of group status and specific affective and grammatical contrasts, additional analyses examined within-group and between-group contrasts by condition; data are displayed in Tables 3 and 4. Groups differed in responses to Angry Statements and Questions. The TD group had significantly stronger activation in a single region, left inferior frontal gyrus (IFG), a region generally associated with higher level comprehension processes (e.g., Cooper, Hasson, & Small, 2011), as shown in Figure 1. In contrast, the ASD group exhibited significantly greater activation across multiple regions, including bilateral and right-localized regions, including right medial frontal gyrus, right superior temporal gyrus (STG), bilateral parahippocampal gyrus, right precentral gyrus, and left globus pallidus. In addition, the ASD group had left-lateralized activations for this prosodic contrast in IFG.

Grammatical Prosody Results

Examining activations in response to grammatical prosody (Neutral and Angry Questions), results indicated that the TD group had relatively greater right-lateralized responses in STG to the prosodic condition than did the ASD group. In contrast, the ASD group had stronger responses in the right anterior cingulate, right superior frontal gyrus, and bilateral middle frontal gyrus, as shown in Figure 2. The contrast between statements and questions, within the ASD group, indicated significantly greater activation in the right middle frontal gyrus, left STG, and left anterior cingulate. For the TD group, activations in response to the grammatical prosody distinctions were significant in the right middle frontal gyrus and left STG but also in the left fusiform.

DISCUSSION

The present study examined the neural characteristics of prosody perception in children with ASD and typical development, contrasting affective and grammatical forms of prosody. Given the conflicting behavioral results from studies of grammatical prosody in ASD, one primary goal was to investigate group differences in processing this form of prosodic information. A related goal was to understand the role of neural processes in underlying prosodic deficits, with the hope of clarifying whether distinct forms of prosody function similarly. Participants with ASD or typical development, matched on age, gender, and verbal IQ, completed an implicit prosody task, in which they made semantic judgments about a series of sentences in the scanner. Standard language assessment scores (CELF-Core) were included as a covariate in all MRI analyses.

Results from the semantic judgment task indicated that groups performed the explicit task with similar speed and accuracy, suggesting that they were equally attentive and engaged. In contrast to this similarity in behavioral performance, imaging results indicated salient group and condition-specific differences. Across groups, there was a main effect of condition, showing significant left-lateralized in addition to right-lateralized activation, which indicates that prosody is not straightforwardly a right-hemisphere-dominated process and rather is subserved by a complex, bilateral network of subcortical and frontal structures. Across groups, the affective prosody contrast elicited activations in language-critical regions (left IFG) reported to be involved in the processing of prosodic perception and production and correlated with affective empathy (Aziz-Zadeh, Sheng, & Gheytanchi, 2010) and sarcasm (Uchiyama et al., 2006) as well as more posterior regions (e.g., right precuneus) implicated in the brain's default network (Cavanna, 2007). Main effects of the grammatical prosody contrast, across groups, indicated activations of the left STG, part

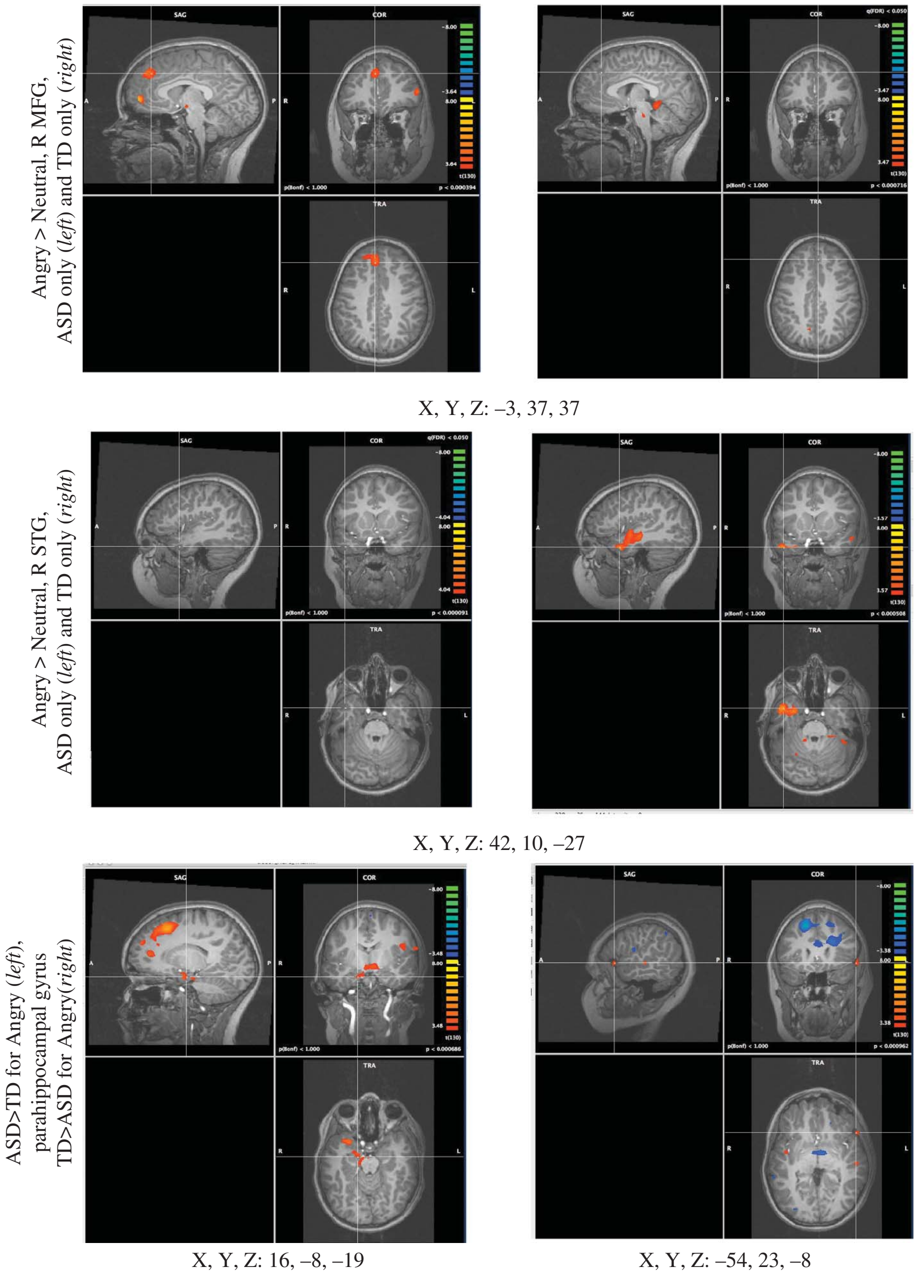

Figure 1 Brain regions of significant activation induced by affective prosodic contrasts in participants with ASD and TD.

Note. Activation maps for the ASD and TD groups obtained by comparing responses while listening to angry and neutral prosodic stimuli and making semantic judgments. Each panel shows significant foci of activation in both groups, in sagittal (top left), coronal (top right) axial (bottom) sections through stereotaxic space of activation maps superimposed onto representative brain anatomy. Stereotaxic coordinates (mm) are derived from the Talairach human brain atlas.

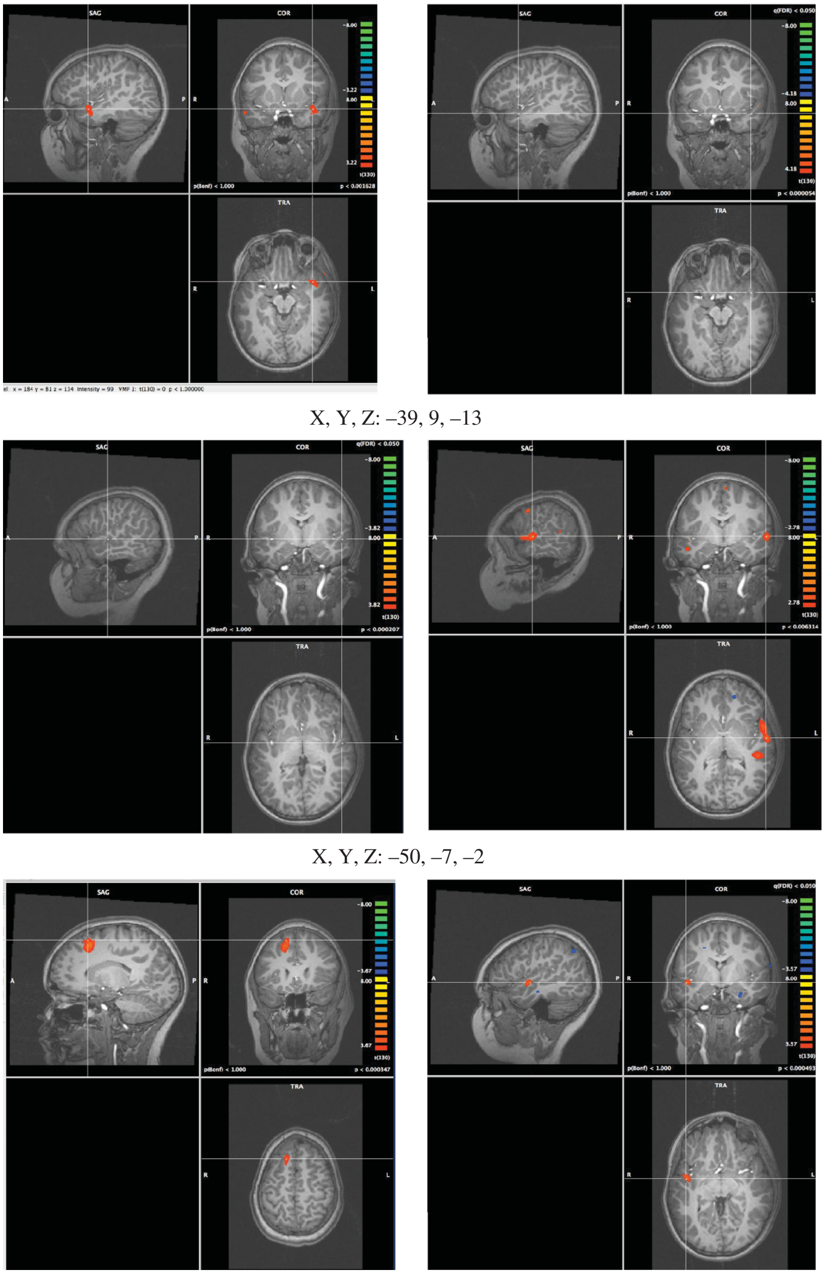

Figure 2 Regions of significant activation induced by grammatical prosodic contrasts.

of primary auditory cortex and often involved in language processes, including prelexical aspects of speech perception (Price, 2010).

Further Group × Condition analyses, focusing on responses of TD group participants, confirmed prior results indicating right lateralization of emotional prosodic cues (e.g., to right STG) and left-lateralized activations for grammatical prosodic cues (e.g., left STG), providing support for models of prosody suggesting hemispheric lateralization of distinct forms. Thus, data from the present study support both a right-lateralized as well as bilateral aspects of prosodic processing, depending upon the function of the prosodic information.

The analyses of group contrasts somewhat complicates this picture. Comparison of group patterns of performance for prosodic cues indicated distinct patterns for both affective and grammatical contrasts, suggesting a significantly different network underlying cue perception in ASD. For affective cues, participants with TD had relatively stronger activation in left IFG, a region associated with language comprehension, and particularly activated in prior studies involving prosody, empathy, and sarcasm (Aziz-Zadeh et al., 2010; Uchiyama et al., 2006). In contrast, participants in the ASD group had significantly more activation in multiple regions, including bilateral parahippocampal gyrus, potentially reflecting memory demands, or perhaps reflecting the active visualization of scenes described in task stimuli (Epstein, 2008). Participants with ASD also had greater activation in left globus pallidus, a region involved in language-relevant cognitive control (Liu, Hu, Guo, & Peng, 2010), suggesting the harnessing of more attentional control resources as they perform the comprehension task. Participants with ASD showed significant right hemisphere activations in right STG (the left homologue of which is critical in language comprehension, and an area often invoked in prosodic processing) and in right MFG, a region involved in making inferences about others' intentions (Mason & Just, 2011). Finally, activations were greater in precentral gyrus (important in motor planning and sometimes in language comprehension; Price, 2010).

There was not sufficient power to analyze effects as a function of ASD diagnostic status (that is, contrasting autistic disorder, PDD/NOS, and Asperger syndrome). Certainly, this represents an opportunity for further research, given the heterogeneity in language skills that is present across diagnostic subtypes. That said, the current results held when CELF Core Language standardized scores were entered as a covariate for fMRI analyses; this suggests that differences in patterns of brain activation were not driven solely by the lower functioning end of the ASD spectrum. Furthermore, results from an extended behavioral assessment of a larger group of children and adolescents with ASD, of which the fMRI group presents a subset, indicate that language abilities (as measured by standardized scores on the CELF and the Children's Communication Checklist, second ed., described in Bishop, 1998) were more closely associated with prosodic difficulties than either IQ scores or diagnostic subtype (Diehl & Paul, 2011). Indeed, this result appears to be consistent with the decreasing importance of diagnostic subtype distinctions in the field (American Psychiatric Association, 2011).

In general, contrasts between the ASD and TD groups for the affective prosody conditions indicated significantly more regions of activation in the ASD group, as well as the activation of regions potentially implicated in cognitive control, visualization, and some aspects of inference about mental states and intentions. It should be noted that the portion of right STG activated significantly more by the ASD group maps onto coordinates of the right temperoparietal junction (TPJ) region, identified in prior studies "theory of mind" and mental inferencing tasks (Saxe & Wexler, 2005).

On one hand, the activation of right TPJ regions might suggest that individuals with ASD are "mentalizing" during prosody perception; that is, they might experience difficulty in interpreting the speaker's communicative intent in processing the angry emotional cues. However, this brain region has also been implicated in lower level (bottom-up) computational processes involved in attentional reorienting (Decety & Lamm, 2007), as well as in service of maintenance of cognitive processes — keeping information "on line" (Ferstl & von Cramon, 2002). As such, greater involvement of this region in processing affective prosodic information could indicate that participants in the ASD group experience a relatively greater difficulty in orienting attention to salient, relevant components of the stimulus; this suggestion is consistent with prior work suggesting that when individuals with ASD are not explicitly told to direct their attention in prosodic comprehension, they perform significantly worse (Wang et al., 2006). That is, participants with ASD may fail to understand the *irrelevance* of prosodic cues to their explicit behavioral semantic judgment task and may devote disproportionate resources to this irrelevant but salient information. Alternatively, when attending to semantic cues, they may be struggling to disengage from prosodic cues, a finding consistent with prior research in which participants with ASD were unable to attend to prosodic cues when those cues conflicted with syntactic information (Diehl et al., 2008).

In response to the grammatical prosody distinction, TD participants exhibited significantly more activation in a single region, the right STG (characteristically involved in prosodic production and perception). In contrast, the ASD group showed activations across multiple regions, including those involved in error detection and cognitive control (right anterior cingulate cortex), cognitive control aspects of language (right superior frontal gyrus) often seen in bilingual language processing (Jamal, Piche, Napoliello, Perfetti, & Eden, 2011), and bilateral middle frontal gyrus. There was overlap for activations in a within-group analysis, but significant differences when groups are compared directly, particularly in regions associated with error detection and effortful control; in this case, the ASD group had significantly greater activation of these regions.

In general, findings suggested that individuals with ASD activated substantially more regions in the course of prosodic perception. Consistent with many other findings that "expertise" is associated with a reduction in activation (Aizenstein et al., 2004; Church, Coalson, Lugar, Petersen, & Schlaggar, 2008; Petrini et al., 2011), this suggests that adolescents with ASD utilize greater processing power during a straightforward linguistic task. During language comprehension, a listener rapidly makes incremental adjustments and uses multiple sources of information to resolve ambiguities (Snedeker, 2008); this demanding process may simply require more cognitive effort and attentional resources in individuals for whom language comprehension may be less efficient (e.g., Eigsti & Bennetto, 2009). This is consistent with better performance in explicit prosody tasks, when individuals know where attention and cognitive resources need to be directed, but worse performance in implicit tasks when participants must determine where to focus attention and are processing multiple levels of information (Paul et al., 2005).

The current results suggest some mechanisms (excessive cognitive control, greater resources dedicated to processing prosody, or greater overlap in processing grammatical as compared to affective prosodic cues) that may relate to prosodic impairments. Due to the implicit nature of the task, it is not possible to know whether participants were attending to prosodic cues, though the striking pattern of differential responses to the prosodic conditions suggests they were. Observed atypical patterns of activity in the ASD group could reflect domain-general difficulties in processing multiple levels of language or marshalling attention to relevant aspects of linguistic stimuli that are not specific to prosody. Studies that contrast various levels of linguistic information, such as syntactic versus semantic or syntactic versus prosodic, could clarify this possibility.

The present study extends the small literature on neural processing of prosody in ASD. It suggests that, at least for tasks in which processing of prosody is implicit, activation of neural regions is more generalized in ASD than in typical development, and areas recruited appear to reflect heightened reliance on cognitive control, reading of intentions, attentional management, and visualization. This broader recruitment of executive and "mind-reading" brain areas for a relative simple language-processing task may be interpreted to suggest that speakers with HFA have developed less automaticity in language processing. Whether a deficit in automaticity is the result of inherently inefficient networks or limited experience due to a lifetime of attenuated responses to speech input, the current paradigm cannot disambiguate. Certainly, these possibilities are not mutually exclusive. Research that contrasts a range of implicit and explicit language-processing demands and compares younger individuals for whom development is ongoing would help to answer these questions.

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STATE OF CONNECTICUT

DEPARTMENT OF PUBLIC HEALTH

Office of Health Care Access

February 10, 2014

VIA FAX ONLY

Lesley N. Salafia
University of Connecticut
Office of the General Counsel
343 Mansfield Road, Unit 1177
Storrs, CT 06269-1177

RE: Certificate of Need Application, Docket Number 14-31889-CON
University of Connecticut
Acquisition of a Magnetic Resonance Imaging Scanner at the University of Connecticut at Storrs

Dear Ms. Salafia:

On January 10, 2014, the Office of Health Care Access ("OHCA") received your Certificate of Need ("CON") application filing on behalf of the University of Connecticut ("Applicant") proposing to acquire a Magnetic Resonance Imaging ("MRI") scanner, with a total associated cost of $7,450,000.

OHCA has reviewed the CON application and requests the following additional information pursuant to Connecticut General Statutes §19a-639a(c).

1. Please revise and resubmit Financial Attachment 1 to address the following:
    a. The Applicant submitted financial projections (Appendix H) which only reflect the proposed UConn MRI Center. Since the proposed UConn MRI Center will be a part of the University of Connecticut at Storrs, please revise Attachment 1 to reflect the University at Storrs overall financials.
    b. Add a column with Fiscal Year 2013 actual results (University of Connecticut at Storrs).
    c. Please be sure to include any and all financial assumptions related to Financial Attachment 1.

2. Pursuant to §19a-639 of the Connecticut General Statutes, the Office of Health Care Access takes into consideration and makes written findings concerning each of the following guidelines and principles regarding the Medicaid population. Please explain how your

proposal addresses a through c below. If not applicable to your proposed MRI acquisition, please indicate so in your response and provide an explanation.

a. Whether the Applicant has satisfactorily demonstrated how the proposal will improve quality, accessibility and cost effectiveness of health care delivery in the region, including, but not limited to, (A) provision of or any change in the access to services for Medicaid recipients and indigent persons, and (B) the impact upon the cost effectiveness of providing access to services provided under the Medicaid program;

b. The Applicant's past and proposed provision of health care services to relevant patient populations and payer mix, including, but not limited to, access to services by Medicaid recipients and indigent persons;

c. Whether the Applicant, who has failed to provide or reduced access to services by Medicaid recipients or indigent persons, has demonstrated good cause for doing so, which shall not be demonstrated solely on the basis of differences in reimbursement rates between Medicaid and other health care payers.

In responding to the questions contained in this letter, please repeat each question before providing your response. Paginate and date your response, i.e., each page in its entirety. Information filed after the initial CON application submission (e.g., completeness response letter, prefile testimony, late file submissions and the like) must be numbered sequentially from the Applicant's document preceding it. Please begin your submission using Page 347 and reference "Docket Number: 14-31889-CON." Submit one (1) original and three (3) hard copies of your response. In addition, please submit a scanned copy of your response, in an Adobe format (.pdf) including all attachments on CD. If available, a copy of the response in MS Word should also be copied to the CD.

Pursuant to Section 19a-639a(c) of the Connecticut General Statutes, you must submit your response to this request for additional information not later than sixty days after the date that this request was transmitted. Therefore, please provide your written responses to OHCA no later than April 11, 2014, otherwise your application will be automatically considered withdrawn. If you have any questions concerning this letter, please feel free to contact me by email or at (860) 418-7007.

Sincerely,

A. Veyberman

Alla Veyberman
Health Care Analyst

* * * COMMUNICATION RESULT REPORT (FEB. 10. 2014 11:15AM) * * *

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STATE OF CONNECTICUT
OFFICE OF HEALTH CARE ACCESS

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FAX: 860.972.4650

AGENCY: HARTFORD HOSPITAL

FROM: OHCA

DATE: 2/10/14 **Time:**

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Comments: Docket Number: 13-31878

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Phone: (860) 418-7001 ***Fax: (860) 418-7053***

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UCONN
UNIVERSITY OF CONNECTICUT

Office of the General Counsel
Lesley N. Salafia
Attorney

Via Hand Delivery

February 28, 2014

RECEIVED
FEB 28 2014
Office of
HEALTHCARE ACCESS

Alla Veyberman
Health Care Analyst
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Department of Public Health
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Hartford, CT 06134

Re: Certificate of Need Application, Docket Number 14-31889-CON
University of Connecticut
Acquisition of a Human Subject Research 3T MRI Scanner at the University of Connecticut at Storrs

Dear Ms. Veyberman,

Enclosed please find the original, three (3) hard copies, and an electronic copy on CD of the University of Connecticut's responses to OHCA's February 10, 2014 completeness questions for the above-referenced CON application.

The Proposed MRI will be used for academic research purposes only and will not provide clinical or health care services or training for clinical purposes.

Please do not hesitate to contact me if I can offer additional information.

Thank you in advance for your time and attention.

Sincerely,

Lesley N. Salafia

Lesley N. Salafia

Enc.

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February 28, 2014

Certificate of Need Application
Docket Number: 14-31889-CON
University of Connecticut

Acquisition of Human Subject Research 3T MRI Scanner at the University of Connecticut at Storrs

Completeness Questions and Responses

1. Please revise and resubmit Financial Attachment 1 to address the following:

    a. The Applicant submitted financial projections (Appendix H) which only reflect the proposed UConn MRI Center. Since the proposed UConn MRI Center will be a part of the University of Connecticut at Storrs, please revise Attachment 1 to reflect the University at Storrs overall financials.

Please see attached Appendix M, which provides a revised Financial Attachment 1-A for the University of Connecticut at Storrs' overall research-based financial projections including Fiscal Year 2013 actual results. The most recent Statement of Operations presented to the University of Connecticut Board of Trustees in January 2014 is also attached within Appendix M.

As Connecticut's flagship public research university, the University has revenue streams from tuition, athletics, the State, research funds and other sources that are restricted to specific purposes, uses and appropriations. The Proposed MRI operations will be supported through the Research Fund managed by the Vice President for Research. Incorporating other revenue streams and financial forecasts from independent units within the University that are not used to support research endeavors would create more confusion than clarity for the purposes of evaluating the financial feasibility of the Proposed MRI, and thus non-research financials have been excluded from Financial Attachment 1-A.

Past annual reports of the University of Connecticut at Storrs' sponsored research endeavors for the years 2006 through 2012 are available at: http://research.uconn.edu/annual_report_archive.

The audited financial statements for the University's overall operations for FY 2013 are attached as Appendix N.

    b. Add a column with Fiscal Year 2013 actual results (University of Connecticut at Storrs).

Please see attached Appendix M, which provides a revised Financial Attachment 1-A for the University of Connecticut at Storrs' overall research-based financial projections including Fiscal Year 2013 actual results.

c. Please be sure to include any and all financial assumptions related to Financial Attachment 1.

The Research Fund Budget Assumptions are as follows:

In any given year expenditures can exceed revenue, since (as of July 1, 2013, the prior fiscal year) the Research Fund had approximately $21m in reserves from prior year gains.

Revenue:
FY15 revenue includes a 0% increase and is equal to FY14.
FY16 includes a 5% increase over the prior year.
FY17 & FY18 include a 10% increase over the prior year.

Expenditures:
FY15 & FY16 include a 2-3% increase each year over prior years.
FY17 & FY18 include a 10% increase each year over prior years.
FY16-18 assumes expenditures, plus the net of transfers in and out, will equal revenue and breakeven.

In relation to the Proposed MRI (Projected Incremental/With CON), it is assumed that there will be a billable rate of $600/hour per use time on grants. It is assumed that a .50 FTE Director, full-time Associate Director, full-time MRI Technician, and .25 FTE Physicist will be hired by FY 2016. It is expected that the Director and Associate Director will be the first hires and will staff the operation in FY 2015. It is assumed that the Supplies and Drugs expenses will have a per-procedure cost of $75 per use and that each use will be one hour; this number was obtained by MD Buyline reports for 3T MRI scanners. Fringe rates are assumed to be the standard fringe rates as projected by the University for members of the AAUP and UCPEA unions (i.e. 35.3% AAUP in FY2015; 37% AAUP / 46% UCPEA in FY2016; 38% AAUP / 47% UCPEA in FY2017; 39% AAUP / 48% UCPEA in FY2018).

The current applicable Office of Sponsored Programs Facilities & Administration rate on grants is 58% as negotiated with the Department of Health and Human Services.[1]

2. Pursuant to §19a-639 of the Connecticut General Statutes, the Office of Health Care Access takes into consideration and makes written findings concerning each of the following guidelines and principles regarding the Medicaid population. Please explain

[1] See http://osp.uconn.edu/budgetprep.php.

how your proposal addresses a through c below. If not applicable to your proposed MRI acquisition, please indicate so in your response and provide an explanation.

a. Whether the Applicant has satisfactorily demonstrated how the proposal will improve quality, accessibility and cost effectiveness of health care delivery in the region, including, but not limited to, (A) provision of or any change in the access to services for Medicaid recipients and indigent persons, and (B) the impact upon the cost effectiveness of providing access to services provided under the Medicaid program;

The Applicant, the University of Connecticut, is an institution of higher education and does not provide health care services to the region. The Proposed MRI will be for research purposes only and will not provide clinical services. This proposal will have no direct impact on health care delivery or the cost effectiveness of health care services to the region, including access to services for Medicaid recipients and indigent persons.

Indirectly, Medicaid recipients and indigent persons, along with the general population, may benefit from the basic scientific research produced utilizing the Proposed MRI in terms of future advancement of the quality, accessibility, and cost effectiveness of health care delivery services. It is expected that the research performed by the Proposed MRI will provide key insights into various areas of cognitive neuroscience, behavioral genetics, and educational neuroscience and will thus enable the continued development and improvement of health care practices and technology. As the State's flagship university, enhanced research opportunities may also contribute to the education of students who may become future health care practitioners in the State if they ultimately pursue clinical training in the health care field, thus enhancing health care delivery services to all patient populations.

b. The Applicant's past and proposed provision of health care services to relevant patient populations and payer mix, including, but not limited to, access to services by Medicaid recipients and indigent persons;

Because the University of Connecticut at Storrs is an institution of higher education and does not provide health care services or have a patient population and payer mix, this item is Not Applicable.

c. Whether the Applicant, who has failed to provide or reduced access to services by Medicaid recipients or indigent persons, has demonstrated good cause for doing so, which shall not be demonstrated solely on the basis of differences in reimbursement rates between Medicaid and other health care payers.

Because the University of Connecticut at Storrs is an institution of higher education and does not provide health care services to any patient population, this item is Not Applicable.

Indirectly, it is anticipated that the research-oriented Proposed MRI will advance the quality, accessibility, and cost effectiveness of health care delivery services to all persons in Connecticut as well as generate sustainable economic growth, ultimately positioning Connecticut as a leader in the field of biomedical research.

APPENDIX M: Revised Financial Attachment 1-A

Revised Financial Attachment I-A

12. C (i). Please provide one year of actual results and three years of projections of **Total Facility** revenue, expense and volume statistics without, incremental to and with the CON proposal in the following reporting format:

Total Facility: Description	FY 2013 Actual Results	FY 2014 Budget Results	FY 2015 Projected W/out CON	FY 2015 Projected Incremental	FY 2015 Projected With CON	FY 2016 Projected W/out CON	FY 2016 Projected Incremental	FY 2016 Projected With CON	FY 2017 Projected W/out CON	FY 2017 Projected Incremental	FY 2017 Projected With CON	FY 2018 Projected W/out CON	FY 2018 Projected Incremental	FY 2018 Projected With CON
NET GRANT REVENUE***														
Grant Revenue	$73,806,398	$69,670,150	$69,670,150	$109,200	$69,779,350	$73,153,600	$360,000	$73,513,600	$80,468,900	$600,000	$81,068,900	$88,515,700	$750,000	$89,265,700
Other Operating Revenue****	$22,913,401	$20,824,950	$20,824,950	$63,336	$20,888,286	$21,866,200	$208,800	$22,075,000	$24,052,900	$348,000	$24,400,900	$26,458,200	$435,000	$26,893,200
Revenue from Operations	$96,719,799	$90,495,100	$90,495,100	$172,536	$90,667,636	$95,019,800	$568,800	$95,588,600	$104,521,800	$948,000	$105,469,800	$114,973,900	$1,185,000	$116,158,900
OPERATING EXPENSES														
Salaries and Fringe Benefits	$51,496,713	$49,635,338	$52,799,718	$216,480	$53,016,198	$54,504,996	$373,433	$54,878,429	$60,033,496	$394,916	$60,428,412	$66,114,786	$405,681	$66,520,467
Professional / Contracted Services	$1,854,278	$1,786,860	$1,844,003	$165,000	$2,009,003	$1,903,559	$165,000	$2,068,559	$2,096,639	$165,000	$2,261,639	$2,309,025	$165,000	$2,474,025
Supplies and Drugs	$4,570,181	$4,404,017	$4,544,856	$13,650	$4,558,506	$4,691,642	$45,000	$4,736,642	$5,167,520	$75,000	$5,242,520	$5,690,981	$93,750	$5,784,731
Bad Debts	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Operating Expense	$35,653,589	$35,533,276	$32,705,231	$15,000	$32,720,231	$33,718,224	$15,300	$33,733,524	$37,002,340	$15,606	$37,017,946	$40,614,835	$15,918	$40,630,753
Subtotal	$93,574,761	$91,359,491	$91,893,808	$410,130	$92,303,938	$94,818,421	$598,733	$95,417,154	$104,299,995	$650,522	$104,950,517	$114,729,627	$680,349	$115,409,976
Depreciation/Amortization*****	$0	$0	$0	$108,667	$108,667	$0	$217,333	$217,333	$0	$217,333	$217,333	$0	$217,333	$217,333
Interest Expense	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Lease Expense	$196,165	$189,033	$195,078	$0	$195,078	$201,379	$0	$201,379	$221,805	$0	$221,805	$244,273	$0	$244,273
Total Operating Expense	$93,770,926	$91,548,524	$92,088,886	$518,797	$92,607,683	$95,019,800	$816,066	$95,835,866	$104,521,800	$867,855	$105,389,655	$114,973,900	$897,682	$115,871,582
Gain/(Loss) from Operations	$2,948,873	($1,053,424)	($1,593,786)	($346,261)	($1,940,047)	$0	($247,266)	($247,266)	$0	$80,145	$80,145	$0	$287,318	$287,318
Plus: Prior Year Research Fund Balance		$20,869,154	$19,815,730	$0	$19,815,730	$18,221,944	$0	$18,221,944	$18,221,944	$0	$18,221,944	$18,221,944	$0	$18,221,944
Revenue Over/(Under) Expense	$2,948,873	$19,815,730	$18,221,944	($346,261)	$17,875,683	$18,221,944	($247,266)	$17,974,678	$18,221,944	$80,145	$18,302,089	$18,221,944	$287,318	$18,509,262
FTEs	289	286	286	1.5	287.5	286	2.75	288.75	286	2.75	288.75	286	2.75	288.75

*Volume Statistics:
Provide projected inpatient and/or outpatient statistics for any new services and provide actual and projected inpatient and/or outpatient statistics for any existing services which will change due to the proposal.
**Not applicable as there is no MRI currently at UConn Storrs
***Since there are no patients or patient revenue, this section has been changed to grant revenue as revenue will be generated through the receipt of grant dollars per hour of usage.
****Other operating revenue would include Office of Sponsored Projects F&A rates on grants.
*****Equipment value is assumed to be $3,260,000 and the expected life of the equipment is 15 years. FY2015 is a partial year, so depreciation is halved.

University of Connecticut (Storrs & Regionals)
FY13 Statement of Current Funds Budget Operations[1] and Variance Analysis ($M)

	Budget	Actual	Variance	% Change
Current Funds Revenues:				
Operating Fund				
State Support	$292.5	$288.5	($4.0)	
Tuition	271.6	269.8	(1.8)	
Fees	104.5	102.9	(1.6)	
Grants & Contracts	61.5	65.6	4.1	
Foundation	20.0	17.6	(2.4)	
Investment Income	0.8	0.8	0.0	
Sales & Service Education	17.5	15.8	(1.7)	
Auxiliary Enterprise Revenue	185.5	188.2	2.7	
Other Revenue	5.4	7.2	1.8	
Total Operating Fund	$959.3	$956.4	($2.9)	-0.3%
Research Fund	94.6	96.7	2.1	2.2%
Total Current Funds Revenues	**$1,053.9**	**$1,053.1**	**($0.8)**	-0.1%
Current Funds Expenditures/Transfers:				
Operating Fund				
Personal Services	$425.7	$425.4	($0.3)	
Fringe Benefits	156.4	170.3	13.9	
Other Expenses	169.5	173.1	3.6	
Energy	23.7	19.7	(4.0)	
Equipment	17.9	15.2	(2.7)	
Student Financial Aid[2]	125.5	125.1	(0.4)	
Transfers	40.6	30.1	(10.5)	
Total Operating Fund	$959.3	$958.9	($0.4)	0.0%
Research Fund	95.6	93.8	(1.8)	-1.9%
Total Current Funds Expenditures/Transfers	**$1,054.9**	**$1,052.7**	**($2.2)**	-0.2%
Net Gain (Loss)[3]	**($1.0)**	**$0.4**	**$1.4**	
Reconciliation to Annual Financial Statements				
Addback Current Funds Transfers		$30.1		
Adjustment for Capitalized Items Expensed in Current Funds		(23.0)		
Depreciation Expense[4]		(91.7)		
Non-Operating Expense[5]		20.4		
Capital Deductions		26.8		
Total Change in Net Assets		**($37.0)**		
Net Assets-Beginning of Year[6]		**$1,489.1**		
Net Assets-End of Year[6]		**$1,452.1**		

[1] The University prepares and presents its Operating Budget requests and annual Spending Plan in a current funds format. The current funds format shows gross student tuition and fees and does not net out scholarship allowances, as required in the financial statements which are prepared in the GASB Nos. 34/35 format. Scholarship allowances are shown as an expense item. In addition, the University's current funds format includes equipment purchases as an expense, does not include depreciation or amortization and does not include the State debt service commitment for principal and interest.

[2] Includes $2.5 million of student work study expenditures.

[3] For the fiscal year ended June 30, 2013, the University had a net gain of $0.4 million in the Operating and Research Funds. Unrestricted ($0.7) million, Restricted $1.1 million.

[4] Not included as a budgeted item in Current Funds Budget.

[5] State Support, Gifts and Investment Income are included above in Current Funds; interest expense (net of state debt service commitment for interest) is the primary remaining component of Non-Operating Expense.

[6] Per University Audited Annual Financial Statements.

APPENDIX N: Audited Financial Statement for 2013

University of Connecticut

Financial Report
For the Year Ended June 30, 2013

Message from the Executive Vice President for Administration and Chief Financial Officer

Founded in 1881, the University of Connecticut (University) serves as the State of Connecticut's (State) flagship institution for higher education, meeting the educational needs of undergraduate, graduate, professional, and continuing education students through the integration of teaching, research, service and outreach. The University of Connecticut is a comprehensive institution of higher education which includes the University of Connecticut Health Center (Health Center). Although governed by a single Board of Trustees, the University and its Health Center maintain separate budgets and are, by statute, separate entities for purposes of maintaining operating funds and State appropriations. The Health Center also has a Board of Directors to whom the Board of Trustees has delegated certain responsibility and authority.

This financial report for the fiscal year ended June 30, 2013 represents the transactions and balances of the University, herein defined as all programs except the Health Center. This includes Storrs-based undergraduate and graduate programs, the regional campuses, the School of Law and the School of Social Work. The University's enrollment in fiscal year 2013 was 29,728 students, taught by 1,377 full-time faculty members and an additional 725 part-time faculty and adjuncts. In total, the University employs 4,624 full and part-time faculty and staff (excluding adjuncts).

The University's Board of Trustees is vested by law with fiscal oversight of the University. The operational authority granted to the University builds upon the successful implementation of legislation known as the Flexibility Acts enacted in the early 1990s. These statutory changes enabled the University to become responsible and accountable for its operational decisions independent of many of the previously imposed regulatory requirements. The University is responsible for the budgetary allocation of its State appropriation, check-writing authority, human resource control, and purchasing authority and, with the advent of the UCONN 2000 building program in 1995, management of capital projects.

While the University's operational flexibility and capacity has grown, all of these activities also take place within a context of continuing vigilance. The financial statements contained in this report reflect budget execution results consistent with spending plans and operating and capital budgets approved by the University's Board of Trustees. The Board of Trustees, through its Joint Audit and Compliance Committee, exercises oversight of the integrity of the University's financial statements and internal control systems, as well as direct engagement in the approval of independent auditing services to augment the University's internal audit capacity and the work performed by the Auditors of Public Accounts. An important component of external oversight, the Auditors of Public Accounts issue an Independent Auditors' Report on the financial statements of the University. They are responsible for auditing its financial operations and their audit opinion appears in this report.

The fiscal operations of the University are not an end in themselves—rather, the maintenance of fiscal health and stability serves the ultimate goal of enabling the University to achieve its teaching, research, service and outreach mission. Over the past decade, the growth and diversification of the University's funding streams, combined with the continuing physical transformation through UCONN 2000, have led the University to record enrollments, research success, and significant contributions to the economy of the State.

The financial condition of the University is closely tied to the State's economic condition. There are significant financial and economic challenges facing the State and the nation. Over the past several years, the University has experienced reductions in the State appropriation in addition to mandatory transfers to the State from the University's unrestricted net assets. Despite the reality of declining State support, the University is committed to continuing its high standard of service to its students and the citizens of the State.

The University continues to seek immediate and long-term efficiencies where possible while focusing on three key goals: assuring access to educational excellence, enabling the University to be a key resource for Connecticut's economic growth, and outreach to Connecticut's people. The fiscal year 2013 financial statements reflect enhanced revenues where possible and reduced expenditures through the following actions: a stringent approval process for all hires and rehires, reductions for non-personnel expenditures, and review of procurement contracts for savings opportunities.

In June 2013, the General Assembly of the State of Connecticut enacted and the Governor signed into law Public Act No. 13-233, An Act Concerning Next Generation Connecticut. The Next Generation Connecticut Act is a new initiative that will greatly expand educational opportunities, research, and innovation in the science, technology, engineering, and math disciplines at the University over the next decade. The commitment to Next Generation Connecticut is a shared fiduciary responsibility with the State. The proposed capital and operating funding for this initiative will be allocated incrementally between fiscal years 2015 and 2024. Certain goals and objectives of Next Generation Connecticut include hiring 259 new faculty members, enrolling an additional 6,580 undergraduate students, upgrading aging infrastructure to accommodate new faculty and students, and relocating the University's Greater Hartford campus.

The University enjoys strong support across the State, is attracting greater numbers of highly qualified applicants than ever before, and maintains solid national rankings in virtually all relevant areas. Among its many accomplishments, the University continues to be the top public university in New England and is among the top public universities in the nation in the annual *U.S. News and World Report (2013 America's Best Colleges)* rankings. The University is also 25th on *Kiplinger's Personal Finance's* list of 100 Best Values in Public Colleges which ranks schools that combine outstanding education with economic value.

- Undergraduate enrollment is at an all-time high, while the quality and diversity of students choosing the University has shown a documented rise every year since the mid-1990s. Compared to fall of 1995, fall 2012 freshman enrollment at the main campus was up 54%, minority freshman enrollment was up 169%, and since 1996, average SAT scores were up 113 points. 48% of these students ranked in the top 10% of their high school class.
- The University's freshman-to-sophomore retention rate at the main campus is 93% and is substantially higher than the 81% average for 382 colleges and universities in the national Consortium for Student Retention Data Exchange. The 6-year graduation rate is 82% and the average time to graduate is 4.2 years among students completing a Bachelor's degree within six years.
- Approximately 7,500 degrees were conferred in the 2012-13 school year for the completion of undergraduate, graduate and professional programs at the Storrs and regional campuses.
- Research awards for the Storrs-based program grew from $55.9 million in fiscal year 1996 to $115.5 million in fiscal year 2013.
- The endowment for both the University and the Health Center is valued at $359.5 million and is maintained by the University, The University of Connecticut Foundation, and The University of Connecticut Law School Foundation. The support provided to or on behalf of the University and the Health Center from both foundations totaled $36.0 million in 2013 for scholarships, faculty, programs and facilities.
- By the end of fiscal year 2013, the UCONN 2000 program has led to the authorization of 108 major projects totaling $2.1 billion in bond proceeds.

Respectfully Submitted,

Lysa D. Teal

Richard D. Gray
Executive Vice President for Administration
and Chief Financial Officer

Lysa D. Teal
Associate Vice President of Finance
and Budget

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STATE OF CONNECTICUT

AUDITORS OF PUBLIC ACCOUNTS
STATE CAPITOL
210 CAPITOL AVENUE
HARTFORD, CONNECTICUT 06106-1559

JOHN C. GERAGOSIAN

ROBERT M. WARD

INDEPENDENT AUDITORS' REPORT

Board of Trustees of the
University of Connecticut

Report on Financial Statements

We have audited the accompanying financial statements of the University of Connecticut (University), a component unit of the University of Connecticut system, which includes the University of Connecticut, the Health Center and the University of Connecticut Foundation, Inc., which comprise the statements of net position as of June 30, 2013 and 2012, and the related statements of revenues, expenses and changes in net position and cash flows for the years then ended, and the related notes to the financial statements.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation and fair presentation of these financial statements in accordance with accounting principles generally accepted in the United States of America; this includes design implementation, and maintenance of internal control relevant to the preparation and fair presentation of financial statements that are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audits in accordance with auditing standards generally accepted in the United States of America. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. We did not audit the financial statements of the University of Connecticut Law School Foundation, Inc., a discretely presented component unit of the University, which statements reflect total assets of $18,650,952 and $17,038,672 as of June 30, 2013 and 2012, respectively and total revenues and support of $3,076,679 and $2,260,926 for the years then ended. Those financial statements were audited by other auditors whose reports thereon have been furnished to us, and our opinion, insofar as it relates to the amounts included for the University of Connecticut Law School Foundation, Inc., is based solely on the reports of the other auditors. The audits of the University of Connecticut Law School Foundation, Inc. were conducted in accordance with auditing standards generally accepted in the United States of America.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the entity's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control. Accordingly, we express no such opinion. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of significant accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.

We believe that audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

In our opinion, based upon our audit and the reports of other auditors, the financial statements referred to above present fairly, in all material respects, the financial position of the University, as of June 30, 2013 and 2012, and the respective changes in financial position and cash flows for the years then ended in accordance with accounting principles generally accepted in the United States of America.

The accompanying Management's Discussion and Analysis on pages 4 through 17 is required by accounting principles generally accepted in the United States of America to supplement the basic financial statements. Such information, although not part of the basic financial statements, is required by the Governmental Accounting Standards Board who considers it to be an essential part of financial reporting for placing the basic financial statements in an appropriate operational, economic, or historical context. We have applied certain limited procedures to the required supplementary information in accordance with auditing standards generally accepted in the United States of America, which consisted of inquires of management about the methods of preparing the information and comparing the information for consistency with management's responses to our inquires, the basic financial statements, and other knowledge we obtained during our audit of the basic financial statements. We do not express an opinion or provide any assurance on the information because the limited procedures do not provide us with sufficient evidence to express an opinion or provide any assurance.

Sincerely,

Robert M. Ward
Auditor of Public Accounts

John C. Geragosian
Auditor of Public Accounts

January 17, 2014
State Capitol
Hartford, Connecticut

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MANAGEMENT'S DISCUSSION AND ANALYSIS

Management's Discussion and Analysis

INTRODUCTION

The following Management's Discussion and Analysis (MD&A) is required supplemental information. Its purpose is to provide users of the basic financial statements with a narrative introduction, overview, and analysis of those statements. The MD&A, which is unaudited, includes an analysis of the financial position and results of activities of the University of Connecticut (University, as defined below) for the fiscal year ended June 30, 2013, based on currently known facts, decisions, or conditions. It also includes selected comparative information for the years ended June 30, 2012 and 2011, and certain amounts previously reported have been reclassified in order to conform to the current year presentation. As the MD&A presentation includes highly summarized information, it should be read in conjunction with the accompanying financial statements and related notes to the financial statements. The financial statements, notes to the financial statements, and this MD&A are the responsibility of management.

Founded in 1881, the University of Connecticut serves as the State of Connecticut's (State) flagship for higher education, meeting the educational needs of undergraduate, graduate, professional, and continuing education students through the integration of teaching, research, service and outreach. The University of Connecticut is a comprehensive institution of higher education, which includes the University of Connecticut Health Center (Health Center). Although governed by a single Board of Trustees, the University and the Health Center maintain separate budgets and are, by statute, separate entities for purposes of maintaining operating funds and State appropriations. The Health Center also has a Board of Directors to whom the Board of Trustees has delegated certain responsibility and authority.

This financial report for the fiscal year ended June 30, 2013 represents the transactions and balances of the University, herein defined as all programs except the Health Center. This includes Storrs-based undergraduate and graduate programs, the regional campuses, the School of Law and the School of Social Work.

In accordance with the current authoritative guidance issued by the Governmental Accounting Standards Board (GASB), The University of Connecticut Law School Foundation, Inc. (Law School Foundation) is included as a component unit with the University (see Note 1). A related, but independent, corporate entity, The University of Connecticut Foundation, Inc. (Foundation), operates exclusively for charitable and educational purposes, raising funds to promote, encourage, and assist education and research at the University and the Health Center (see Note 12). The Foundation solicits and accepts donations of properties, monies, and securities and invests and administers these gifts. The Foundation materially supports the mission of both the University and the Health Center which are separately audited, producing their own financial statements. Displaying the Foundation's financial statements as a component unit of either the University or the Health Center would distort its actual contribution or economic benefit to that entity, and therefore the Foundation is not included as a component unit in the accompanying financial statements.

The University adopted GASB Statement No. 63, *Financial Reporting of Deferred Outflows of Resources, Deferred Inflows of Resources and Net Position*, as of July 1, 2012. This Statement amends the net asset reporting requirements defined in previously issued pronouncements by incorporating deferred outflows of resources and deferred inflows of resources into the definitions of the required components of the residual measure and by renaming that measure from net assets to net position. The deferred outflows and inflows represent the consumption or acquisition of resources by the University that are applicable to a future reporting period, but do not require further exchange of goods or services. These changes have been reflected in the MD&A, accompanying financial statements and notes to the financial statements.

Effective for the fiscal year ended June 30, 2013, the University changed its practice of accruing construction retainage in order to conform with the provisions of authoritative guidance currently in effect. This change was applied retrospectively to the balances presented on the Statement of Net Position for the fiscal year ended June 30, 2012, but did not affect beginning net position (see Note 1). For purposes of the MD&A, certain amounts were also restated for fiscal year 2012.

The University's Board of Trustees is vested by law with fiscal oversight of the University. The operational authority granted to the University builds upon the successful implementation of several pieces of legislation known as the Flexibility Acts, enacted in the early 1990s. These statutory changes enabled the University to become responsible and accountable for its operational decisions independent of many of the previously imposed regulatory requirements. The University is now responsible for the budgetary allocation of its State appropriation, check-writing authority, human resource control, purchasing authority and, with the advent of UCONN 2000 in 1995, management of capital projects.

While the University's operational flexibility and capacity has grown, all of these activities also take place within a context of continuing external review. The financial statements contained in this report reflect budget execution results consistent with spending plans and operating and capital budgets approved by the University's Board of Trustees. The Auditors of

Public Accounts issue an Independent Auditors' Report on the financial statements of the University. They are responsible for auditing its financial operations and their opinion appears on pages 1 and 2.

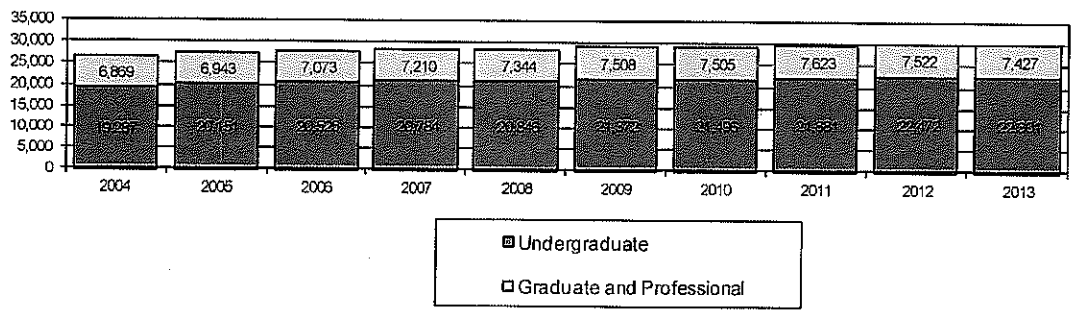
FINANCIAL HIGHLIGHTS AND ECONOMIC OUTLOOK

The University submits a separate biennial operating budget request to the Governor through the Secretary of the Office of Policy and Management (the Governor's fiscal office). The General Assembly appropriates funds upon passage of the annual appropriations bill. In general, the Governor may reduce State agency allotments by not more than 5%, although the General Assembly can approve additional reductions requested by the Governor in order to prevent a deficit in the State budget.

The financial statements contained herein show an operating loss of $367.9 million for the year ended June 30, 2013 (fiscal year 2013) as compared to $340.5 million for the year ended June 30, 2012 (fiscal year 2012), and $376.9 million for the year ended June 30, 2011 (fiscal year 2011). The increase in operating loss in fiscal year 2013 from fiscal year 2012 was due to an increase in total operating expenses of 4.4%, primarily attributed to an increase in fringe benefit rates in addition to an increase in commodities, supplies, and other expenses. The decrease in operating loss in fiscal year 2012 from fiscal year 2011 was due to an increase in total operating revenues of 2.8%, primarily attributed to an increase in undergraduate enrollment, tuition and fees, and board and room fees. There was also a 2.0% decrease in total operating expenses, as result of cost saving measures implemented during the year. For public institutions, the measure more indicative of normal and recurring activities is income or loss before other changes in net position, which includes revenue from the State appropriation. The University experienced a loss before other changes in net position of $63.9 million in fiscal year 2013 as compared to $41.9 million and $49.9 million for fiscal years 2012 and 2011, respectively. Total operating revenues grew $14.4 million in fiscal year 2013 and $16.7 million in fiscal year 2012. At the same time, operating expenses increased $41.7 million in fiscal year 2013 as compared to a decrease in fiscal year 2012 of $19.6 million from fiscal year 2011. Investment income decreased $0.04 million in fiscal year 2013, $0.1 million in fiscal year 2012 and $0.3 million in fiscal year 2011.

Sources of recurring revenues continued to exhibit strength. The University's total enrollment in fiscal year 2003 topped 25,000 students and grew to 29,728 students in fiscal year 2013. These students are taught by 1,377 full-time faculty members (an increase of 47 faculty over the prior year) and an additional 725 part-time faculty and adjuncts. Undergraduate enrollment at the University reached 22,301 students in fiscal year 2013, 0.8% less than fiscal year 2012 (2.7% more students in fiscal year 2012 over 2011). At the same time, an in-state tuition and mandatory fee increase of 6.5% and an out-of-state increase of 5.9% were approved for fiscal year 2013. Graduate and professional enrollment decreased by 1.3% with an in-state tuition and mandatory fee increase of 6.1% and an out-of-state increase of 5.8%. The net decrease in overall enrollment, when combined with the tuition and mandatory fee increases, resulted in an increase in tuition and fee revenue, before scholarship allowances, of $15.5 million (4.3%) as compared to a $19.2 million (5.6%) increase in fiscal year 2012. Sales and services of auxiliary enterprises, before scholarship allowances, increased $3.1 million (1.7%), primarily as a result of an overall increase in room and board fees of 3.0% for undergraduate and 3.6% for graduate students and a decrease in room occupancy of 2.4% from fiscal year 2012. In fiscal year 2012, sales and services of auxiliary enterprises, before scholarship allowances, increased $3.3 million (1.8%), primarily as a result of an overall increase in room and board fees of 2.5% for undergraduate and graduate students and an increase in room occupancy of 1.6% over fiscal year 2011. Grant and contract revenues increased $0.1 million (0.1%) in fiscal year 2013 as compared to a decrease of $4.9 million (3.0%) in fiscal year 2012 from 2011.

HEADCOUNT ENROLLMENT IN FALL OF EACH FISCAL YEAR
TEN YEAR COMPARISON



The University has received reductions in State funding as a result of a continuing economic recession and the State's commitment to a balanced budget. Prior to increases in fringe benefit rates, the State rescinded approximately $15.0 million in appropriation and payments for fringe benefits in response to a widening State budget deficit in fiscal year 2013. In fiscal year 2012, the University experienced a reduction of approximately $39.4 million in appropriation and payments for fringe benefits from the State. In fiscal year 2011, the University also transferred $15.0 million from unrestricted funds to the State's General Fund as a result of a deficit mitigation plan implemented by the State. These funds have not been restored to the University and further reductions in State support of approximately $1.2 million are anticipated in fiscal year 2014 for required adjustments to agency-specific appropriations in accordance with Public Act 13-184, as amended by Public Act 13-247. In response to these measures, the University continues to seek immediate and long-term efficiencies where possible while focusing on three key goals: assuring access to educational excellence, enabling the University to be a key resource for Connecticut's economic growth, and outreach to Connecticut's people. Despite the reality of declining State support, the University is committed to continue its high standard of service to its students and the citizens of the State.

Pursuant to various public or special bond acts, the General Assembly empowers the State Bond Commission to authorize and approve bonds for a variety of projects or purposes. In August 2011, the State Bond Commission approved the issuance of $18.0 million in State General Obligation Bonds to finance the initial design and development costs of the Technology Park (Tech Park) on the Storrs campus. In April 2013, the State Bond Commission approved an additional issuance of $20.0 million in State General Obligation Bonds to purchase equipment for the Tech Park. The total cost of the project is estimated to be approximately $172.5 million. This project will drive technology-based economic development by creating a partnership between UConn and industry, where the University will support the growth of companies by offering access to advanced technology, faculty expertise, along with providing incubator space for new companies. The Tech Park will be a critical component of the State's plan to stimulate long-term economic growth by supporting innovation, new technologies and the creation of new companies and sustainable jobs.

The UCONN 2000 Infrastructure Improvement Program, established by The University of Connecticut 2000 Act (UCONN 2000), is designed to modernize and expand the physical plant of the University and the Health Center. As amended, it provides for a twenty-nine year capital budget program in three phases, estimated to cost $4.6 billion. The UCONN 2000 Act was originally adopted in 1995 to authorize and finance the UCONN Phase I and Phase II projects at the University. It was amended in 2002, to add Phase III projects, and again in fiscal years 2010 and 2011 which extended the UCONN 2000 program for two more years and increased the estimated cost for certain Health Center projects. In June 2013, the General Assembly of the State of Connecticut enacted and the Governor signed into law Public Act No. 13-233, An Act Concerning Next Generation Connecticut (Next Generation Connecticut), which increased the authorized bond funding by $1.6 billion, which also includes funding for the Health Center, and extended UCONN 2000 for an additional six fiscal years to 2024.

Next Generation Connecticut is a new initiative that will greatly expand educational opportunities, research, and innovation in the science, technology, engineering, and math disciplines at the University over the next decade. The commitment to Next Generation Connecticut is a shared fiduciary responsibility with the State. Proposed capital and operating funding for Next Generation Connecticut will be allocated incrementally between fiscal years 2015 and 2024. Additionally, the University will commit significant institutional resources to launch Next Generation Connecticut by contributing approximately $235.0 million in reallocated UCONN 2000 funds for the Next Generation Connecticut building program and approximately $149.0 million in operating funds to support the academic program components. The total State request for operating funds is $137.0 million through fiscal year 2024, however such funding is not guaranteed. Certain goals and objectives of Next Generation Connecticut include hiring 259 new faculty members, enrolling an additional 6,580 undergraduate students, upgrading aging infrastructure to accommodate new faculty and students, and relocating the University's Greater Hartford campus.

FINANCIAL STATEMENTS

GASB Statement No. 35, *Basic Financial Statements - and Management's Discussion and Analysis - for Public Colleges and Universities*, as amended by GASB Statement No. 63, establishes standards for financial reporting for public colleges and universities. The University's financial report includes three basic financial statements: Statements of Net Position; Statements of Revenues, Expenses, and Changes in Net Position; and Statements of Cash Flows. In addition, the following elements are included with these general-purpose financial statements: Management's Discussion and Analysis and Notes to the Financial Statements. GASB Statement No. 35 focuses on the University as a whole rather than on accountability by individual fund groups and provides accounting and financial reporting guidelines, enhancing the usefulness and comprehension of financial reports by external users. The adoption of these standards resulted in the conversion from fund accounting statements to statements presented in a single-column format.

The financial statements reflect budget execution results consistent with operating budgets and spending plans approved by the University's Board of Trustees. The University prepares and presents its Operating Budget requests and annual Spending Plan in a current funds format.

STATEMENTS OF NET POSITION

The Statements of Net Position present the assets, deferred outflows of resources, liabilities, deferred inflows of resources, and net position of the University as of the end of the fiscal year, June 30. The Statements of Net Position are a point in time financial statement – a snapshot – and a measure of the financial condition of the University. These statements present end-of-year data concerning assets, classified as current (those available for use within one year) and noncurrent (those available beyond one year), liabilities, categorized as current (those maturing and due within one year) and noncurrent (those maturing and due after one year) and net position. Net position represents assets, plus deferred outflows, less liabilities, less deferred inflows. Assets represent what is owned by or what is owed to the University, including payments made to others before a service was received. Assets are recorded at their current value, except for property and equipment which are recorded at historical cost, net of accumulated depreciation and amortization. Liabilities represent what is owed to others or what has been received from others prior to services being provided by the University. Deferred outflow of resources represent the consumption of net assets by the University that is applicable to a future reporting period, while deferred inflow of resources is an acquisition of net assets by the University that is applicable to a future reporting period.

The Statements of Net Position demonstrate the assets available to continue the operations of the University. The University's net position is the residual value in the University's assets and deferred outflows, after liabilities and deferred inflows are deducted. Over time, an increase in net position is an indicator of the University's improving financial strength.

The following table shows condensed Statements of Net Position at June 30 (in millions):

	2013	2012*	2011
Current assets	$ 500.4	$ 612.3	$ 500.6
Noncurrent assets			
State debt service commitment	751.0	828.8	735.0
Investments	10.6	10.3	10.7
Property and equipment, net	1,474.6	1,430.6	1,399.3
Other	19.0	19.8	19.3
Total assets	$2,755.6	$2,901.8	$2,664.9
Current liabilities	$ 293.5	$ 310.5	$ 268.3
Noncurrent liabilities			
Long-term debt and bonds payable	988.9	1,082.4	978.1
Other	21.2	19.8	23.2
Total liabilities	$1,303.6	$1,412.7	$1,269.6
Net investment in capital assets	$1,222.1	$1,163.4	$1,144.9
Restricted	75.7	156.6	75.0
Unrestricted	154.2	169.1	175.4
Total net position	$1,452.0	$1,489.1	$1,395.3

*As restated

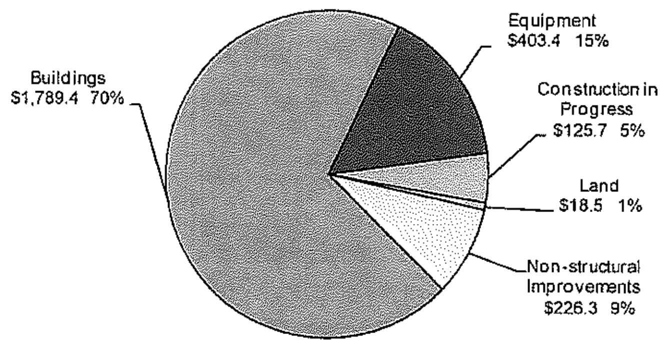
The total assets decreased $146.2 million in fiscal year 2013 from 2012 as compared to an increase of $236.9 million in fiscal year 2012 over 2011. The decrease in fiscal year 2013 was primarily attributed to the $119.5 million decrease in deposit with bond trustee ($106.8 million increase in fiscal year 2012).

The total liabilities for fiscal year 2013 decreased $109.1 million ($143.2 million increase in fiscal year 2012) primarily due to the retirement and refundings of debt on existing bonds and loans of $192.3 million in fiscal year 2013 ($126.1 million in fiscal year 2012) offset by newly acquired debt of $102.8 million ($238.1 million in fiscal year 2012). The combination of the decrease in total assets of $146.2 million ($236.9 million increase for fiscal year 2012) and total liabilities of $109.1 million ($143.2 million increase for fiscal year 2012) yields a decrease in total net position of $37.1 million ($93.8 million increase in fiscal year 2012).

Capital and Debt Activities

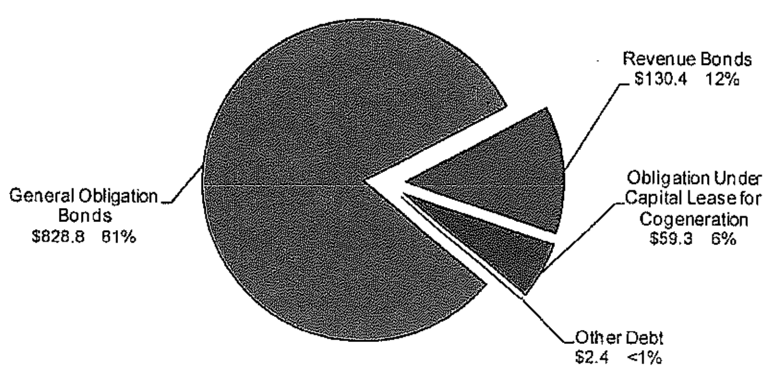
During fiscal year 2013, the University recorded additions to property and equipment totaling $136.1 million ($120.5 million and $93.1 million in fiscal years 2012 and 2011, respectively) of which $110.9 million related to buildings and construction in progress ($91.0 million and $69.2 million in fiscal years 2012 and 2011, respectively). The growth of the University's property and equipment is a direct result of the successful UCONN 2000 program. Subsequent to the year ended June 30, 2013, it was determined by management that buildings with a total carrying amount of approximately $24.5 million were potentially impaired as of year-end; however, the total impairment loss could not be reasonably estimated as of the date of the accompanying financial statements (see Note 4). The following pie chart presents the total property and equipment at cost:

TOTAL PROPERTY AND EQUIPMENT AT COST AT JUNE 30, 2013
($ in Millions) Total $2,563.3



In fiscal year 2013, the University did not issue UCONN 2000 general obligation bonds ($179.7 million in fiscal year 2012 of which $62.5 million was committed to the Health Center for its UCONN 2000 projects. See Note 5). The State has made a commitment to fund the University for all principal and interest payments due on UCONN 2000 general obligation debt. As the general obligation debt is incurred, the commitment from the State is recorded as a current and noncurrent receivable (State debt service commitment in the accompanying Statements of Net Position). When bonds are issued, the amount of the commitment for the Health Center is reflected as a liability by the University. Subsequent to the year ended June 30, 2013, the University issued a combined $223.9 million, with a closing date of July 31, 2013, to fund UCONN 2000 projects and to refund portions of outstanding general obligation bonds (see Note 5). The following chart illustrates the categories of debt as of June 30, 2013, exclusive of premiums, discounts and debt differences due to refunding:

CATEGORIES OF DEBT AT JUNE 30, 2013
($ in Millions) Total $1,020.9

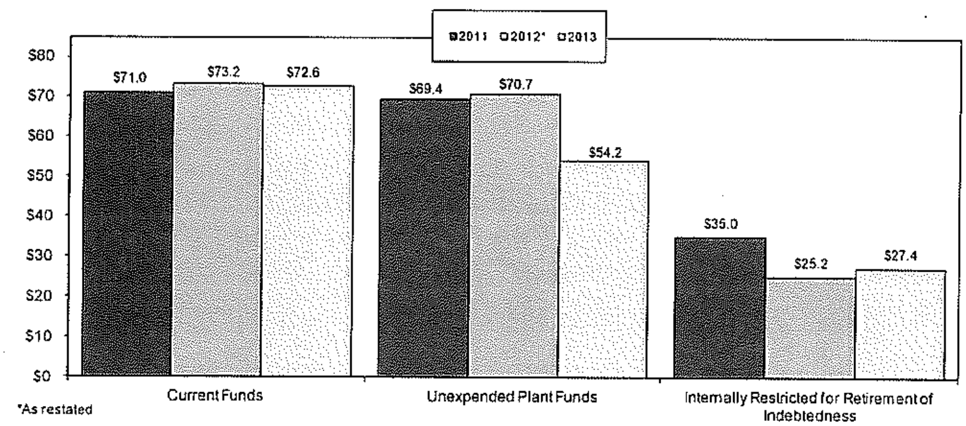


See Notes 4 and 5 of the financial statements for further information on capital and debt activities.

Net Position

Net position is divided into three major categories. The first category, net investment in capital assets, represents the University's equity in property and equipment. The restricted net position category is subdivided into nonexpendable and expendable. The corpus of restricted nonexpendable resources is only available for investment purposes, and in the University's Statements of Net Position this amount represents endowment assets. Expendable restricted net position is available for expenditure by the institution, but must be spent for purposes determined by donors and/or external entities that have placed time or purpose restrictions on the use of the assets. The final category is unrestricted net position. Unrestricted net position is defined by GASB Statement Nos. 35 and 63 to include funds not restricted by third-parties, including all unrestricted funds formerly (prior to fiscal year 2002) included in the balances of unrestricted current funds, retirement of indebtedness funds, and plant funds on the Statements of Net Position. Unrestricted net position may be designated for specific purposes by action of management or the Board of Trustees or may otherwise be limited by contractual agreements with outside parties. GASB prohibits a breakout of designated unrestricted funds on the face of the Statements of Net Position. Unrestricted funds are available to the University for any lawful purpose of the institution. The following shows a comparison between fiscal years by category of unrestricted net position:

UNRESTRICTED NET POSITION ($ in Millions)



For the most part all unrestricted funds are internally designated for academic and research programs, capital programs, retirement of debt, and auxiliary enterprise activities.

STATEMENTS OF REVENUES, EXPENSES, AND CHANGES IN NET POSITION

Revenues and expenses are classified as operating, nonoperating, or other changes in net position according to definitions prescribed by GASB. Significant recurring sources of nonoperating revenues utilized in balancing the operating loss each year include State appropriation for general operations, State debt service commitment for interest, noncapital gifts, and short-term investment income. By its very nature, a State funded institution does not receive tuition, fees, and room and board revenues sufficient to support the operations of the University. Therefore, these nonoperating revenues are essential to the programs and services provided by the University. Unless a significant increase in tuition and fees and room and board revenues occurs, the University will always show a loss from operations.

The University performed a review of the categorization of functional expenses and certain reclassifications were made to the Statements of Revenues, Expenses, and Changes in Net Position for the years ended June 30, 2012 and 2011 to better reflect the appropriate classifications in accordance with applicable guidance. These increases (decreases) have no effect on operating loss or net position for the years indicated and are summarized in the table below (in millions):

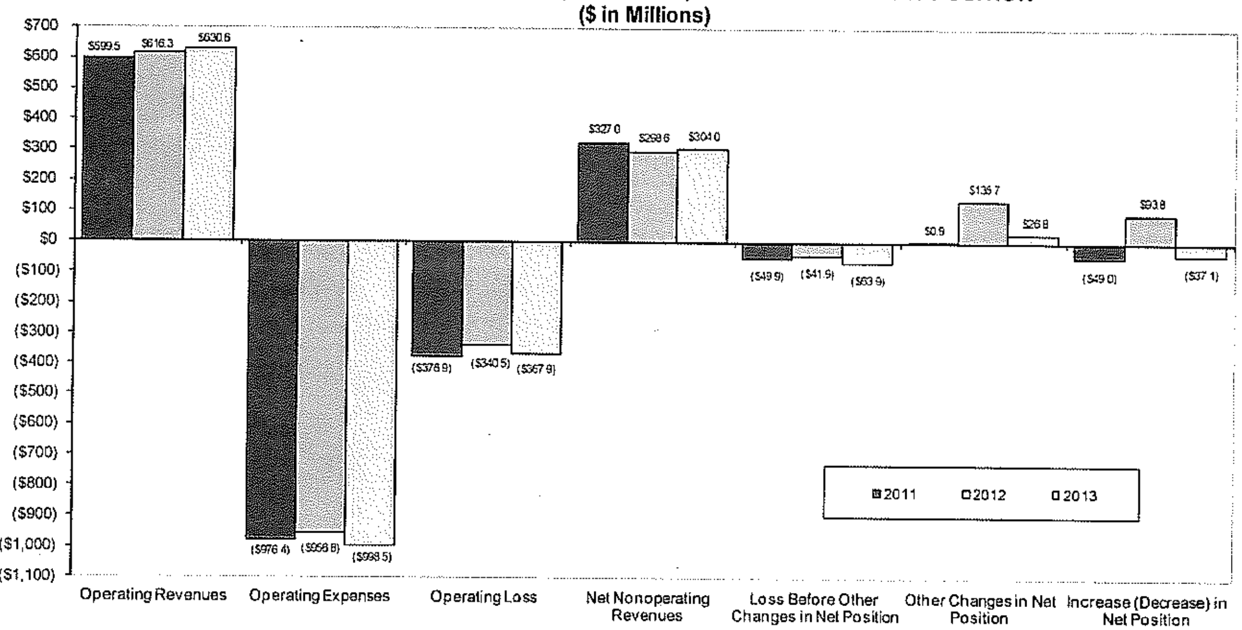
	2012	2011
Instruction	$ (4.3)	$ (4.8)
Research	0.7	0.7
Public service	(4.2)	(4.1)
Academic support	8.2	9.1
Student services	(3.8)	(3.7)
Institutional support	(25.6)	(20.1)
Operations and maintenance of plant	35.5	38.0
Auxiliary enterprises	5.1	4.6
Other operating expenses	(11.6)	(19.7)
Total operating expenses	$ -	$ -

The following table shows condensed Statements of Revenues, Expenses, and Changes in Net Position for the fiscal years ended June 30 (in millions):

	2013	2012	2011
Operating revenues	$ 630.6	$ 616.3	$ 599.5
Operating expenses	998.5	956.8	976.4
Operating loss	(367.9)	(340.5)	(376.9)
Net nonoperating revenues	304.0	298.6	327.0
Loss before other changes in net position	(63.9)	(41.9)	(49.9)
Net other changes in net position	26.8	135.7	0.9
Increase (decrease) in net position	$ (37.1)	$ 93.8	$ (49.0)

While the Statements of Net Position present the financial condition at a point in time, the Statements of Revenues, Expenses, and Changes in Net Position represent the activity for a period of time – one year. These statements present either an increase or decrease in net position based on the revenues received by the University, both operating and nonoperating, the expenses paid by the University, operating and nonoperating, and any other revenues, expenses, gains and losses received or spent by the University.

STATEMENTS OF REVENUES, EXPENSES, AND CHANGES IN NET POSITION
($ in Millions)



Generally, operating revenues are earned when providing goods and services to the various customers of the University. Operating expenses are incurred in the normal operation of the University and represent those expenses paid to acquire or produce the goods and services provided in return for the operating revenues. Operating expenses also include the provision for estimated depreciation and amortization of property and equipment. The difference between operating revenues and operating expenses is the operating income or loss. The University typically experiences an operating loss each year because State appropriation, the University's largest source of revenue, is not included as operating income.

Nonoperating revenues are revenues received for which goods and services are not provided, including State appropriation and State debt service commitment for interest. Such revenues are provided by the State to the University without the State directly receiving commensurate goods and services in exchange for those revenues. Nonoperating revenues (expenses) also include noncapital gifts, investment income, interest expense, and other expenses not considered operating expenses.

Other changes in net position are comprised of the State's debt service commitment for principal payments on general obligation bonds used for capital purposes, capital allocation, capital grants and gifts, the disposal of property and equipment, and additions to permanent endowments. The Statements of Revenues, Expenses, and Changes in Net Position reflect a decrease in the net position of $37.1 million in fiscal year 2013, an increase in the net position of $93.8 million in fiscal year 2012, and a decrease of $49.0 million in fiscal year 2011.

Revenues

The following table summarizes operating and nonoperating revenues and other changes in net position for the fiscal years ended June 30 (in millions):

	2013	2012	2011
Operating revenues:			
Student tuition and fees, net	$ 261.7	$ 251.0	$ 233.9
Grants and contracts	159.8	159.7	164.5
Sales and services of educational departments	15.8	17.4	16.2
Sales and services of auxiliary enterprises, net	185.2	182.0	178.5
Other sources	8.1	6.2	6.4
Total operating revenues	630.6	616.3	599.5
Nonoperating revenues:			
State appropriation	288.4	282.4	329.0
State debt service commitment for interest	40.6	39.8	40.0
Gifts	20.0	24.3	21.1
Investment income	0.9	0.9	1.0
Total nonoperating revenues	349.9	347.4	391.1
Other changes in net position:			
State debt service commitment for principal	-	115.4	-
Capital allocation	20.0	18.0	-
Capital grants and gifts	6.7	2.8	2.0
Disposal of property and equipment, net and additions to permanent endowments	0.1	-	-
Total other changes in net position	26.8	136.2	2.0
Total revenues	$ 1,007.3	$ 1,099.9	$ 992.6

Revenue highlights, for fiscal years 2013 and 2012 and comparison between fiscal years, including operating and nonoperating revenues and other changes in net position, presented on the Statements of Revenues, Expenses, and Changes in Net Position are as follows:

- Student tuition and fees, net of scholarship allowances, increased 4.2% in fiscal year 2013 (7.3% in fiscal year 2012) and 4.3% before scholarship allowances (5.6% in fiscal year 2012). The increase in fiscal year 2013 was due in part to a 6.5% increase (2.4% in fiscal year 2012) for undergraduate in-state tuition and mandatory fees charged, and a 5.9% increase (2.6% in fiscal year 2012) for out-of-state tuition and mandatory fees offset by a decrease of 0.8% in undergraduate enrollment (2.7% increase in fiscal year 2012) and a 1.3% decrease in graduate enrollment (1.3% in fiscal year 2012).

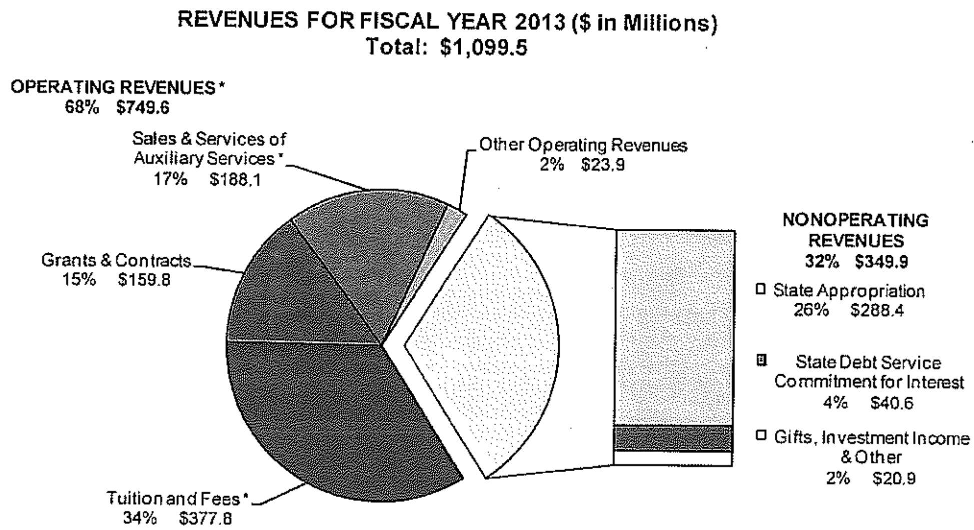
- Total grants and contracts increased $0.1 million (0.1%) in fiscal year 2013 ($4.9 million or 3.0% decrease in fiscal year 2012) primarily due to a $5.9 million (16.7%) increase in state, local, and nongovernmental grant aid offset by a $5.8 million (4.6%) decrease in federal funding primarily due to sequestration cuts during fiscal year 2013.

- Sales and services of auxiliary enterprises, net of scholarship allowances, increased approximately 1.8% and 2.0% during fiscal years 2013 and 2012, respectively. The increase in fiscal year 2013 resulted from an increase in fees charged for both room and board of 3.0% for undergraduate and 3.6% for graduate students offset by a decrease in room occupancy of 2.4% from fiscal year 2012. The increase in fiscal year 2012 resulted from an increase in fees charged for both room and board of 2.5% for undergraduate students and graduate students and an increase in room occupancy of 1.6% over fiscal year 2011.

- The largest source of revenue, State appropriation including fringe benefits, increased $6.1 million in fiscal year 2013 compared to a decrease of $46.6 million in fiscal year 2012. The State appropriation is included in the nonoperating section. The State also provides State debt service commitment for the interest payments made annually on general obligation bonds. State debt service commitment for interest revenue is included with nonoperating revenues and corresponds to the total interest paid and accrued on general obligation bonds. Effectively, this revenue offsets a significant portion of interest expense each year. Also, as general obligation bonds are issued (see Note 5) the State commits to the repayment of the future principal amounts and a receivable is recorded on the Statements of Net Position to reflect this commitment. This results in revenue that is recorded in other changes in net position that totaled $115.4 million in fiscal year 2012. There were no general obligation bonds issued in fiscal year 2013. Included in other changes in net position, the State also allocated $20.0 million to purchase equipment in fiscal year 2013 and $18.0 million for design and development costs in fiscal year 2012 for the Tech Park on the Storrs campus (see Note 12).

- Gift revenue, both capital and noncapital, is derived from gifts made directly to the University and from the Foundation and the Law School Foundation. These spendable funds are provided to the University for educational, cultural, recreational, and research activities. Both the Foundation and the Law School Foundation disburse funds to the University as requests are made, provided the request is in accordance with donor restrictions, if any. These gifts, including capital gifts, received by the University from both Foundations in fiscal years 2013 and 2012 totaled approximately $22.9 million for each year. On a combined basis, both Foundations also paid approximately $3.0 million in fiscal year 2013 ($3.1 million in fiscal year 2012) to third parties on behalf of the University. This amount is not reflected in the University's financial statements. Total nonoperating gifts and capital grants revenue to the University from all sources amounted to $26.7 million and $27.1 million in fiscal years 2013 and 2012, respectively.

Revenues, excluding other changes in net position, come from a variety of sources and are illustrated in the following graph:



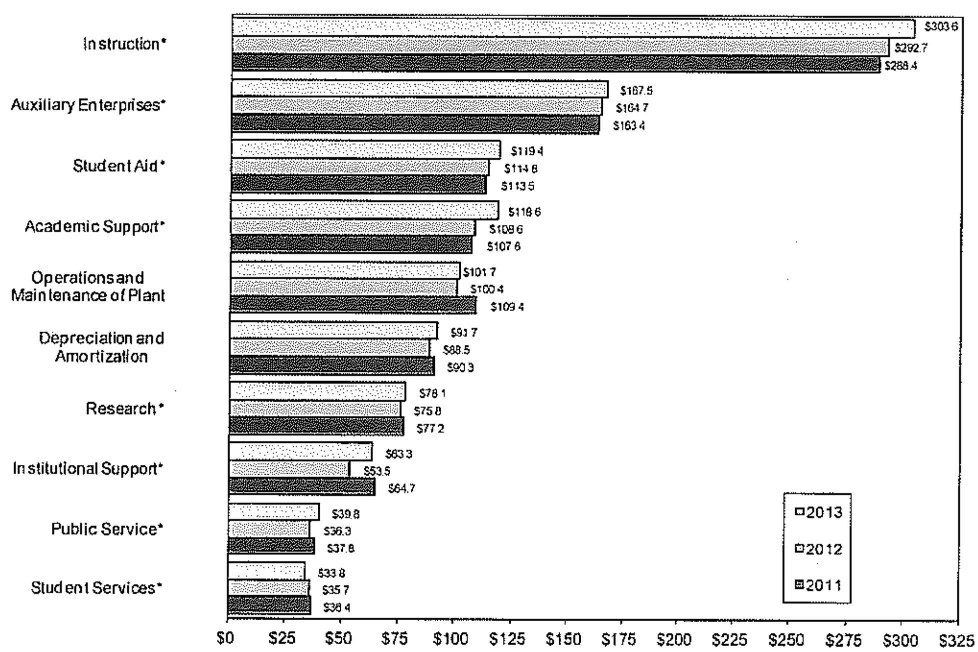
* Shown here at gross amounts, not netted for student financial aid totaling $119.0 million.

Expenses
The following table summarizes operating and nonoperating expenses and other changes in net position for the fiscal years ended June 30 (in millions):

	2013	2012	2011
Operating expenses:			
Instruction	$ 302.2	$ 291.4	$ 287.4
Research	74.9	73.5	75.2
Operations and maintenance of plant	101.7	100.4	109.4
Auxiliary enterprises	167.5	164.4	163.1
Depreciation and amortization	91.7	88.5	90.3
Other	260.5	238.6	251.0
Total operating expenses	998.5	956.8	976.4
Nonoperating expenses:			
Interest expense	45.4	47.1	48.8
Transfers to State General Fund	-	-	15.0
Other nonoperating expense, net	0.5	1.7	0.3
Total nonoperating expenses	45.9	48.8	64.1
Other changes in net position:			
Capital allocation	-	-	0.5
Disposal of property and equipment, net	-	0.5	0.6
Total other changes in net position	-	0.5	1.1
Total expenses	$ 1,044.4	$ 1,006.1	$ 1,041.6

Operating expenses are classified by function in the accompanying Statements of Revenues, Expenses, and Changes in Net Position. These functions directly contribute to the major mission of the University. Certain amounts previously reported in fiscal years 2012 and 2011 have been reclassified in order to conform to the current year presentation. The following chart depicts comparative functional expenses of the University. It does not include other operating expenses:

EXPENSES BY FUNCTIONAL CLASSIFICATION
($ in Millions)



*Shown here at gross amounts, not netted for financial aid totaling $119.0 million.

Total operating expenses were $998.5 million and $956.8 million in fiscal years 2013 and 2012, respectively, netted for student financial aid totaling $119.0 million and $114.2 million, respectively. Natural classification includes salaries, fringe benefits, utilities, and supplies and other expenses (see Note 14 for operating expenses by natural classification).

Highlights of expenses presented on the Statements of Revenues, Expenses, and Changes in Net Position are as follows:

- Instruction, the University's largest operating expense, increased $10.8 million (3.7%) primarily due to a net increase of approximately 66 full-time equivalent faculty and staff that was mainly a result of a major expansion of faculty. In addition, there was an increase in fringe benefit rates. These increases were offset by a 6.6% decrease in supplies and other expenses. In fiscal year 2012, instruction increased $4.0 million (1.4%) primarily due to an increase of approximately 29 full-time equivalent faculty and staff due to the University's strategic faculty hiring plan which was offset by a 6.2% decrease in supplies and other expenses.

- In fiscal year 2013, research expenses increased $1.4 million or 2.0% ($1.7 million or 2.2% decrease in fiscal year 2012). These expenses are related primarily to sponsored research revenues and are affected by the timing of salaries and the purchase of supplies and commodities that can be charged to grants.

- Academic support increased $9.3 million or 8.6% for fiscal year 2013 ($0.8 million or 0.8% in fiscal year 2012) primarily due to a net increase of approximately 58 full-time equivalent staff and an increase in fringe benefit rates. Furthermore, supplies and other expenses also increased 17.8% which was mostly attributed to an increase in information technology related expenses.

- In fiscal year 2013, institutional support experienced an increase of $9.8 million or 18.4% ($11.2 million or 17.3% decrease in fiscal year 2012). This resulted primarily from an increase of 29.5% in fringe benefits due to rate increases combined with a 23.1% net increase in supplies and other expenses. In fiscal year 2012, institutional support decreased mainly due to a 35.8% net decrease in supplies and other expenses in addition to a 8.1% net decrease in the number of full-time equivalent staff.

- Operations and maintenance of plant increased $1.3 million or 1.3% in fiscal year 2013 as compared to a $9.0 million or 8.2% decrease in fiscal year 2012. This is primarily attributed to an increase of 7.2% (13.1% decrease in fiscal year 2012) for supplies and other expenses related to general maintenance and repairs. This increase was offset by a decrease in natural gas rates, of approximately 9.1% in fiscal year 2013 (8.6% in fiscal year 2012). Natural gas consumption for the Cogeneration plant also decreased in fiscal year 2013 mainly due to switching over to oil for a longer period of time during the winter. The University also experienced a decrease in electricity rates, including distribution and demand charges, of approximately 18.9% in fiscal year 2013 (9.7% in fiscal year 2012).

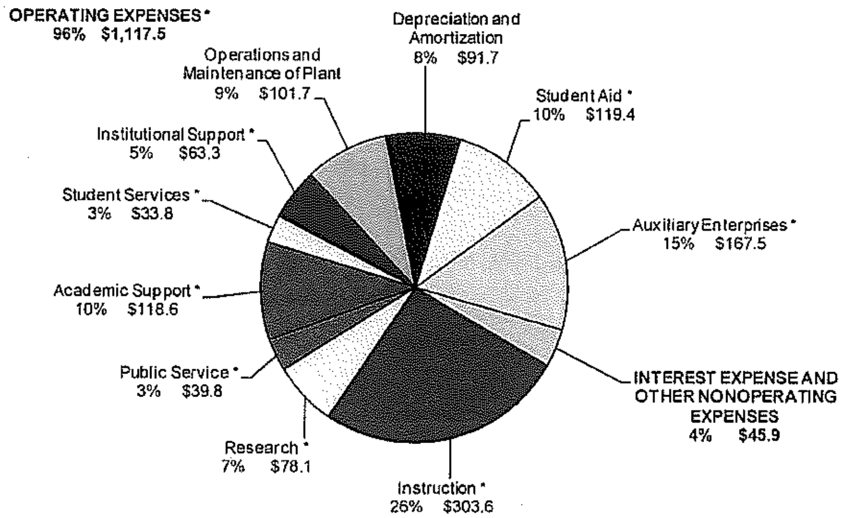
- In fiscal year 2013, the University began to depreciate an additional $49.9 million ($45.6 million in fiscal year 2012) in property and equipment which attributed to an increase of $3.2 million ($1.9 million decrease in fiscal year 2012) in depreciation and amortization expense. Fiscal year 2012 depreciation and amortization was lower than fiscal year 2011 due to changes in the capitalization policy that impacted the capitalization threshold for equipment.

- Auxiliary enterprises expenses increased $3.1 million or 1.9% in fiscal year 2013 (0.7% in fiscal year 2012), primarily due to a net increase of 14 full-time equivalent staff and an increase in fringe benefit rates offset by a 10.5% decrease in utilities (18.7% in fiscal year 2012).

- In fiscal year 2013, the University began allocating expenses by function that were formerly reported under other operating expenses and related to non-capital projects. The majority of these expenses, $11.9 million ($11.5 million in fiscal 2012) were allocated to operations and maintenance of plant and $3.1 million ($0.3 million in fiscal year 2012) were allocated to institutional support. These amounts consist of expenses pertaining to inspections, fire and safety code updates, and other corrective actions needed in order to achieve safety goals for all buildings, in addition to write-offs of certain software (see Note 4). Other expenses include costs not capitalized under University policy such as repairs, project management fees, capital project studies, and mold, lead and asbestos removal projects.

The pie chart below illustrates operating expenses by function, not netted for financial aid, and also includes other operating expenses. A significant portion of student aid is reflected as an allowance against tuition and fees revenue and sales and services of auxiliary enterprises on the Statements of Revenues, Expenses, and Changes in Net Position. The chart also shows interest expense and other nonoperating expenses.

EXPENSES FOR FISCALYEAR 2013 ($ in Millions)
Total $1,163.4



* Shown here at gross amounts, not netted for financial aid totaling $119.0 million.

STATEMENTS OF CASH FLOWS

The Statements of Cash Flows present detailed information about the cash activity of the University during the year. The first section of these statements, cash flows from operating activities, will always be different from the Statements of Revenues, Expenses, and Changes in Net Positions' operating loss amount. The difference results from noncash items such as depreciation and amortization expense and the use of the accrual basis of accounting in preparing the Statements of Revenues, Expenses, and Changes in Net Position. These statements show revenues and expenses when incurred, not necessarily when cash is received or used. The Statements of Cash Flows, on the other hand, show cash inflows and outflows without regard to accruals. The Statements of Cash Flows have four additional sections including: cash flows from noncapital financing activities including State appropriation, transfers to State General Fund, gifts and other nonoperating revenues and expenses; cash flows from capital financing activities that reflect the cash received and used by the University for financing, principally capital in nature, capital grants and gifts, and State debt service commitments for principal and interest; cash flows from investing activities showing the purchases, proceeds and interest received from investing activities; and a reconciliation of operating loss reflected on the Statements of Revenues, Expenses, and Changes in Net Position to net cash used in operating activities.

The following table shows condensed Statements of Cash Flows for the years ended June 30 (in millions):

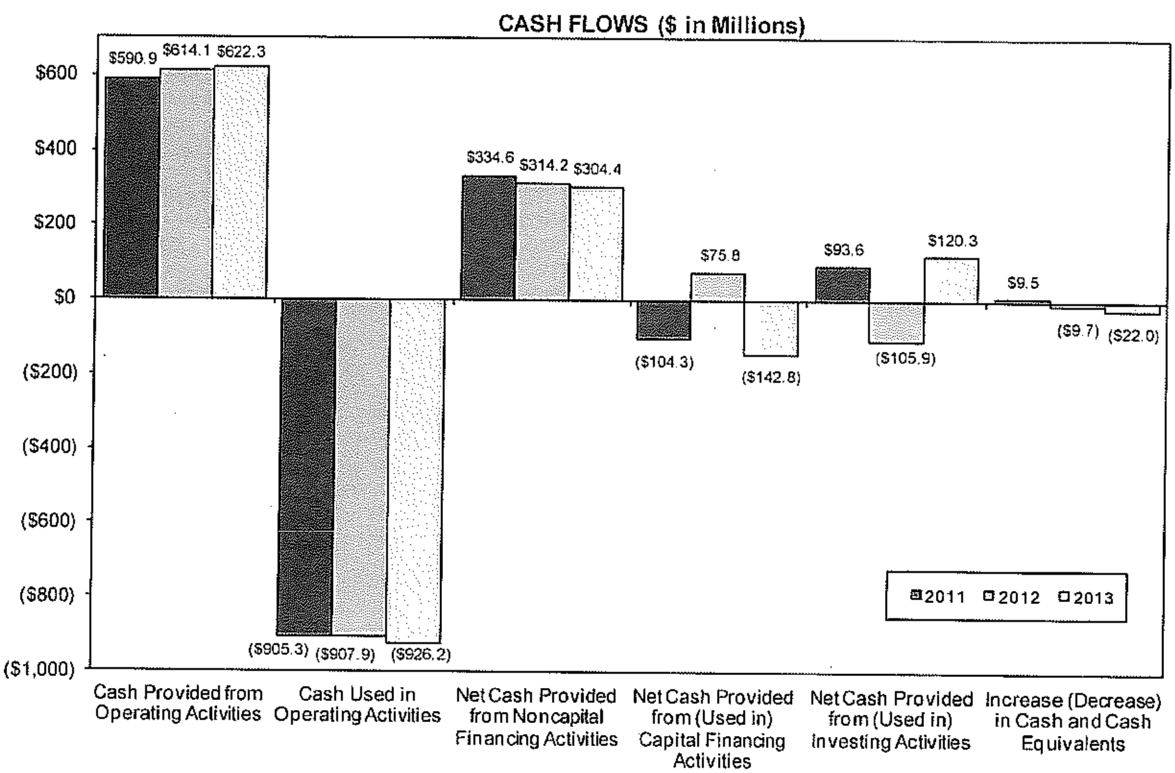
	2013	2012	2011
Cash provided from operating activities	$ 622.3	$ 614.1	$ 590.9
Cash used in operating activities	(926.2)	(907.9)	(905.3)
Net cash used in operating activities	(303.9)	(293.8)	(314.4)
Net cash provided from noncapital financing activities	304.4	314.2	334.6
Net cash provided from (used in) capital financing activities	(142.8)	75.8	(104.3)
Net cash provided from (used in) investing activities	120.3	(105.9)	93.6
Net increase (decrease) in cash and cash equivalents	$ (22.0)	$ (9.7)	$ 9.5

Net cash used in operating activities was $303.9 million and $293.8 million in fiscal years 2013 and 2012, respectively, and is consistent with the operating loss discussed earlier after adding back depreciation and amortization, a noncash expense. GASB requires that cash flows from noncapital financing activities include State appropriation and noncapital gifts. Cash flows from these activities totaled $304.4 million in fiscal year 2013 ($314.2 million in fiscal year 2012), a $9.8 million decrease from fiscal year 2012 ($20.4 million from fiscal year 2011).

Cash flows used in capital financing activities was $142.8 million in fiscal year 2013 and $75.8 million provided in fiscal year 2012. The major difference between fiscal years 2013 and 2012 was that $200.0 million in bond proceeds were received in fiscal year 2012 ($0 in fiscal year 2013) in addition to an increase in the amount of purchases of property and equipment of $23.6 million ($20.0 million in 2012).

Net cash provided from investing activities was $120.3 million in fiscal year 2013 and $105.9 million used in fiscal year 2012. The major difference between fiscal years 2013 and 2012 was that $200.0 million in bond proceeds were received in fiscal year 2012 ($0 in fiscal year 2013) which were invested in the deposit with bond trustee.

Total cash and cash equivalents decreased $22.0 million and $9.7 million in fiscal years 2013 and 2012, respectively, as a result of these activities. The following bar graph shows the cash flows provided from and used by major categories and as described in the preceding paragraphs:



FINANCIAL STATEMENTS

UNIVERSITY OF CONNECTICUT
STATEMENTS OF NET POSITION
As of June 30, 2013 and 2012

($ in thousands)

	2013	2012 (Restated)
ASSETS		
Current Assets		
Cash and cash equivalents	$ 243,348	$ 265,374
Accounts receivable, net	39,204	33,217
Student loans receivable, net	1,838	1,744
Due from State of Connecticut	74,950	52,346
State debt service commitment	92,168	90,600
Inventories	4,237	4,198
Deposit with bond trustee	41,030	160,524
Deferred charges	713	785
Prepaid expenses	2,901	3,515
Total Current Assets	500,389	612,303
Noncurrent Assets		
Cash and cash equivalents	1,438	1,420
Investments	10,614	10,303
Student loans receivable, net	10,374	10,494
State debt service commitment	751,045	828,795
Property and equipment, net	1,474,569	1,430,589
Deferred charges	7,211	7,923
Total Noncurrent Assets	2,255,251	2,289,524
Total Assets	$ 2,755,640	$ 2,901,827
LIABILITIES		
Current Liabilities		
Accounts payable	$ 55,694	$ 33,667
Deferred income	25,525	24,809
Deposits held for others	2,425	2,887
Wages payable	39,898	40,326
Compensated absences	23,302	24,266
Due to State of Connecticut	17,904	14,570
Due to affiliate (see Note 5)	3,938	48,300
Current portion of long-term debt and bonds payable	92,274	88,372
Other current liabilities	32,547	33,360
Total Current Liabilities	293,507	310,557
Noncurrent Liabilities		
Compensated absences	9,925	8,740
Long-term debt and bonds payable	988,922	1,082,351
Refundable for federal loan program	11,233	11,076
Total Noncurrent Liabilities	1,010,080	1,102,167
Total Liabilities	$ 1,303,587	$ 1,412,724
NET POSITION		
Net investment in capital assets	$ 1,222,167	$ 1,163,416
Restricted nonexpendable	11,902	11,574
Restricted expendable		
Research, instruction, scholarships and other	20,602	19,536
Loans	2,469	2,425
Capital projects	33,416	115,315
Debt service	7,279	7,737
Unrestricted (see Note 1)	154,218	169,100
Total Net Position	$ 1,452,053	$ 1,489,103

The accompanying notes are an integral part of these financial statements.

UNIVERSITY OF CONNECTICUT
STATEMENTS OF REVENUES, EXPENSES, AND CHANGES IN NET POSITION
For the Years Ended June 30, 2013 and 2012

($ in thousands)

	2013	2012
OPERATING REVENUES		
Student tuition and fees (Net of scholarship allowances of $116,062 for 2013 and $111,139 for 2012. See Note 1.)	$ 261,641	$ 251,017
Federal grants and contracts	118,715	124,478
State and local grants and contracts	25,898	22,078
Nongovernmental grants and contracts	15,212	13,141
Sales and services of educational departments	15,814	17,348
Sales and services of auxiliary enterprises (Net of scholarship allowances of $2,907 for 2013 and $3,030 for 2012. See Note 1.)	185,240	181,974
Other sources	8,114	6,229
Total Operating Revenues	630,634	616,265
OPERATING EXPENSES		
Educational and general		
Instruction	302,202	291,370
Research	74,948	73,509
Public service	39,068	35,478
Academic support	117,679	108,340
Student services	33,315	35,256
Institutional support	63,302	53,465
Operations and maintenance of plant	101,661	100,402
Depreciation and amortization	91,713	88,478
Student aid	7,154	6,107
Auxiliary enterprises	167,474	164,388
Total Operating Expenses	998,516	956,793
Operating Loss	(367,882)	(340,528)
NONOPERATING REVENUES (EXPENSES)		
State appropriation	288,456	282,370
State debt service commitment for interest	40,571	39,755
Gifts	19,996	24,377
Investment income	859	898
Interest expense	(45,402)	(47,117)
Other nonoperating expenses, net	(439)	(1,635)
Net Nonoperating Revenues	304,041	298,648
Loss Before Other Changes in Net Position	(63,841)	(41,880)
OTHER CHANGES IN NET POSITION		
State debt service commitment for principal	-	115,400
Capital allocation	20,000	18,000
Capital grants and gifts	6,675	2,768
Disposal of property and equipment, net	103	(540)
Additions to permanent endowments	13	-
Net Other Changes in Net Position	26,791	135,628
Increase (Decrease) in Net Position	(37,050)	93,748
NET POSITION		
Net Position-beginning of year	1,489,103	1,395,355
Net Position-end of year	$ 1,452,053	$ 1,489,103

The accompanying notes are an integral part of these financial statements.

UNIVERSITY OF CONNECTICUT
STATEMENTS OF CASH FLOWS
For the Years Ended June 30, 2013 and 2012

($ in thousands)

	2013	2012
CASH FLOWS FROM OPERATING ACTIVITIES		
Student tuition and fees	$ 255,173	$ 248,473
Grants and contracts	154,631	156,152
Sales and services of auxiliary enterprises	185,999	183,996
Sales and services of educational departments	17,146	17,382
Payments to suppliers and others	(259,308)	(247,396)
Payments to employees	(483,049)	(491,073)
Payments for benefits	(181,704)	(167,506)
Loans issued to students	(2,098)	(1,965)
Collection of loans to students	2,095	2,071
Other receipts, net	7,217	6,059
Net Cash Used in Operating Activities	(303,898)	(293,807)
CASH FLOWS FROM NONCAPITAL FINANCING ACTIVITIES		
State appropriation	283,031	289,771
Gifts	21,910	24,529
Other nonoperating expenses, net	(544)	(94)
Net Cash Provided from Noncapital Financing Activities	304,397	314,206
CASH FLOWS FROM CAPITAL FINANCING ACTIVITIES		
Proceeds from bonds	-	200,000
State debt service commitment	116,753	116,684
Purchases of property and equipment	(129,530)	(105,885)
Proceeds from sale of property and equipment	514	182
Principal paid on debt and bonds payable	(84,767)	(88,139)
Interest paid on debt and bonds payable	(51,182)	(48,628)
Capital allocation	2,279	151
Capital grants and gifts	3,081	1,441
Net Cash Provided from (Used in) Capital Financing Activities	(142,852)	75,806
CASH FLOWS FROM INVESTING ACTIVITIES		
Purchase of investments, net	(21)	(54)
Interest on investments	872	952
Deposit with bond trustee	119,494	(106,794)
Net Cash Provided from (Used in) Investing Activities	120,345	(105,896)
DECREASE IN CASH AND CASH EQUIVALENTS	(22,008)	(9,691)
BEGINNING CASH AND CASH EQUIVALENTS	266,794	276,485
ENDING CASH AND CASH EQUIVALENTS	$ 244,786	$ 266,794

The accompanying notes are an integral part of these financial statements.

UNIVERSITY OF CONNECTICUT
STATEMENTS OF CASH FLOWS (Continued)
For the Years Ended June 30, 2013 and 2012

($ in thousands)

	2013	2012
RECONCILIATION OF OPERATING LOSS TO NET CASH USED IN OPERATING ACTIVITIES		
Operating Loss	$ (367,882)	$ (340,528)
Adjustments to Reconcile Operating Loss to Net Cash Provided from (Used in) Operating Activities:		
Depreciation and amortization expense	91,713	88,478
Property and equipment	1,154	(4,995)
In-kind donations	-	96
In-kind worker's compensation	1,915	2,337
Obligations under capital leases	-	1,840
Changes in Assets and Liabilities:		
Receivables, net	(6,009)	514
Inventories	(39)	(341)
Prepaid expenses	614	(12)
Accounts payable, wages payable and compensated absences	4,682	(19,061)
Deferred income	716	32
Deferred charges	(9)	46
Deposits	(462)	525
Due from (to) State of Connecticut	1,959	(2,329)
Due to affiliate	(33,246)	(21,075)
Other liabilities	813	(1)
Loans to students	183	667
Net Cash Used in Operating Activities	$ (303,898)	$ (293,807)

The accompanying notes are an integral part of these financial statements.

UNIVERSITY OF CONNECTICUT
COMPONENT UNIT
THE UNIVERSITY OF CONNECTICUT LAW SCHOOL FOUNDATION, INC.
STATEMENTS OF FINANCIAL POSITION
As of June 30, 2013 and 2012

($ in thousands)

	2013	2012
ASSETS		
Current Assets		
Cash and cash equivalents	$ 1,148	$ 1,428
Pledges receivable, net of allowance	203	392
Other current assets	71	72
Total Current Assets	1,422	1,892
Noncurrent Assets		
Pledges receivable, net of allowance	119	148
Investments	17,104	14,990
Property and equipment, net of accumulated depreciation of $129 for 2013 and $127 for 2012	6	8
Total Noncurrent Assets	17,229	15,146
Total Assets	$ 18,651	$ 17,038
LIABILITIES AND NET ASSETS		
Current Liabilities		
Accounts payable	$ 9	$ -
Net Assets		
Unrestricted	1,270	1,216
Temporarily restricted	3,869	2,500
Permanently restricted	13,503	13,322
Total Net Assets	18,642	17,038
Total Liabilities and Net Assets	$ 18,651	$ 17,038

STATEMENTS OF ACTIVITIES
For the Years Ended June 30, 2013 and 2012

($ in thousands)

	Unrestricted	Temporarily Restricted	Permanently Restricted	2013 Total	2012 Total
REVENUES AND SUPPORT					
Contributions and grants	$ 387	$ 297	$ 181	$ 865	$ 1,780
Interest and dividends	24	441	-	465	437
Net realized and unrealized gains	88	1,659	-	1,747	43
Net assets released from restrictions	984	(984)	-	-	-
Change in original restriction by donor	-	(44)	44	-	-
Write off of pledges receivable	44	-	(44)	-	-
Total Revenues and Support	1,527	1,369	181	3,077	2,260
EXPENSES					
Program Expenses					
Scholarships and awards	217	-	-	217	195
Student support and faculty support	604	-	-	604	609
Alumni and graduate relations	76	-	-	76	98
Total Program Expenses	897	-	-	897	902
Support Expenses					
Management and general	470	-	-	470	568
Fundraising	106	-	-	106	128
Total Support Expenses	576	-	-	576	696
Total Expenses	1,473	-	-	1,473	1,598
Changes in Net Assets	54	1,369	181	1,604	662
Net Assets-beginning of year	1,216	2,500	13,322	17,038	16,376
Net Assets-end of year	$ 1,270	$ 3,869	$ 13,503	$ 18,642	$ 17,038

The accompanying notes are an integral part of these financial statements.

NOTES TO FINANCIAL STATEMENTS

Notes to Financial Statements
For the Years Ended June 30, 2013 and 2012

1. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Related Entities

The University of Connecticut is a comprehensive institution of higher education, which includes the University of Connecticut Health Center (Health Center). Although governed by a single Board of Trustees, the University of Connecticut and its Health Center maintain separate budgets and are, by statute, separate entities for purposes of maintaining operating funds and appropriations from the State of Connecticut (State). The Health Center also has a Board of Directors to whom the Board of Trustees has delegated certain responsibility and authority. This financial report for the fiscal years ended June 30, 2013 and 2012 represents the transactions and balances of the University of Connecticut (University), herein defined as all programs except the Health Center.

Two related, but independent, corporate entities support the mission of the University: The University of Connecticut Foundation, Inc. (Foundation) (see Note 12) and The University of Connecticut Law School Foundation, Inc. (Law School Foundation). The Foundation raises funds to promote, encourage, and assist education and research at both the University and the Health Center, while the Law School Foundation, with similar objectives, supports only the University.

Governmental Accounting Standards Board (GASB) Statement No. 14, *The Financial Reporting Entity*, as amended by Statement No. 39, *Determining Whether Certain Organizations Are Component Units*, and Statement No. 61, *The Financial Reporting Entity: Omnibus*, states that the financial reporting entity consists of the primary government, organizations for which the primary government is financially accountable, and other organizations for which the nature and significance of their relationship with the primary government are such that exclusion would cause the reporting entity's financial statements to be misleading.

GASB Statement No. 39 additionally requires that legally separate and tax exempt entities be presented as component units of the reporting entity if they meet all of the following criteria: the economic resources of the organization are entirely or almost entirely for the direct benefit of the reporting unit; the reporting unit is entitled to access all or a majority of the economic resources received or held by the organization; and the economic resources received or held by the organization are significant to the reporting unit. As a result, the Law School Foundation, which is organized for the benefit of the University and whose economic resources can only be used by or for the benefit of the University, is included as a component unit of the University. The Law School Foundation's audited Statements of Financial Position and Statements of Activities are discreetly presented in their original formats on a separate page of the accompanying financial statements.

The Foundation materially supports the mission of the University and the Health Center, which are separately audited, producing their own financial statements. Displaying the Foundation's financial statements as a component unit of either the University or the Health Center would distort its actual contribution or economic benefit to that entity, and therefore, the Foundation is not included as a component unit in the accompanying financial statements.

Financial Statement Presentation

The financial statements have been prepared using the economic resources measurement focus and the accrual basis of accounting in accordance with accounting principles generally accepted in the United States of America, as prescribed by the GASB.

GASB Statement No. 35, *Basic Financial Statements - and Management's Discussion and Analysis - for Public Colleges and Universities*, as amended by GASB Statement No. 63, *Financial Reporting of Deferred Outflows of Resources, Deferred Inflows of Resources and Net Position*, establishes standards for financial reporting for public colleges and universities. These reporting standards focus on the University as a whole rather than on accountability by individual fund groups and provide accounting and financial reporting guidelines, enhancing the usefulness and comprehension of financial reports by external users. To that end, GASB requires that resources be classified for accounting and reporting purposes into the following categories in net position:

- **Net investment in capital assets:** Capital assets, net of accumulated depreciation and amortization, and reduced by outstanding principal balances of bonds (net of State debt service commitment) and notes that are attributable to the acquisition, construction, or improvement of those assets. Deferred outflows of resources and deferred inflows of resources that are attributable to the acquisition, construction, or improvement of those assets or related debt are also included in this component.

- **Restricted nonexpendable:** Represents endowment and similar type assets in which donors or outside sources have stipulated, as a condition of the gift instrument, that the principal is to be maintained inviolate and in perpetuity and invested for the purpose of producing present and future income, which may be expended or reinvested in principal.

- **Restricted expendable:** Assets reduced by liabilities and deferred inflows of resources related to those assets that are expendable but where the University is legally or contractually obligated to spend the resources in accordance with restrictions imposed by external third parties.

- **Unrestricted:** The net amount of the assets, deferred outflows of resources, liabilities, and deferred inflows of resources that do not meet the definition of "restricted" or "net investment in capital assets." These assets are not subject to externally imposed stipulations; however, they are subject to internal designations. For example, amounts classified as unrestricted may be designated for specific purposes by action of management or the Board of Trustees or may otherwise be limited by contractual agreements with outside parties. For the most part, all unrestricted amounts in net position are internally designated to support academic and research programs, capital projects, retirement of indebtedness, and auxiliary enterprise activities.

The University follows the "business-type activities" (BTA) requirements of GASB Statement No. 35. BTAs are defined as those that are financed in whole or in part by fees charged to external parties for goods or services. In accordance with reporting requirements defined in GASB Statement Nos. 35 and 63, the University presents a Management's Discussion and Analysis; a Statement of Net Position; a Statement of Revenues, Expenses, and Changes in Net Position; a Statement of Cash Flows; and Notes to the Financial Statements. All significant intra-agency transactions have been eliminated.

Expenses are classified either as restricted or unrestricted based on a variety of factors, including consideration of prior or future revenue sources, the type of expense incurred, the University's budgetary policies surrounding the various revenue sources or whether the expense is a recurring cost.

In order to ensure observance of limitations and restrictions placed on the use of the resources available to the University, the accounts of the University are maintained internally following the principles of "fund accounting." This is the procedure by which resources for various purposes are classified for accounting and reporting purposes into funds that are in accordance with specified activities or objectives.

Certain assets, liabilities, and components of net position were restated for the fiscal year ended June 30, 2012 for accruals related to construction retainage. Historically, the University's practice was to delay recording a liability for retainage until projects were closed out due to the uncertainty regarding the progress towards completion prior to final inspection and approval. Effective for the fiscal year ended June 30, 2013, this approach was revised to provide for the recording of a liability for retainage at the point at which the retainage is withheld in order to conform with the provisions of authoritative guidance currently in effect. This change was applied retrospectively to the balances presented for the fiscal year ended June 30, 2012. It did not require restatement of the beginning net position for the fiscal year ended June 30, 2012, as this adjustment did not affect total net position. The net effect of the change was an increase in both assets and liabilities by $7.8 million for the fiscal year ended June 30, 2012. The table below illustrates the adjustments to the Statement of Net Position (amounts in thousands):

Total assets previously reported as of June 30, 2012	$	2,894,027
Increase in property and equipment, net		7,800
Total assets after adjustment as of June 30, 2012	$	2,901,827
Total liabilities previously reported as of June 30, 2012	$	1,404,924
Increase in accounts payable		7,800
Total liabilities after adjustment as of June 30, 2012	$	1,412,724
Increase in net investment in capital assets	$	7,800
Decrease in restricted capital projects		(5,700)
Decrease in unrestricted		(2,100)
Total net effect on net position as of June 30, 2012	$	-

For fiscal year 2013, the University performed a review of the categorization of functional expenses and certain reclassifications were made to the Statement of Revenues, Expenses, and Changes in Net Position for the year ended June 30, 2012 to better reflect the appropriate classifications in accordance with applicable guidance. These increases (decreases) have no effect on operating loss or net position for the year ended June 30, 2012 and are summarized in the table below (amounts in thousands):

		2012
Instruction	$	(4,314)
Research		748
Public service		(4,158)
Academic support		8,198
Student services		(3,792)
Institutional support		(25,638)
Operations and maintenance of plant		35,522
Auxiliary enterprises		5,078
Other operating expenses		(11,644)
Total operating expenses	$	-

New Accounting Standards

The University's financial statements and notes for fiscal years 2013 and 2012 as presented herein include the provisions of the following GASB pronouncements:

The University adopted GASB Statement No. 60, *Accounting and Financial Reporting for Service Concession Arrangements*, as of July 1, 2012. This statement establishes recognition, measurement, and disclosure requirements for Service Concession Arrangements (SCAs), which are a type of public-private or public-public partnership. An SCA is an arrangement between a transferor and an operator in which the transferor conveys to an operator the right and related obligation to provide services through the use of infrastructure or another public asset in exchange for significant consideration and the operator collects and is compensated by fees from third parties. There was no impact on the financial statements as a result of this adoption.

The University adopted GASB Statement No. 61, *The Financial Reporting Entity: Omnibus*, as of July 1, 2012. This statement amends certain reporting criteria set forth in GASB Statement Nos. 14 and 34 for component units presented within the financial statements of the reporting entity. There was no significant impact on the financial statements as a result of this adoption.

The University adopted GASB Statement No. 62, *Codification of Accounting and Financial Reporting Guidance Contained in Pre-November 30, 1989 FASB and AICPA Pronouncements*, as of July 1, 2011. This statement incorporates specific guidance found only under pronouncements issued by FASB and the American Institute of Certified Public Accountants (AICPA) into the GASB's authoritative literature. There was no significant impact on the financial statements as a result of this adoption.

The University adopted GASB Statement No. 63, *Financial Reporting of Deferred Outflows of Resources, Deferred Inflows of Resources, and Net Position*, as of July 1, 2012. This Statement amends the net asset reporting requirements defined in previously issued pronouncements by incorporating deferred outflows of resources and deferred inflows of resources into the definitions of the required components of the residual measure and by renaming that measure from net assets to net position. The deferred outflows and inflows represent the consumption or acquisition of resources by the University that are applicable to a future reporting period, but do not require further exchange of goods or services. These changes have been reflected in the accompanying financial statements and notes to the financial statements.

In March 2012, GASB issued Statement No. 65, *Items Previously Reported as Assets and Liabilities*, which establishes accounting and financial reporting standards that reclassify, as deferred outflows of resources or deferred inflows of resources, certain items that were previously reported as assets and liabilities and recognizes, as outflows of resources or inflows of resources, certain items that were previously reported as assets and liabilities. The provisions of this statement are effective for financial statements for periods beginning after December 15, 2012. While the University is not required to implement this new standard until fiscal year 2014, the University is evaluating its overall impact on the financial statements. It is anticipated at this time to have a significant impact on the accounting and reporting of the University's debt issuance costs.

Cash Equivalents (see Note 2)
For the purposes of the Statements of Cash Flows, the University considers all highly liquid investments with an original maturity of three months or less to be cash equivalents. Funds invested in the State of Connecticut Treasurer's Short-Term Investment Fund are considered cash equivalents.

Investments (see Note 2)
The University accounts for its investments at fair value in accordance with GASB Statement No. 3, *Deposits with Financial Institutions, Investments (including Repurchase Agreements), and Reverse Repurchase Agreements* and GASB Statement No. 40, *Deposit and Investment Risk Disclosures,* an amendment of GASB Statement No. 3. Changes in the unrealized gain (loss) on the carrying value are recorded in Nonoperating Revenues (Expenses) in the accompanying Statements of Revenues, Expenses, and Changes in Net Position. Noncurrent investments are externally restricted by donors or outside sources that have stipulated as a condition of the gift instrument that the principal be maintained inviolate and in perpetuity. Noncurrent investments also include those amounts restricted by creditors for certain debt service payments (see Note 5).

Accounts and Student Loans Receivable (see Note 3)
Accounts receivable consist of tuition, fees, auxiliary enterprises service fees charged to students, faculty, staff and others, and amounts due from state and federal governments for grants and contracts. Student loans receivable consist primarily of amounts due from students under the Federal Perkins Loan Program, which are subject to significant restrictions. The student loans receivable is classified as current and noncurrent based on the amount estimated to be collected from students in one year and beyond one year. Accounts and student loans receivable are recorded net of an estimated allowance for doubtful accounts.

Inventories
Consumable supplies are expensed when received with the exception of certain central inventories which consist primarily of maintenance and custodial supplies, repair parts, and other general supplies used in the daily operations of the University. Inventory is valued at cost as determined by various methods, including the first-in, first-out method.

Deposit with Bond Trustee (see Note 5)
Tax-exempt bond proceeds are deposited to various accounts held by the Trustee Bank as required by certain trust indentures. The funds are invested and disbursed as directed by the University. The University's bond proceeds investment policy is to balance an appropriate risk-return level heavily weighted towards safety of assets, as defined and permitted under the relative indentures and Connecticut General Statutes.

The University directs the Trustee Bank to invest UCONN 2000 General Obligation construction fund proceeds in the State Treasurer's Short-Term Investment Fund. Similarly, the University has directed the Trustee Bank to invest the debt service funds and cost of issuance for the special obligation bonds in dedicated Short-Term Investment Fund accounts.

Investment earnings from UCONN 2000 General Obligation bond proceeds are retained by the State Treasurer's Office and do not flow to the University or to the Trustee Bank. The Student Fee Revenue Bonds investment earnings are part of the pledged revenues and are directly retained by the Trustee Bank to pay debt service on the bonds or for other indenture permitted purposes. The earnings on the UCONN 2000 General Obligation Debt Service Commitment Refunding Bonds and the Special Obligation Student Fee Revenue Refunding Redemption Fund escrows form part of the irrevocable escrows and are used by the Trustee Bank to meet the debt service payments on the defeased bonds until called.

Deferred Charges – Current and Noncurrent (see Note 10)
Deferred charges consist of payments made in advance of revenues being earned. Deferred charges also represent the cost of issuance which will be amortized over the terms of the respective bond issuances.

Noncurrent Cash and Cash Equivalents (see Note 2)
Noncurrent cash and cash equivalents are related to endowment assets and are externally restricted as to use.

Property and Equipment (see Note 4)
Property and equipment are reported at cost at date of acquisition or fair value at date of donation as in the case of gifts. Property and equipment that are exchanged for other assets are recorded based on the fair value of the asset given up or the fair value of the asset received, whichever value is most clearly evident. Renovations that significantly increase the value or useful life of an asset are capitalized. Routine repairs and maintenance, and certain library materials, are charged to

operating expenses in the year incurred. Building components and non-structural improvements have estimated useful lives of 2 years to 60 years. Equipment has estimated useful lives of 3 years to 30 years.

Deferred Income (see Note 10)
Deferred income includes amounts received for services rendered in a future accounting period including tuition and fee revenues and event ticket sales. It also includes amounts received for certain restricted research grants that are included in revenue until the funds are expended.

Compensated Absences (see Note 7)
Employee vacation, holiday, compensatory, and sick leave are accrued at year-end for financial statement purposes. The liability and expense incurred are recorded at year-end as compensated absences in the Statements of Net Position and in the various expense functions on the Statements of Revenues, Expenses, and Changes in Net Position. The liability for compensated absences is also classified as current and noncurrent based on the amount estimated to be paid to employees in one year and beyond one year.

Noncurrent Liabilities
Noncurrent liabilities include the long-term portion of compensated absences of the University, principal payments due on bonds (net of unamortized premiums, discounts, and debt differences), loans and capital leases with a maturity of more than one year, and governmental advances for revolving loan programs that would be returned to the federal government upon cessation of the student loan program.

Revenues and Expenses
Operating revenues consist of tuition and fees, state and federal grants and contracts, sales and services of educational activities, auxiliary enterprises revenue, and other sources of revenue. GASB Statement No. 33, *Accounting and Financial Reporting for Nonexchange Transactions*, requires recipients of government-mandated and voluntary nonexchange transactions to recognize revenue when all applicable eligibility requirements are met for these transactions. Restricted grant revenue that does not meet the nonexchange transaction definition is recognized to the extent expended or in the case of fixed price contracts, when the contract terms are met or completed.

Operating expenses, except for depreciation and amortization and other operating expenses, are reported using functional classification, including those under educational and general and auxiliary enterprises. See Note 14 for operating expenses by natural classification. All other revenues and expenses of the University are reported as nonoperating revenues and expenses including State appropriation, debt service commitment for interest, noncapital gifts, investment income, interest expense, other nonoperating revenues (expenses), net, and other changes in net position. Revenues are recognized when earned and expenses are recognized when incurred.

GASB Statement No. 35 requires that revenues be reported net of discounts and scholarship allowances. Student aid for scholarships and fellowships, recorded in the Statements of Revenues, Expenses and Changes in Net Position, includes payments made directly to students. Any aid applied directly to the students' accounts in payment of tuition and fees, housing charges and dining services is reflected as a scholarship allowance and is deducted from the University's revenues. Certain governmental grants, such as Pell grants, and other federal, state or nongovernmental programs, are recorded as operating revenues in the University's financial statements. To the extent that revenues from such programs are used to satisfy tuition and fees and other student charges, the University has recorded a scholarship allowance.

Component Unit
The Law School Foundation prepares its financial statements on the accrual basis of accounting in accordance with accounting principles generally accepted in the United States of America. Net assets, revenues and expenses are classified based on the terms of donor-imposed restrictions, if any. Accordingly, the Law School Foundation's net assets and changes therein are classified and reported as follows:

- **Unrestricted Net Assets:** Net assets that are not subject to donor-imposed restrictions.
- **Temporarily Restricted Net Assets:** Net assets subject to donor-imposed stipulations that may or will be met, either by actions of the Law School Foundation and/or passage of time. When the restriction expires, temporarily restricted net assets are reclassified to unrestricted net assets.

- **Permanently Restricted Net Assets:** Net assets subject to donor-imposed stipulations that they be maintained permanently by the Law School Foundation. Generally, the donors of these assets permit the Foundation to use all or part of the income earned on related investments for general or specific purposes.

Contributions, including unconditional promises to give, are recognized as revenue in the period received. Conditional promises to give are not recognized as revenue until the conditions on which they depend are substantially met. Investments are reported at fair value based upon quoted market prices. Certain amounts reported in 2012 have been reclassified in order to conform to the current year presentations.

2. CASH AND CASH EQUIVALENTS AND INVESTMENTS

GASB Statement No. 40 requires governmental entities to disclose credit risk associated with cash deposits and investment balances, and investment policies applied to mitigate such risks, especially as they relate to uninsured and unregistered investments for which the securities are held by the broker or dealer, or by its trust department or agent, but not in the University's name.

The University's total cash and cash equivalents balance was $244.8 million and $266.8 million as of June 30, 2013 and 2012, respectively, and included the following (amounts in thousands):

	2013	2012
Cash maintained by State of Connecticut Treasurer	$ 212,749	$ 244,342
Invested in State of Connecticut Short-Term Investment Fund	17,624	16,953
Invested in State of Connecticut Short-Term Investment Fund - Endowments	1,438	1,420
Invested in Short-Term Corporate Notes	6,435	2,639
Deposits with Financial Institutions and Other	6,540	1,440
Total cash and cash equivalents	244,786	266,794
Less: current balance	243,348	265,374
Total noncurrent balance	$ 1,438	$ 1,420

Collateralized deposits are protected by Connecticut statute. Under this statute, any bank holding public deposits must at all times maintain, segregated from its other assets, eligible collateral in an amount equal to at least a certain percentage of its public deposits. The applicable percentage is determined based on the bank's risk-based capital ratio – a measure of the bank's financial condition. The collateral is kept in the custody of the trust department of either the pledging bank or another bank in the name of the pledging bank. Portions of the bank balance of the State are insured by the Federal Deposit Insurance Corporation or collateralized. As a State agency, the University benefits from this protection, though the extent to which the deposits of an individual State agency such as the University are protected cannot be readily determined.

Short-Term Investment Fund (STIF) is a money market investment pool in which the State, municipal entities, and other political subdivisions of the State are eligible to invest. The State Treasurer is authorized to invest monies of STIF in United States government and agency obligations, certificates of deposit, commercial paper, corporate bonds, savings accounts, bankers' acceptances, repurchase agreements, asset-backed securities, and student loans. For financial reporting purposes, STIF is considered to be "cash equivalents" in the Statement of Net Position.

The University's cash management investment policy permits the University to invest in STIF, United States Treasury bills, United States Treasury notes and bonds, United States Government Agency obligations, banker's acceptances, certificates of deposit (including EURO Dollars), commercial paper, money market funds, repurchase agreements, and savings accounts. Cash and cash equivalents include amounts of $17.6 million and $1.4 million invested in STIF, which had a Standard and Poor's rating of AAAm during fiscal year 2013. The $6.4 million invested in Short-Term Corporate Notes during fiscal year 2013 includes repurchase agreements held with a financial institution and is collateralized by the Federal National Mortgage Association and the Federal Home Loan Mortgage Corporation, both of which had an AA+ Standard and Poor's rating.

The University designated the Foundation as the manager of the University's endowment funds. Gifts that are internally designated as endowments, and externally designated endowment gifts that are to be processed for transfer to the Foundation, are included in cash and cash equivalents. The Foundation makes spending allocation distributions to the University for each participating endowment. The distribution is spent by the University in accordance with the respective purposes of the endowments, the policies and procedures of the University and State statutes, as well as in accordance with the Foundation's endowment spending policy described below.

The endowment spending policy adopted by the Foundation's Board of Directors, in conjunction with the strategic asset allocation policy for the long-term pooled investment portfolio, is designed to provide reliable growth in annual spending allocation levels and to preserve or increase the real value of the endowment principal over time. To meet these objectives, the Foundation utilizes a total return investment approach, with total return consisting of interest and dividends as well as realized and unrealized gains and losses, net of management fees.

The Foundation's endowment spending allocation policy adheres to the Connecticut Uniform Prudent Management of Institutional Funds Act (UPMIFA). UPMIFA considers prudence in maintaining an endowment fund in perpetuity. Therefore, spending can occur from an endowment fund whose fair value is below its historic value as long as the governing body has determined that its policies will continue the perpetual nature of the endowment over time. The Foundation amended its endowment spending allocation policy in February 2009 in recognition of the change in approach to spending under UPMIFA. Calculations are performed for individual endowment funds at a rate of 4.25% of the rolling 12 quarter average market value on a unitized basis on March 31st each year for the following fiscal year beginning July 1st. The corresponding calculated spending allocations are distributed in equal quarterly installments on the first day of each quarter from the accumulated net total investment return for individual endowment funds where available, otherwise from principal.

An administrative fee is assessed to fund expenses incurred in meeting the Foundation's fiduciary and fundraising responsibilities to donors and the University. This on-going administrative fee is also assessed based on a rolling 12 quarter unitized market value calculated on March 31st for the following fiscal year beginning July 1st at a rate of 1.25% to cover the estimated cost of meeting the fiduciary responsibilities associated with each endowment. The calculated fee is charged in equal quarterly installments on the first day of each quarter from the accumulated net total investment return for individual endowment funds where available, otherwise from principal.

The endowment spending allocation and administrative fee taken together cannot exceed 6.5% or fall below 3.0% of the fair value of endowment funds at March 31st. Should this occur, the calculated amounts will be decreased or increased, respectively, on a pro rata basis.

Over the long term, the Foundation expects the current spending allocation and administrative fee policies to allow endowments to grow at least at the annualized rate of inflation on average. This is consistent with the organization's objective of providing resources for the underlying purposes of endowment assets over the life of the endowments whether in perpetuity or for a specified term, as well as to provide additional growth through new gifts and investment return.

University endowment investments are managed by the Foundation in a pooled portfolio, which is actively managed by professional investment managers as determined by the Investment Committee of the Foundation's Board of Directors. The Foundation has established asset allocation guidelines for the pooled investment portfolio, which provides that the maximum exposure with any one manager would be 20% for liquid assets and 5% for illiquid assets. The Foundation's Board of Directors also established an asset allocation policy for the long-term pooled investment portfolio (see following table). The Foundation expects that portfolios will be invested in only the strategies described in the table, not above or below the individual strategy percentage and its total percentage by objective, unless otherwise specified by its Board of Directors.

Investment Objective/Strategies	Allocation Range as Percentage of Market Value
Growth	
High yield fixed income	0% - 10%
Global equities	0% - 70%
Private capital	0% - 20%
Global macro strategies	0% - 10%
Event driven strategies (ex diversified)	0% - 10%
Real estate (public & private)	0% - 10%
Other opportunistic	0% - 10%
Total Growth	40% - 85%
Inflation Hedge	
TIPS	0% - 10%
Natural resources/commodities	0% - 15%
Other inflation hedging strategies	0% - 10%
Total Inflation Hedge	5% - 25%
Risk Minimizing	
Investment grade fixed income	0% - 20%
Relative value/Event driven (diversified)	0% - 15%
Cash equivalents	0% - 10%
Other low volatility strategies	0% - 10%
Total Risk Minimizing	5% - 40%

The endowments invested with the Foundation are subject to risk due to the uncollateralized nature of most of its investments. Certain investments of the Foundation include external investment pools. The bond mutual funds, high yield fixed income, and bank loans had average credit quality of Ba1 (Moody's). The University endowment's foreign publicly traded equities totaled $1.3 million in 2013 and 2012, and private capital investments totaled approximately $1.7 million and $1.9 million at June 30, 2013 and 2012, respectively.

The University also holds a partnership interest in Campus Associates Limited Partnership (see Note 12). The cost basis was used to estimate fair market value for this investment because the fair value was not readily available as of June 30, 2013 and 2012. As a result, the estimated fair value may differ from the value that would have been assigned had a ready market for such an investment existed; however, it is unlikely that such differences would be material.

The cost and fair value of the University's investments including those managed by the Foundation at June 30, 2013 and 2012 were (amounts in thousands):

	2013		2012	
	Cost	Fair Value	Cost	Fair Value
Endowments:				
Foundation Managed	$ 9,594	$ 10,464	$ 9,550	$ 10,153
Other:				
Campus Associates Limited Partnership Interest	150	150	150	150
Total Investments	$ 9,744	$ 10,614	$ 9,700	$ 10,303

Certain other funds are held in trust for investment by outside trustees. The University is designated as the income beneficiary and the funds are not under the direct control of the University. Accordingly, the assets of these funds are not included in the financial statements. The fair value of these funds was $12.8 million and $12.0 million as of June 30, 2013 and 2012, respectively. Investment income earned on these assets is transferred to the University in accordance with applicable trust agreements. Income received from those sources for the years ended June 30, 2013 and 2012 was $456,000 and $486,000, respectively.

3. ACCOUNTS AND STUDENT LOANS RECEIVABLE

Accounts receivable at June 30, 2013 and 2012 consisted of the following (amounts in thousands):

	2013	2012
Grants and contracts	$ 27,876	$ 22,477
Student and general	16,318	16,180
Investment income	66	79
Allowance for doubtful accounts	(5,056)	(5,519)
Total accounts receivable, net	$ 39,204	$ 33,217

The University participated in the U.S. Department of Education Federal Direct Lending program during fiscal years 2013 and 2012 and distributed student loans through this program of $154.6 million and $162.0 million, respectively. These distributions and related funding are not reflected as expenses and revenues or as cash disbursements and cash receipts in the accompanying financial statements. The excess of direct loans distributed over funding received from the U.S. Department of Education as of June 30, 2013 and 2012 was $68,000 and $93,000, respectively, and these amounts were included as receivables under grants and contracts.

Student loans receivable are substantially comprised of amounts owed from students under the Federal Perkins Loan Program and are reported separately from accounts receivable on the Statements of Net Position, net of an allowance for doubtful accounts of $1.1 million at June 30, 2013 and 2012.

4. PROPERTY AND EQUIPMENT

Land, buildings, non-structural improvements, and equipment are reported at cost at date of acquisition or fair value at date of donation as in the case of gifts. Property and equipment that are exchanged for other assets are recorded based on the fair value of the asset given up or the fair value of the asset received, whichever value is most clearly evident. Any gains or losses on the exchange are recognized immediately.

Depreciation and amortization are recorded on a straight-line basis over the estimated useful lives of the respective assets. Building components and non-structural improvements have estimated useful lives of 2 years to 60 years. Equipment has estimated useful lives of 3 years to 30 years. Library materials, capitalized software, art and historical collections are all included in equipment in the schedule of Changes in Property and Equipment.

Library materials have an estimated useful life of 15 years. The value of library materials, before depreciation, was $80.6 million and $80.1 million with accumulated depreciation of $52.6 million and $47.3 million at June 30, 2013 and 2012, respectively.

Capitalized software has an estimated life of 3 years to 5 years. The value of capitalized software, before amortization, was $26.6 million and $25.1 million with accumulated amortization of $15.5 million and $12.4 million at June 30, 2013 and 2012, respectively.

Art and historical collections are recognized at their estimated fair values at the time of donation, and are not depreciated. Art totaled $13.3 million and $12.8 million at June 30, 2013 and 2012, respectively. Historical collections totaled $41.1 million and $40.5 million at June 30, 2013 and 2012, respectively. The Thomas J. Dodd Research Center (Dodd Center) maintains historical collections of original source materials used for research as well as the University's official archive. In fiscal year 2002, historical collections were initially valued at $31.1 million based on an internal valuation performed by the Dodd Center. Since 2002, the value of the Dodd Center Collection has been adjusted for new items only if their fair value could be substantiated by an appraisal or similar authoritative documentation.

On July 1, 2010, the University increased the capitalization threshold for equipment from $1,000 to $5,000. Equipment previously capitalized under the $5,000 threshold will be written-off when it becomes fully depreciated. For the years ended June 30, 2013 and 2012, total amounts of $5.5 million and $13.9 million, respectively, of fully depreciated equipment falling under the new threshold are included in equipment retirements.

As of June 30, 2011, a liability in the amount of $2.7 million was recorded in other current liabilities on the Statement of Net Position for a project to correct structural deficiencies related to the roof design and construction of the Agricultural Biotechnology Laboratory and Advanced Technology Laboratory buildings. This amount was based on an estimate of the cost to replace the roofs on both buildings as of that date. A determination has been made that the replacement of the roofs on these buildings is not necessary and repairs can be made to correct the deficiencies; therefore the $2.7 million liability is no longer needed, and was reversed during the fiscal year ended June 30, 2013. The University has entered into, and is in the process of entering into, agreements seeking funds and in-kind services from the original design professionals and construction contractors to perform the repairs to the roofs. The total cost of the repairs is not fully known at this time.

For the years ended June 30, 2013 and 2012, total amounts of $7.6 million and $3.2 million, respectively, were expensed in the accompanying Statements of Revenues, Expenses, and Changes in Net Position in operating expenses for inspections, fire and safety code updates, and other corrective action needed in order to achieve safety goals for all buildings. At June 30, 2013 and 2012, an accrual for estimated expenses to complete these projects totaling $16.6 million and $12.1 million, respectively, was recorded in other current liabilities in the Statements of Net Position. While the University intends to pursue the recovery of costs related to the code updates and corrective work, the total amount to be recovered is unknown as of the date of these financial statements.

For the year ended June 30, 2013, a total of $1.3 million was expensed in institutional support in the accompanying Statements of Revenues, Expenses, and Changes in Net Position for costs related to the implementation of certain software. It was determined that costs capitalized to date had no realizable value as of June 30, 2013.

Subsequent to the year ended June 30, 2013, it was determined by management that certain buildings with a total carrying amount of approximately $24.5 million were potentially impaired as of year-end. The total impairment loss could not be reasonably estimated as of the date of these financial statements.

The following table describes the changes in property and equipment for the years ended June 30, 2013 and 2012 (amounts in thousands):

Changes in Property and Equipment for the Year Ended June 30, 2013:

	Balance July 1, 2012	Additions	Retirements	Transfers and other	Balance June 30, 2013
Property and equipment:					
Land	$ 14,657	$ 3,843	$ (3)	$ -	$ 18,497
Non-structural improvements	217,567	4,837	-	3,886	226,290
Buildings	1,708,888	28,537	-	51,993	1,789,418
Equipment	396,662	16,543	(9,841)	-	403,364
Construction in progress	99,271	82,343	-	(55,879)	125,735
Total property and equipment	2,437,045	136,103	(9,844)	-	2,563,304
Less accumulated depreciation and amortization:					
Non-structural improvements	107,079	8,395	-	-	115,474
Buildings	673,778	58,523	-	-	732,301
Equipment	225,599	24,795	(9,434)	-	240,960
Total accumulated depreciation and amortization	1,006,456	91,713	(9,434)	-	1,088,735
Property and equipment, net:					
Land	14,657	3,843	(3)	-	18,497
Non-structural improvements	110,488	(3,558)	-	3,886	110,816
Buildings	1,035,110	(29,986)	-	51,993	1,057,117
Equipment	171,063	(8,252)	(407)	-	162,404
Construction in progress	99,271	82,343	-	(55,879)	125,735
Property and equipment, net:	$ 1,430,589	$ 44,390	$ (410)	$ -	$ 1,474,569

Changes in Property and Equipment for the Year Ended June 30, 2012, restated (see Note 1):

	Balance July 1, 2011	Additions	Retirements	Transfers and other	Balance June 30, 2012
Property and equipment:					
Land	$ 14,676	$ -	$ (19)	$ -	$ 14,657
Non-structural improvements	205,766	3,450	-	8,351	217,567
Buildings	1,643,933	16,065	(1,844)	50,734	1,708,888
Equipment	396,841	26,088	(26,267)	-	396,662
Construction in progress	83,433	74,923	-	(59,085)	99,271
Total property and equipment	2,344,649	120,526	(28,130)	-	2,437,045
Less accumulated depreciation and amortization:					
Non-structural improvements	99,318	7,761	-	-	107,079
Buildings	619,902	55,450	(1,574)	-	673,778
Equipment	226,166	25,267	(25,834)	-	225,599
Total accumulated depreciation and amortization	945,386	88,478	(27,408)	-	1,006,456
Property and equipment, net:					
Land	14,676	-	(19)	-	14,657
Non-structural improvements	106,448	(4,311)	-	8,351	110,488
Buildings	1,024,031	(39,385)	(270)	50,734	1,035,110
Equipment	170,675	821	(433)	-	171,063
Construction in progress	83,433	74,923	-	(59,085)	99,271
Property and equipment, net:	$ 1,399,263	$ 32,048	$ (722)	$ -	$ 1,430,589

5. LONG-TERM DEBT PAYABLE

Public Act No. 95-230 enabled the University to borrow money in its own name for a special ten year capital improvement program (UCONN 2000) designed to modernize, rehabilitate, and expand the physical plant of the University. It authorized projects for Phases I and II of UCONN 2000, estimated to cost $1,250.0 million, of which $962.0 million was to be financed by bonds of the University; $18.0 million was to be funded by State general obligation bonds; and the balance of $270.0 million to be financed by gifts, other revenue, or borrowing resources of the University.

In fiscal year 2002, the General Assembly of the State of Connecticut enacted and the Governor signed into law Public Act No. 02-3 of the May 9 Special Session, An Act Concerning 21st Century UConn (Act). The new Act authorized additional projects for the University and the Health Center for what is called Phase III of UCONN 2000 at an estimated cost of $1,348.4 million, of which $1,300.0 million is to be financed by bonds of the University. This Act amended Public Act No. 95-230 and extended the UCONN 2000 financing program that was scheduled to end in 2005, for an additional 10 years to June 30, 2015. The 21st Century UConn program was amended in fiscal year 2008, extending it an additional year to June 30, 2016, without any change in the total amount. In fiscal year 2010, the Act was amended again including a $25.0 million reallocation from existing UCONN 2000 Health Center allocations, and a $207.0 million increase in UCONN 2000 debt service commitment authorizations for the UConn Health Network. This also extended the UCONN 2000 program two additional years to fiscal year 2018. In fiscal year 2011, the General Assembly enacted and the Governor signed Public Act No. 11-75, An Act Concerning the University of Connecticut Health Center, which increased the authorized project costs for the Health Center under Phase III by $262.9 million. The Act, as amended, authorized projects under Phase III at a total estimated cost of $1,818.3 million, of which $1,769.9 million is to be financed by bonds of the University and $48.4 million is to be financed by the issuance of special obligation bonds of the University, from gifts, other revenue or borrowing resources of the University, or through the deferring of projects or achieved savings. Total project costs estimated under Phase III are $775.3 million for the Health Center and $1,043.0 million for the University.

In June 2013, the General Assembly of the State of Connecticut enacted and the Governor signed into law Public Act No. 13-233, An Act Concerning Next Generation Connecticut, which authorized additional projects, increased the cost of certain projects, increased the authorized bond funding by $1,551.0 million and extended UCONN 2000 for an additional six fiscal years to 2024.

The total estimated cost for Phase I, II, and III under UCONN 2000, a twenty-nine year capital project program, is $4,619.3 million.

As part of the UCONN 2000 program and in addition to $4.6 billion for phases I through III, the State Bond Commission authorized $172.5 million in State General Obligation Bonds to finance the development of the Technology Park (Tech Park) on the Storrs campus for the University (see Note 12). In August 2011 and April 2013, $18.0 million and $20.0 million respectively, were approved and issued. These bonds are obligations of the State and are not included as debt in the University's financial statements.

The table below lists general obligation bonds issued to finance UCONN 2000 projects as of June 30, 2013 (amounts in thousands). Please refer to the subsequent detailed schedules for outstanding balances.

1996 Series A	$ 83,930
1997 Series A	124,392
1998 Series A	99,520
1999 Series A	79,735
2000 Series A	130,850
2001 Series A	100,000
2002 Series A	100,000
2003 Series A	96,210
2004 Series A	97,845
2005 Series A	98,110
2006 Series A	77,145
2007 Series A	89,355
2009 Series A	144,855
2010 Series A	97,115
2011 Series A	179,730
Total issued	$ 1,598,792

The University has also issued several series of general obligation refunding bonds, providing debt service savings for bonds refunded in advance of maturity. Sufficient proceeds were deposited into irrevocable escrow accounts held by the Trustee Bank to meet all obligations on the refunded debt (see Note 1) and invested in U.S. Treasury, State and Local Government Securities and cash in accordance with the Escrow Agreement. These bonds are general obligations of the University, for which its full faith and credit are pledged, and are payable from all assured revenues. The bonds are additionally secured by the pledge of and a lien upon the State debt service commitment. The State debt service commitment is the commitment by the State to pay an annual amount of debt service on securities issued as general obligations of the University. The University, consistent with the Act, is relying upon the receipt of the annual amount of the pledged State debt service commitment for the payment of the bonds and, accordingly, is not planning to budget any revenues for the payment of these bonds. Under the Master Indenture, the University expects to issue additional bonds to finance UCONN 2000 projects secured by the State debt service commitment.

In fiscal year 2013, there were no general obligation bonds issued or refunded. In fiscal year 2012, the University recorded $179.7 million as State debt service commitment for principal together with part of the original issue premium, which resulted in total proceeds of $200.0 million for the 2011 Series A bonds. The proceeds included $62.5 million to finance projects for the Health Center for fiscal year 2012. As bonds are issued, the amount of the commitment for the Health Center is reflected as an offset to the revenue for the University. In fiscal year 2012, this offset to finance projects for the Health Center resulted in net revenue of $115.4 million, recorded in the Other Changes in Net Position section of the Statements of Revenues, Expenses, and Changes in Net Position in the accompanying financial statements. A corresponding liability is recorded in due to affiliate in the Statements of Net Position for the unspent portion of the bonds due to the Health Center ($3.9 million and $48.3 million at June 30, 2013 and 2012, respectively). Also, for the years ended June 30, 2013 and 2012, nonoperating revenues include the State debt service commitment for interest on general obligation bonds of $40.6 million and $39.8 million, respectively. A portion of interest on general obligation bonds is associated with Health Center projects.

Subsequent to the year ended June 30, 2013, the University issued $172.7 million of general obligation bonds, 2013 Series A, to fund UCONN 2000 phase III projects and $51.2 million of General Obligation Bonds, 2013 Refunding Service A, to refund $54.4 million of the University's outstanding balances consisting of a portion of the 2004 and 2005 Service A bonds previously issued. The sale of this issue concluded in July 2013, with the closing date of July 31, 2013.

The University may also issue special obligation bonds, also called student fee revenue bonds, which are backed by certain pledged revenues of the University. In 1998, 2000 and 2002, the University issued $33.6 million, $89.6 million and $75.4 million of special obligation bonds, respectively, to fund new construction of dormitories, apartments, a parking garage, and the renovations of several dormitories. The 2000 special obligation bonds were refunded in advance of maturity in fiscal year 2002 with the issuance of $96.1 million in refunding bonds. The 1998 and a portion of the 2002 special obligation bonds were refunded in advance of maturity in fiscal year 2010 with the issuance of $47.5 million refunding bonds. The 2002 special obligation bonds and 2002 refunding bonds were refunded in advance of maturity in fiscal year 2013 with the issuance of $88.0 million of special obligation refunding bonds. The 2012 special obligation refunding bonds reduced the special obligation debt service payments in future years by approximately $31.9 million and resulted in an economic gain (the present value of the savings) of approximately $26.7 million. Similar to general obligation bond refundings, the proceeds from special obligation or student fee revenue bond refundings are deposited into certain escrow accounts to meet all obligations of the refunded maturities. In fiscal year 2012, there were no special obligation bonds issued or refunded.

The special obligation bonds are secured by certain pledged revenues, as defined in the indenture, including gross and net revenue amounts. The total gross and net pledged revenues from tuition and fees, auxiliary, investment and other revenues of the University were approximately $67.3 million and $65.1 million in fiscal years 2013 and 2012, respectively. Gross pledged revenues include the infrastructure maintenance fee and the general university fee plus investment income on the bond accounts held by the Trustee Bank, prior to any payments, deductions, offsets, or provisions. Net pledged revenues include the residential life room fee, student apartment rentals, Greek housing fee, the board (dining) fee, and the parking and transportation fees, after providing for the cost of maintaining, repairing, insuring, and operating the facilities for which the fees are imposed. In addition to securing revenue bonds, the gross and net pledged revenues available are pledged toward certain other debt. The University has covenanted to collect in each fiscal year, fees representing pledged revenues so that the sum of gross and net revenue amounts is no less than 1.25 times the debt service requirements in such fiscal year for the special obligation bonds.

The total principal and interest remaining to be paid on all special obligation bonds as of June 30, 2013 and 2012 was $187.6 million and $231.5 million, respectively. The total amount paid by pledged revenues were $5.7 million and $5.1

million, for the principal and $6.3 million and $7.6 million for the interest on this debt in both fiscal years 2013 and 2012, respectively.

Net unamortized premium, discounts, and debt differences due to refundings are recorded as additions to the face value of bonds payable. These amounts are amortized using the straight-line basis over the life of the bonds, reducing interest expense for premiums and increasing it for discounts.

The State issues certain general obligation bonds that are categorized as self-liquidating bonds. These bonds were issued to fund the construction and renovations of revenue-generating capital projects. The University reimburses the State primarily with revenue from student fee charges in the amount equal to the debt service on self-liquidating bonds.

Long-term debt activity, including refunding of debt, for the years ended June 30, 2013 and 2012 was as follows (amounts in thousands):

Long-term Debt Activity for the Year Ended June 30, 2013:

	Balance July 1, 2012	Additions	Retirements	Balance June 30, 2013	Current portion
General obligation bonds	$ 903,550	$ -	$ (74,755)	$ 828,795	$ 77,750
Revenue bonds	154,170	87,980	(111,735)	130,415	5,800
Self-liquidating bonds	2,171	-	(1,121)	1,050	500
Installment loans	1,727	-	(408)	1,319	377
Obligation under capital lease for Cogeneration	62,785	-	(3,465)	59,320	3,623
Total long-term debt	1,124,403	87,980	(191,484)	1,020,899	88,050
Premiums/discounts/debt difference due to refunding	46,320	14,796	(819)	60,297	4,224
Total long-term debt, net	$ 1,170,723	$ 102,776	$ (192,303)	$ 1,081,196	$ 92,274

Long-term Debt Activity for the Year Ended June 30, 2012:

	Balance July 1, 2011	Additions	Retirements	Balance June 30, 2012	Current portion
General obligation bonds	$ 804,310	$ 211,635	$ (112,395)	$ 903,550	$ 74,755
Revenue bonds	159,290	-	(5,120)	154,170	5,705
Self-liquidating bonds	2,953	-	(782)	2,171	569
Installment loans	150	1,840	(263)	1,727	408
Obligation under capital lease for Cogeneration	66,098	-	(3,313)	62,785	3,465
Total long-term debt	1,032,801	213,475	(121,873)	1,124,403	84,902
Premiums/discounts/debt difference due to refunding	25,849	24,663	(4,192)	46,320	3,470
Total long-term debt, net	$ 1,058,650	$ 238,138	$ (126,065)	$ 1,170,723	$ 88,372

Long-term debt outstanding at June 30, 2013 and 2012 consisted of the following (amounts in thousands):

Type of debt and issue date	Type of issue	Principal payable	Maturity dates through fiscal year	Interest rate*	Balance 2013	Balance 2012
Bonds:						
GO 2003 Series A	original	annually	2013	3.2-4.4%	$ -	$ 4,735
GO 2004 Series A	original	various	2024	3.0-5.0%	22,160	27,055
GO 2004 Ref. Series A	refund	annually	2020	3.9-5.0%	120,570	149,730
GO 2005 Series A	original	annually	2025	3.7%	55,630	60,530
GO 2006 Series A	original	annually	2026	4.0-5.0%	50,130	53,990
GO 2006 Ref. Series A	refund	annually	2020	4.75-5.0%	57,780	59,555
GO 2007 Series A	original	annually	2027	3.6-5.0%	58,800	63,005
GO 2007 Ref. Series A	refund	various	2022	5.0%	46,030	46,030
GO 2009 Series A	original	annually	2029	3.0-5.0%	115,465	122,815
GO 2010 Series A	original	annually	2030	3.0-5.0%	82,540	87,400
GO 2010 Ref. Series A	refund	annually	2021	2.25-5.0%	26,410	26,435
GO 2011 Series A	original	annually	2031	3.515-5.0%	161,755	170,745
GO 2011 Ref. Series A	refund	various	2023	2.0-5.0%	31,525	31,525
Total general obligation bonds					828,795	903,550
Rev 2002 Series A	original	various	2030	4.125-5.0%	-	32,430
Rev 2002 Ref. Series A	refund	annually	2030	4.0-5.25%	-	76,230
Rev 2010 Ref. Series A	refund	annually	2028	3.0-5.0%	42,435	45,510
Rev 2012 Ref. Series A	refund	annually	2030	1.5-5.0%	87,980	-
Total revenue bonds					130,415	154,170
June 2001	refund	annually	2016	5.5%	225	301
November 2001	refund	annually	2014	5.0-5.125%	295	592
August 2002	refund	various	2016	3.62-4.0%	-	552
April 2005	refund	various	2017	4.37-5.25%	275	275
December 2007	refund	annually	2015	3.5-5.0%	255	451
Total self-liquidating bonds					1,050	2,171
Total bonds					960,260	1,059,891
Loans and other debt:						
Installment loans		various	various	1.05-1.959%	1,319	1,727
Obligation under capital lease for Cogeneration		monthly	2026	4.42-5.09%	59,320	62,785
Total loans and other debt					60,639	64,512
Total bonds, loans and installment purchases					1,020,899	1,124,403
Premiums/discounts/debt difference due to refunding					60,297	46,320
Total bonds, loans and installment purchases, net					1,081,196	1,170,723
Less: current portion, net					92,274	88,372
Total noncurrent portion, net					$ 988,922	$ 1,082,351

**Weighted average coupon rates averaged by year of redemption.*

Long-term debt including general obligation bonds, revenue bonds and loans are scheduled to mature in the following fiscal years as of June 30 (amounts in thousands):

	General obligation bonds			Long-term debt other than general obligation bonds			Total obligations		
Year(s)	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total
2014	$ 77,750	$ 38,502	$ 116,252	$ 10,300	$ 8,420	$ 18,720	$ 88,050	$ 46,922	$ 134,972
2015	77,595	35,145	112,740	10,353	8,057	18,410	87,948	43,202	131,150
2016	72,965	31,561	104,526	10,629	7,611	18,240	83,594	39,172	122,766
2017	71,295	28,146	99,441	11,065	7,178	18,243	82,360	35,324	117,684
2018	68,215	24,865	93,080	11,032	6,724	17,756	79,247	31,589	110,836
2019-2023	268,695	80,490	349,185	62,464	25,875	88,339	331,159	106,365	437,524
2024-2028	148,270	29,669	177,939	58,611	10,912	69,523	206,881	40,581	247,462
2029-2033	44,010	3,654	47,664	17,650	880	18,530	61,660	4,534	66,194
Total	$ 828,795	$ 272,032	$ 1,100,827	$ 192,104	$ 75,657	$ 267,761	$ 1,020,899	$ 347,689	$ 1,368,588

6. RETIREMENT PLANS AND POST EMPLOYMENT BENEFITS

All eligible employees participate in essentially one of three retirement plans. The State Employees' Retirement System (SERS), a single-employer defined-benefit pension plan, is administered by the State and covers approximately 43% of the University's eligible employees. Plan benefits and contribution requirements of plan members and the University are described in Section 5-152 to 5-192 of the General Statutes. The State is statutorily responsible for the pension benefits of University employees who participate in this plan; therefore, no liability for pension benefits is recorded in the University's financial statements. The State is required to contribute at an actuarially determined rate, which may be reduced by an act of the State legislature. The plan does not issue stand-alone financial reports. Information on the plan is publicly available in the State of Connecticut's Comprehensive Annual Financial Report.

The University also sponsors the Alternative Retirement Plan (ARP) for unclassified eligible employees, a defined contribution plan administered through a third-party administrator, ING Life Insurance and Annuity Company. Plan provisions, including contribution requirements of plan members and the University, are described in Section 5-156 of the General Statutes.

In accordance with the State Employees Bargaining Agency Coalition (SEBAC) ARP Grievance Award signed by the State and SEBAC on September 22, 2010, employees enrolled in ARP have the one-time opportunity to make their irrevocable choice to either remain in ARP or transfer to SERS. The University employs approximately 2,600 individuals eligible for the conversion. If eligible individuals choose to convert to SERS, fringe benefit costs for these individuals would increase. The deadline for this election shall be determined following receipt of the Internal Revenue Service Private Letter Ruling. It is unclear at this time what the financial impact on the University will be, if any.

On July 22, 2011, an agreement between the State and SEBAC was signed which created a new hybrid plan option for professional employees of higher education institutions. In accordance with the 2011 SEBAC agreement, all employees hired on or after July 1, 2011, that are otherwise eligible for ARP, shall have the choice to enroll into a new hybrid plan, in addition to the other two retirement plan options. Also, employees who are currently members of ARP will be eligible to join the hybrid plan on a one time option at the full actuarial cost. The hybrid plan has defined benefits identical to SERS, but will require additional employee contributions, and have the option of taking out a lump sum cash payment, including interest, at the time of retirement in lieu of a lifetime benefit. The University makes contributions on behalf of the employees for all plans, through a fringe benefit charge assessed by the State.

Employees previously qualified for the Teachers' Retirement System (TRS) continue coverage during employment with the University, and do not participate in the above mentioned retirement plans. TRS is a single-employer defined-benefit plan covering any teacher, principal, superintendent, or supervisor engaged in service of public schools in the State. Plan benefits and required contributions of plan members and the University, are described in Section 10-183b to 10-183pp of the General Statutes.

With respect to the University's Department of Dining Services (DDS), of its 503 full-time employees, 78 participate in either SERS or ARP, while 425 are eligible to participate in two other retirement plans: the Department of Dining Services Money Purchase Pension Plan (MPPP) or the University of Connecticut Department of Dining Services 403(b) Retirement Plan. Under the provisions of MPPP, the University DDS is required to contribute 6% or 8% of employee's covered compensation for eligible employees, dependent upon hire date, and its employees do not make any contributions to the Plan. The MPPP is a defined contribution plan administrated through a third-party administrator, Pension Consultants, Inc. On behalf of MPPP participants, DDS contributed approximately $639,000 and $590,000 to the plan for the years ended June 30, 2013 and 2012, respectively.

In addition to the pension benefits, the State provides post retirement health care and life insurance benefits to University employees in accordance with State Statutes Sections 5-257(d) and 5-259(a). When employees retire, the State may pay up to 100% of their health care insurance premium cost (including dependents' coverage) based on the plan chosen by the employee. In addition, the State pays 100% of the premium cost for a portion of the employee's life insurance continued after retirement. The amount of life insurance continued at no cost to the retiree is determined by a formula based on the number of years of State service that the retiree had at the time of retirement. The State is responsible and finances the cost of post retirement health care and life insurance benefits on a pay-as-you-go basis through an appropriation in the General Fund; therefore, no liability is recorded in the University's financial statements.

7. COMPENSATED ABSENCES AND WAGES PAYABLE

Compensated absences are recorded in accordance with GASB Statement No. 16, *Accounting for Compensated Absences*. The liability for compensated absences is classified as current and noncurrent based on the amount estimated to be paid to eligible employees in one year and beyond one year, respectively. Compensated absences include accrued unused vacation, holiday, compensatory and sick leave balances for employees. As of June 30, 2013 and 2012, compensated absences totaled $33.2 million and $33.0 million, respectively. During fiscal year 2009, the State offered a Retirement Incentive Plan (RIP) to University employees. According to the terms of the RIP, unused vacation and sick leave will be paid in three payments on July 1 of each year, beginning July 1, 2012. Included in the current compensated absences liability as of June 30, 2013 and 2012, were $873,000 and $897,000, respectively, for accrued vacation and sick leave for University employees that participated in RIP. The noncurrent compensated absences liability as of June 30, 2013 and 2012, included $873,000 and $1.7 million, respectively, for such employees. The following table shows activity for compensated absences for the fiscal years ended June 30 (amounts in thousands):

	2013	2012
Beginning balance, July 1st	$ 33,006	$ 34,467
Additions, net	2,787	1,250
Deductions (separations only)	(2,566)	(2,711)
Ending balance, June 30th	$ 33,227	$ 33,006

Wages payable includes salaries and wages for amounts owed at the fiscal year end June 30. The State administers benefit and retirement plans for the University. Therefore, the payable for fringe benefits related to wages payable is included in due to the State as of June 30.

8. COMMITMENTS

On June 30, 2013, the University had outstanding commitments in excess of $500,000 each, which totaled $346.8 million, and included $343.6 million of commitments related to capital projects. Of this amount, commitments totaling $291.3 million related to UCONN 2000 capital projects that are administered by the University for the Health Center. The commitments on behalf of the Health Center are included in the due to affiliate (see Note 5). A portion of the total amount of outstanding commitments was also included in accounts payable on the Statement of Net Position as of June 30, 2013. In addition to the amount for capital outlay, commitments were also related to research and academic support. Of these commitments, the University expects approximately $1.7 million to be reimbursed by federal and state grants.

9. LEASES

Operating Leases
The University leases equipment and building space which expire at various dates. Future minimum rental payments at June 30, 2013 under non-cancelable operating leases, that exceeded $500,000 each, were as follows (amounts in thousands):

Fiscal Year	Payments
2014	$ 1,460
2015	1,532
2016	1,207
2017	374
2018	302
Thereafter	1,154
Total	$ 6,029

Expenses related to operating lease commitments in excess of $500,000 each were approximately $1.5 million and $1.0 million for the fiscal years ended June 30, 2013 and 2012, respectively.

Capital Leases
In December 2003, the University entered into a 20-year lease purchase agreement for a project to provide on-site generation of electricity, steam and chilled water for heating and cooling for the University at its Storrs campus. The project initially assumed a total cost of $75.0 million and included construction of a building, engineering, design and installation of certain equipment at the Storrs campus. The lease was amended in August 2005 as a result of an increase in the total anticipated cost to $81.9 million. With the amendment, monthly payments of $471,000 increased to $517,000. Payments began January 2006 with interest at a nominal rate of 4.42% on the first $75.0 million and 5.09% for the last $6.9 million of advances. The lease was amended again in July 2013 to reflect a new nominal rate of 3.22% on the total amount of advances. The remaining monthly payments decreased to $482,000 beginning August 2013, and the original lease term did not change. Amounts advanced by the lessor include capitalized interest during construction, and are reflected as long-term debt in the accompanying financial statements. At the completion of the lease term, the University has an option to purchase the project assets for one dollar. The historical cost and accumulated depreciation of the Cogeneration facility were $85.0 million and $26.1 million, respectively, as of June 30, 2013.

The University leases equipment assets with an historical cost and accumulated depreciation of $1.9 million and $335,000, respectively, as of June 30, 2013.

All assets subject to capital lease agreements are included in property and equipment on the accompanying Statements of Net Position, and depreciation on these assets is included in depreciation and amortization expense in the accompanying Statements of Revenues, Expenses, and Changes in Net Position (see Note 4). Loans related to these capital lease agreements are included in long-term debt and bonds payable on the accompanying Statements of Net Position (see Note 5).

10. DEFERRED INCOME AND CHARGES

Deferred income is comprised of certain restricted research and operating grants that are not included in revenue until the funds are expended; tuition and fees and auxiliary enterprises fees received in advance of services rendered for summer and fall sessions; athletic ticket sales and commitments received in advance of the season; and other revenues received but not earned.

As of June 30, 2013 and 2012 deferred income was as follows (amounts in thousands):

	2013	2012
Certain restricted research and operating grants	$ 8,358	$ 8,363
Tuition and fees and auxiliary enterprises	13,809	13,619
Athletic ticket sales and commitments	3,358	2,827
Total deferred income	$ 25,525	$ 24,809

A portion of current deferred charges totaling $661,000 and $741,000 and noncurrent deferred charges totaling $7.2 million and $7.9 million at June 30, 2013 and 2012, respectively, represented the cost of issuance on certain bond issuances which is amortized over the terms of the respective bond issues (see Note 5).

11. TUITION WAIVERS AND GRADUATE ASSISTANTSHIPS

The University is required by law to waive tuition for certain veterans and children of veterans, certain students over the age of 62, graduate assistants, and certain other students. The University is also required by collective bargaining agreements to waive tuition for certain employees and their dependents. The University has included the portion of waived tuition related to employees and their dependents as a fringe benefit cost and the same amount as tuition revenue in the Statements of Revenues, Expenses and Changes in Net Position. This increased tuition and fee revenues and operating expenses by $5.1 million and $5.2 million for the fiscal years ended June 30, 2013 and 2012, respectively. The total amount of waivers not reflected in the accompanying financial statements were $44.2 million and $43.6 million in fiscal years 2013 and 2012, respectively. In fiscal years 2013 and 2012, approximately 94% and 93%, respectively, were provided to graduate assistants. Of these amounts, $1.4 million and $1.1 million, respectively, were charged back to grants for reimbursement.

12. RELATED PARTY TRANSACTIONS

The Foundation

The Foundation is a tax-exempt organization supporting the University and the Health Center (see Note 1). The University has entered into a written agreement with the Foundation whereby the University agreed to provide financial support to the Foundation through a guaranteed contractual amount and the Foundation agreed to reimburse the University for certain operating expenses incurred on the Foundation's behalf. The terms of the agreement also stipulate that goals, objectives, and financial arrangements are reviewed and agreed-upon by both parties on a bi-annual basis. The University also provides other services to the Foundation in addition to this agreement.

The following transactions occurred between the University and the Foundation as of and for the years ended June 30, 2013 and 2012 (amounts in thousands):

	2013	2012
Amount paid to the Foundation for its guaranteed contractual services	$ 7,120	$ 7,120
Reimbursements from the Foundation for operating expenses	$ 290	$ 331
Accrued capital and noncapital gift and grant revenue from the Foundation	$ 22,461	$ 22,335
Amount receivable from the Foundation*	$ 2,533	$ 2,885

**Included in accounts receivable, net, in the accompanying Statements of Net Position.*

In accordance with the terms of a ground lease between the University and the Foundation, the University leases approximately 1.58 acres to the Foundation, on which the Foundation building was constructed, at an annual rental amount of one dollar. The initial term of the ground lease is ninety-nine years and the Foundation has the right to extend the term of the ground lease for another ninety-nine years. The ground lease provides that, at its expiration or earlier termination, the Foundation shall surrender the premises and title to the building will be transferred to the University.

The State

The State supports the University's mission primarily via two mechanisms: State appropriation and the provision of payments for fringe benefits. State appropriation represents amounts appropriated to the University from the State's General Fund. Payments for fringe benefits were made by the State for reimbursements related to salaries expensed from the General Fund.

State appropriation and the provision of payments for fringe benefits for the years ended June 30, 2013 and 2012 consisted of the following (amounts in thousands):

	2013	2012
Amount of General Fund appropriation received from the State	$ 195,847	$ 205,586
Amount of payments for fringe benefits received from the State	89,099	86,522
Increase (decrease) of General Fund payroll included in receivable from the State	3,510	(9,738)
Total appropriation and payments for fringe benefits from the State	$ 288,456	$ 282,370

In fiscal year 2012, the University experienced a reduction of approximately $39.4 million in appropriation and payments for fringe benefits as a result of the State's economic difficulties. Prior to increases in fringe benefit rates, the State also rescinded approximately $15.0 million in appropriation and payments for fringe benefits in response to a widening State budget deficit in fiscal year 2013. For fiscal year 2014, the University will be subject to reductions in State support for required adjustments to agency-specific appropriations in accordance with Public Act 13-184, as amended by Public Act 13-247. The reductions pertaining to this legislation are estimated at $1.2 million in fiscal year 2014.

Pursuant to various public or special bond acts, the General Assembly empowers the State Bond Commission to authorize and approve the issuance of bonds for a variety of projects or purposes. In 2011, the State Bond Commission authorized $172.5 million of State General Obligation Bonds to create a Tech Park on the Storrs campus (see Note 5). On August 26, 2011, they approved and issued $18.0 million to finance the initial design and development costs of the Tech Park. On April 26, 2013, they approved an additional issuance of $20.0 million to purchase equipment for the Tech Park. These bonds are an obligation of the State; therefore, they are not recorded as a liability in the accompanying financial statements. The total amounts of $20.0 million and $18.0 million allotted by the State were recorded as capital allocations in other changes in net position in the accompanying Statements of Revenues, Expenses, and Changes in Net Position for the years ended June 30, 2013 and 2012, respectively. The unspent portion of these amounts were $35.6 million and $17.8 million as of June 30, 2013 and 2012, respectively, and were included in due from the State of Connecticut in the accompanying Statements of Net Position.

The State and the University were defendants in a lawsuit that was settled for $5.5 million in September 2013. The settlement was paid by the State from funds appropriated to the State Insurance Risk Management Board and from certain insurance policies maintained by the State (see Note 13).

Health Center and Office of Economic Development

Prior to fiscal year 2013, the Office of Technology Commercialization (OTC) was established as a university-wide function consisting of the following divisions: the Center for Science and Technology Commercialization (CSTC), the Research and Development Corporation (R&D Corp), and the Technology Incubation Program (TIP). In fiscal year 2012, the funding for these divisions was consolidated into the Health Center's budget, a part of which was reimbursed by the University in accordance with an annual memorandum of agreement for the transfer of funds. The aggregate total contributed by the University to fund the OTC in fiscal year 2012 was $952,000. Of this amount, $326,000 represented expenses paid by the University associated with OTC functions based on the Storrs campus.

During fiscal year 2012, the Office of Economic Development (OED) was established to ensure the successful economic development outcomes for the Tech Park and Bioscience Connecticut initiative along with coordinating all of the University's economic development activities. The OED consists of divisions formally under the OTC with the addition of the U.S. Economic Development Administration Program. In fiscal year 2013, the Health Center and the University each provided fifty percent funding for CSTC, R&D Corp, and TIP in accordance with an annual memorandum of agreement. The OED budget was managed by the University while selected expenses were paid directly by the Health Center. Any amounts owed by the Health Center for its remaining OED funding obligations were reimbursed directly to the University.

The University also engaged in certain cost share arrangements with the Health Center for shared services such as senior management salaries and managed UCONN 2000 funds for the Health Center's construction projects as well.

University of Connecticut Alumni Association

The University and the University of Connecticut Alumni Association (Association), a Connecticut non-stock corporation that is exempt from taxation under section 501(c)(3) of the Internal Revenue Code have an agreement that recognizes the benefits of a coordinated approach to alumni relationship building and defines the responsibilities of the parties. During the years ended June 30, 2013 and 2012, the University directed $1.1 million of support each year to the Association. The amounts supported by the University consist primarily of payroll and other operating expenses which facilitate the alumni programs and services for the benefit of the University. The Association also agreed to reimburse the University for certain operating expenses incurred on the Association's behalf. The amounts owed to the University related to these expenses from the Association as of June 30, 2013 and 2012 were $45,000 and $14,000, respectively, which were included in accounts receivable, net, in the accompanying Statements of Net Position.

Additionally, the Association manages the University's license plate program that has been established through the Department of Motor Vehicles. All revenue received by the University from the license plate program is disbursed to the Association to fund scholarships and to further support alumni outreach efforts. There was approximately $2,120 and $1,400 payable to the Association for the license plate program as of June 30, 2013 and 2012, respectively.

Campus Associates Limited Partnership

The University entered into a 50-year land lease with Campus Associates Limited Partnership (Campus Associates) on February 1, 2000. The limited partnership was formed for the purpose of managing the Nathan Hale Inn, a hotel located on campus. The lease provided for base rents of $5,000 for the first five years and $25,000 for the sixth year. For the seventh year and every year thereafter, base rent is adjusted by the increase in the Consumer Price Index. In exchange for a rent concession amounting to $100,000 in total for five years, the University received two limited partnership units. On June 15, 2009, the University purchased a third unit in the limited partnership paying $50,000 for the limited partnership interest (see Note 2). Under the land lease agreement, Campus Associates is responsible for certain costs which include real estate taxes, charges for public utilities, and other services. The amounts owed by Campus Associates for these costs as of June 30, 2013 and 2012, were $156,000 and $104,000, respectively, which were included in accounts receivable, net, in the accompanying Statements of Net Position.

Mansfield Downtown Partnership, Incorporated

The Mansfield Downtown Partnership, Incorporated (MDP) is a not-for-profit corporation that is exempt from taxation under section 501(c)(3) of the Internal Revenue Code and is comprised of the Town of Mansfield (Mansfield), the University, and individual business members and residents. MDP is responsible for organizing the enhancement and revitalization of three of Mansfield's commercial areas: Storrs Center, King Hill Road and the Four Corners. In accordance with its governing by-laws, members are required to submit annual dues, as determined by the board of directors, in lieu of financial support. In fiscal years 2013 and 2012, the University paid $125,000 each year in annual membership dues to MDP.

In connection with the Storrs Center project, the University entered into an agreement with the master developer of the project to sell 18.80 acres of land for approximately $101,000 per acre which is to be divided up in phases. In fiscal years 2013 and 2012, the University conveyed 5.09 acres and 1.80 acres, respectively, to the master developer which were sold at the stated price per acre. Related to the respective land sales in fiscal year 2012, the University conveyed 4.04 acres that were in turn, transferred to Mansfield at no cost for the provision of public improvements. In a separate transaction, the University also transferred 24.2 acres of land subject to a conservation restriction to Mansfield for consideration of one dollar in fiscal year 2012. Further land transactions are expected as the Storrs Center project continues to progress. Moreover, the University also provided water and sewer services, which were billed in accordance with the University's standard billing practices.

In addition, the University has also provided office space and administrative support for certain other related parties.

13. CONTINGENCIES

Certain claims and judgments against the University are covered by the State under Connecticut General Statute § 4-160 (see Note 12), which governs most tort and breach of contract claims. Additional coverage is provided for the University by insurance policies and funds maintained by the State.

The University is a party to various legal actions arising in the ordinary course of its operations. While it is not feasible to predict the ultimate outcome of these actions, it is the opinion of management that the resolution of the majority of these matters will not have a material effect on the University's financial statements. However, there are a small number of outstanding matters, including unasserted claims, of potential individual significance. With respect to two matters, certain claimants seek an aggregate of approximately $25.0 million. If claimants are successful, the claim would be paid from the State's General Fund, not from the University. The State expects these matters to be resolved for substantially less than the amounts claimed.

In the opinion of legal counsel, the aggregate exposure pertaining to the other remaining claims and unasserted claims cannot be reasonably estimated but is not expected to exceed $5.0 million.

A matter involving allegations of misconduct by a University faculty member has received public attention. In the opinion of legal counsel, this matter does not constitute pending or threatened litigation, nor does it constitute an unasserted possible claim or assessment probable of assertion.

The University also participates in federal, state and local government programs that are subject to final audit by the granting agencies. Management believes the adjustment of costs, if any, resulting from such audits would not have a material effect on the University's financial statements.

14. OPERATING EXPENSES BY NATURAL CLASSIFICATION

The table below details the University's operating expenses by natural classification for the years ended June 30, 2013 and 2012 (amounts in thousands):

For the fiscal year ended June 30, 2013:

	Salaries and wages	Fringe benefits	Supplies and other expenses	Utilities	Depreciation and amortization	Total
Instruction	$ 203,219	$ 73,328	$ 25,655	$ -	$ -	$ 302,202
Research	39,543	8,956	26,449	-	-	74,948
Public services	22,322	7,444	9,302	-	-	39,068
Academic support	61,143	26,573	29,963	-	-	117,679
Student services	19,785	7,738	5,787	5	-	33,315
Institutional support	31,340	16,202	15,696	64	-	63,302
Operations and maintenance	31,984	20,484	36,270	12,923	-	101,661
Depreciation and amortization	-	-	-	-	91,713	91,713
Student aid	301	3	6,850	-	-	7,154
Auxiliary enterprises	73,048	29,821	57,872	6,733	-	167,474
	$ 482,685	$ 190,549	$ 213,844	$ 19,725	$ 91,713	$ 998,516

For the fiscal year ended June 30, 2012:

	Salaries and wages	Fringe benefits	Supplies and other expenses	Utilities	Depreciation and amortization	Total
Instruction	$ 198,883	$ 65,031	$ 27,456	$ -	$ -	$ 291,370
Research	40,887	9,423	23,199	-	-	73,509
Public services	21,169	6,444	7,865	-	-	35,478
Academic support	59,226	23,671	25,443	-	-	108,340
Student services	21,974	8,228	5,054	-	-	35,256
Institutional support	28,130	12,513	12,749	73	-	53,465
Operations and maintenance	32,942	19,549	33,824	14,087	-	100,402
Depreciation and amortization	-	-	-	-	88,478	88,478
Student aid	361	1	5,745	-	-	6,107
Auxiliary enterprises	70,813	27,905	58,146	7,524	-	164,388
	$ 474,385	$ 172,765	$ 199,481	$ 21,684	$ 88,478	$ 956,793

TRUSTEES AND FINANCIAL OFFICERS
As of June 30, 2013

STATE OF CONNECTICUT
DEPARTMENT OF PUBLIC HEALTH
Office of Health Care Access

March 21, 2014 VIA FACISIMILE ONLY

Lesley N. Salafia
University of Connecticut
Office of the General Counsel
343 Mansfield Road, Unit 1177
Storrs, CT 06269-1177

RE: Certificate of Need Application, Docket Number 14-31889-CON
University of Connecticut
Certificate of Need Application Deemed Complete

Dear Ms. Salafia,

This letter is to inform you that, pursuant to Section 19a-639a (d) of the Connecticut General Statutes, the Office of Health Care Access has deemed the above-referenced application complete as of March 21, 2014.

If you have any questions regarding this matter, please feel free to contact me at (860) 418-7007.

Sincerely,

A. Veyberman

Alla Veyberman
Health Care Analyst

* * * COMMUNICATION RESULT REPORT (MAR. 21. 2014 2:43PM) * * *

FAX HEADER:

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STATE OF CONNECTICUT
OFFICE OF HEALTH CARE ACCESS

FAX SHEET

TO: MS.SALAFIA

FAX: 860.486.4369

AGENCY: UCONN

FROM: OHCA

DATE: 03/21/14 **Time:**

NUMBER OF PAGES: 2
(including transmittal sheet

Comments:
Docket Number: 14-31889

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Phone: (860) 418-7001 Fax: (860) 418-7053

410 Capitol Ave., MS#13HCA
P.O.Box 340308
Hartford, CT 06134

STATE OF CONNECTICUT
DEPARTMENT OF PUBLIC HEALTH
Office of Health Care Access

May 15, 2014

IN THE MATTER OF:

An Application for a Certificate of Need filed Pursuant to Section 19a-638, C.G.S. by:	Notice of Final Decision Office of Health Care Access Docket Number: 14-31889-CON
University of Connecticut	**Acquisition of a Magnetic Resonance Imaging Scanner at the University of Connecticut at Storrs**

To:

Lesley N. Salafia, Esq.
University of Connecticut
Office of the General Counsel
343 Mansfield Road, Unit 1177
Storrs, CT 06269-1177

Dear Attorney Salafia:

This letter will serve as notice of the Final Decision of the Office of Health Care Access in the above matter, as provided by Section 19a-638, C.G.S. On May 15, 2014, the Final Decision was rendered as the finding and order of the Office of Health Care Access. A copy of the Final Decision is attached hereto for your information.

Kimberly R. Martone
Director of Operations

Enclosure
KRM:amv

Department of Public Health
Office of Health Care Access
Certificate of Need Application

Final Decision

Applicant: **University of Connecticut**
343 Mansfield Road, Unit 1177, Storrs, CT

Docket Number: **14-31889-CON**

Project Title: **Acquisition of a 3.0 Tesla MRI Scanner**

Project Description: The University of Connecticut at Storrs ("University" or "Applicant") seeks authorization to acquire a new 3.0 Tesla ("3T") Magnetic Resonance Imaging ("MRI") scanner for research purposes. The total capital expenditure associated with this proposal is $8,000,000.

Procedural History: The Applicant published notice of its intent to file the Certificate of Need ("CON") application in the *Chronicle* on November 25, 26 and 27, 2013. On January 10, 2014, the Office of Health Care Access ("OHCA") received the CON application from the Applicant for the above-referenced project and deemed the application complete on March 21, 2014. OHCA received no responses from the public concerning the Applicant's proposal and no hearing requests were received from the public pursuant to Connecticut General Statutes ("Conn. Gen. Stat.") § 19a-639a. In rendering her decision, Deputy Commissioner Davis considered the entire record in this matter.

To the extent the findings of fact actually represent conclusions of law, they should be so considered, and vice versa. *SAS Inst., Inc., v. S & H Computer Systems, Inc.*, 605 F.Supp. 816 (Md. Tenn. 1985).

Findings of Fact and Conclusions of Law

1. The Applicant is a public research University with its main campus located in Storrs, Connecticut. http://www.uconn.edu

2. The Applicant proposes to acquire and install a 3T MRI scanner at its Storrs campus. The MRI will be used for functional magnetic resonance imaging ("fMRI")[1] research and will be located at the University's Phillips Communication Sciences Building, 850 Bolton Road, Storrs, Connecticut ("UConn MRI Center"). Ex. A., p. 5

3. The proposed MRI will be used by the Departments of Psychology, Physiology and Neurobiology, Linguistics, Kinesiology, Speech-Language-and-Hearing-Sciences and Economics. Researchers will utilize the scanner to study brain correlates of typical and atypical language processing, developmental disabilities (e.g., autism spectrum disorders or dyslexia), decision making and the processing of emotional or social stimuli. Ex. A., p. 5

4. The research performed using fMRI technology will provide key insights into various areas of cognitive neuroscience, behavioral genetics and educational neuroscience. It will help physicians understand developmental disorders such as autism, especially the unique brain adaptations associated with the disorder. Ex. A., p. 17

5. Due to its lack of fMRI technology, the University is severely limited in conducting research in the areas of brain correlates of typical and atypical language processing, developmental disabilities such as autism and dyslexia and the processing of decision making. Ex. A., p. 8

6. As there is no research MRI scanner available within the University's service area of Mansfield, Tolland or Windham, University researchers currently must travel to other research institutions in Connecticut or other states in order to use these institutions' fMRI scanners. Several researchers from the University's Department of Psychology and Cognitive Science program lease session times at other research MRI scanners in Connecticut or Rhode Island. Ex. A., pp. 5, 8-9

7. The University proposes to acquire a 3T MRI because of its desired Signal-to-Noise ratio which makes it the standard research tool in cognitive neuroscience and other brain research areas. Ex. A., p. 6

8. In accordance with State of Connecticut procurement practices, the University has released a competitive RFP for this acquisition, and will be seeking proposals from Siemens, Philips and GE. Thus, the acquired model could be one of the following: a 3T Siemens Prisma, a 3T Philips Ingenia or a 3T GE Discovery. Ex. A., p. 8

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[1] fMRI uses a combination of a magnet and radio frequencies to study oxygen flow to areas of the brain. Resulting images help researchers map which parts of the brain are used for speech, hearing, vision and motor skills. Ex. A, p. 5

9. Having the UConn MRI Center at the Storrs campus will help recruit new research faculty and attract and secure federal research funds granted to academic research sites that have fMRI technology. Ex. A., p. 9

10. The UConn MRI Center at the Storrs campus was selected as the location for the UConn MRI Center due to its ideal site parameters for an MRI scanner and the most centralized location, space availability and the greatest level of safety. Ex. A., p. 10

11. The proposed MRI will be used exclusively for research purposes and will not be used for the delivery of health care services. Ex. A., pp. 5-6

12. Volunteer research participants will be recruited from surrounding towns, University students, staff or faculty members. These research participants will not be provided any health care services. Ex. A., pp. 6, 10

13. All volunteer research subjects recruited for research studies at the UConn MRI Center will grant Informed Consent in accordance with the University's Institutional Review Board ("IRB") applicable policies. Ex. A., p. 10

14. The Applicant projects the following volume statistics for the first four years of 3T MRI operation:

Table 1: Projected Utilization for Research 3T MRI

FY 2015*	FY 2016**	FY 2017***	FY 2018****
182 hours*****	600 hours	1,000 hours	1,250 hours

Note: Applicant's Fiscal Year is from July 1st – June 30th
*The Applicant projects that FY 2015, as a partial period (6 mos), is expected to have 182 hours of use time at 7 hours per week for 26 weeks as the UConn MRI Center develops its operations and user base.
**For FY 2016, it is expected that the UConn MRI Center will be fully operational and usage will ramp up to 12 hours per week for 50 weeks.
***In FY 2017, it is expected that 20 hours per week of use time will be established, for which there will be a net gain for the UConn MRI Center due to billable hours and Office of Sponsored Program rates on grants for plant and administrative costs.
****In FY 2018, the operational goal is 25 hours per week for 50 weeks per year.
*****Unit of service is calculated in terms of use hours, as internal and external grant charges will be accrued on an hourly basis. The Applicant estimates that the MRI will be used 50 weeks per year with 2 weeks of service time.
Ex. A., p. 12

15. This proposal will have no impact on existing clinical MRI service area providers in Mansfield, Tolland or Windham, since the proposed MRI will be used for research purposes only and will not be offering clinical services. The existing MRI scanners in the area are used for clinical purposes and are not suitable for University research because their magnet strengths are lower than 3T. Ex. A., p. 9, 11

16. The UConn MRI Center will operate as a non-profit research entity that will rely upon research grants from federal agencies and private foundations, as well as on internal operational support from the University, for its operating costs. The initial capital expenditures for this proposal were allocated by the University's Board of Trustees as part of internal appropriations for scientific research initiatives. Ex. A., p. 6

17. The funding for this acquisition is secured through UConn 2000 State bond funds, as follows:

Table 2: Funding Source

Description	Amount
UConn 2000 Phase III-FY14DM	$4,700,000
UConn 2000 Equipment	$3,225,000
University Plant Funds	$75,000

Ex. A., pp. 6, 19, 243

18. The proposal's total capital expenditure is itemized as follows:

Table 3: Total Capital Expenditure

Description	Amount
Imaging Equipment Purchase	$3,225,000
Construction/Renovation*	$4,225,000
Project Contingency	$550,000
Total Project Cost	$8,000,000

* Construction/Renovation costs includes construction ($3,500,000), design services ($350,000), telecommunications ($35,000), construction administration ($90,000), project management and architectural engineering expenses ($150,000), relocation of existing space uses ($10,000), environmental costs ($60,000), insurance and legal costs ($10,000), and miscellaneous expenses ($20,000).
Ex. A., pp. 18, 243

19. The University anticipates an operational loss for direct UConn MRI Center operations in FY 2015 and 2016 but an overall gain in institutional wealth and prestige through this project. The University is financially prepared to assume short-term financial losses in direct operations of the UConn MRI Center.

Table **4: Projected Incremental Revenues and Expenditures**

Description	FY 2015	FY 2016	FY 2017	FY 2018
Revenue from Operations*	$172,536	$568,800	$948,000	$1,185,000
Total Operating Expenses**	$518,797	$816,066	$867,855	$897,682
Gain/(Loss) from Operations	($346,261)	($247,266)	$80,145	$287,318

*It is assumed that there will be a billable rate of $600/hour per use time on grants.
**Operating expenses include salaries/fringe benefits and depreciation.
Note: Incremental losses for each of the FY 2015 and FY 2016 are due to a number of factors. FY 2015 is a partial year of operation. Also, MRI research has not been conducted on the Storrs campus before; as such, there is a level of ramp-up expected and a level of conservatism with use hour projections. In addition, this is not a full accounting of the benefits/revenues derived or other costs that could be attributable to these other revenue generating activities.
Ex. A., p. 353

20. The proposed MRI will allow University researchers to have greater access to necessary fMRI equipment, greater flexibility in scheduling their research and better control over their research. Ex. A., p. 9

21. The research performed using the fMRI technology will provide key insights into various areas of cognitive neuroscience and thus enable continuous development and improvement of health care practices and technology. Ex. A., p. 19

22. This proposal will indirectly benefit the State's health care system by improving the quality of available research in cognitive neuroscience, behavioral genetics, and educational neuroscience, and provide enhanced techniques and technology. Ex. A., p. 19

23. This proposal will have no impact on access to services for Medicaid recipients or indigent persons because the proposed MRI will be used for research purposes only and will not be offering or providing clinical services. Ex. A., p. 20

24. OHCA is currently in the process of establishing its policies and standards as regulations. Therefore, OHCA has not made any findings as to this proposal's relationship to any regulations adopted by OHCA. (Conn .Gen. Stat. § 19a-639(a)(1))

25. This CON application is consistent with the overall goals of the State Health Care Facilities and Services Plan. (Conn. Gen. Stat. § 19a-639(a)(2))

26. The Applicant has established that there is a clear public need for its proposal. (Conn. Gen. Stat. § 19a-639(a)(3))

27. The Applicant has satisfactorily demonstrated that its proposal is financially feasible. (Conn. Gen. Stat. § 19a-639(a)(4))

28. The Applicant has satisfactorily demonstrated that its proposal is for research only and will not be used to provide any clinical services. Therefore, it has no impact on the accessibility and cost effectiveness of health care delivery in the region. The proposal has the potential to improve the quality of health care delivery in the region. (Conn. Gen. Stat. § 19a-639(a)(5))

29. The Applicant has shown that there will be no change in access to the provision of health care services to the relevant populations and payer mix since the proposed equipment is for research purposes only. (Conn. Gen. Stat. § 19a-639(a)(6))

30. The Applicant has satisfactorily identified the population to be served and has satisfactorily demonstrated that this population has a need. (Conn. Gen. Stat. § 19a-639(a)(7))

31. The utilization of existing health care facilities and health care services in the Applicant's service area is not applicable for this application since it is for research purposes only. (Conn. Gen. Stat. § 19a-639(a)(8))

32. The Applicant has satisfactorily demonstrated that the proposal will not result in an unnecessary duplication of existing services in the area. (Conn. Gen. Stat. § 19a-639(a)(9))

33. The Applicant has satisfactorily demonstrated that the proposal will not result in a reduction or change in access to services for Medicaid recipients or indigent persons. (Conn. Gen. Stat. § 19a-639(a)(10))

Discussion

CON applications are decided on a case by case basis and do not lend themselves to general applicability due to the uniqueness of the facts in each case. In rendering its decision, OHCA considers the factors set forth in General Statutes § 19a-639(a). The Applicant bears the burden of proof in this matter by a preponderance of the evidence. *Jones v. Connecticut Medical Examining Board, 309 Conn. 727 (2013).*

The University of Connecticut, a public research university with its main campus located in Storrs, Connecticut, proposes to acquire and install a 3T MRI scanner at its Storrs campus. *FF1-2* The MRI will be used for functional magnetic resonance imaging ("fMRI") research and will be utilized by the Departments of Psychology, Physiology and Neurobiology, Linguistics, Kinesiology, Speech-Language-and-Hearing-Sciences and Economics. Researchers will utilize the scanner to provide key insights into various areas of cognitive neuroscience, behavioral genetics and educational neuroscience. *FF3-4*

Due to its lack of fMRI technology, the University is severely limited in conducting research in the areas of brain correlates of typical and atypical language processing, developmental disabilities such as autism and dyslexia and the processing of decision making. *FF5* Currently, there is no research MRI scanner available within the University's service area of Mansfield, Tolland or Windham. *FF6* Other top-tier public research-intensive universities have one or more 3T MRI scanners dedicated specifically to research. *Ex. A, p. 9* As a result, the University's researchers must travel to other in-state research institutions or out-of-state to use other universities' fMRI scanners. *FF6*

The proposed MRI will be used exclusively for research purposes and will not be used for the delivery of health care services. *FF11* Volunteer research participants will be recruited from surrounding towns, University students, staff and faculty members. *FF12* All volunteer research participants will grant Informed Consent in accordance with the University's Institutional Review Board applicable policies.*FF13*

The UConn MRI Center will operate as a non-profit research entity that will rely on research grants from federal agencies and private foundations, as well as on internal support from the University, for its operating costs. The initial capital expenditures for this proposal were allocated by the University's Board of Trustees as part of internal appropriations for scientific research initiatives. *FF19* This proposal is financially feasible as the funding for this acquisition is secured through UConn 2000 State bond funds and will be operating at a net gain after the first two years of operation. *FF17-19*

Because the proposed MRI will be used for research purposes only, the proposal will not have an impact on existing clinical MRI service providers in the area, access to care, cost effectiveness or financial strength of the state's health care system. *FF16* Likewise, it will not have any impact on the services provided to the Medicaid population. It will, however, indirectly benefit the strength of the state's health care system by improving the quality of available research for cognitive neuroscience, behavioral genetics and educational neuroscience. *FF20-23* The research conducted will help physicians better understand developmental disorders such as autism, especially the unique brain adaptations associated with the disorder. *FF 4* In addition, the University's research efforts will enhance the knowledge about such disorders and have the potential to improve future treatment and quality of life outcomes for individuals suffering from these neurological and behavioral disorders. *FF22* This research-oriented MRI has the potential to advance the quality and effectiveness of health care delivery services in Connecticut as well as improve the state's position in the field of biomedical research. Therefore, OHCA concludes the Applicant has demonstrated clear public need for the proposal.

Order

Based upon the foregoing Findings of Fact and Discussion, the Certificate of Need application of University of Connecticut for the acquisition of one Human Subject Research 3T MRI scanner is hereby **approved**.

All of the foregoing constitutes the final order of the Office of Health Care Access in this matter.

By Order of the
Department of Public Health
Office of Health Care Access

5/15/14
Date

Lisa A. Davis
Lisa A. Davis, MBA, BS, RN
Deputy Commissioner

* * * COMMUNICATION RESULT REPORT (MAY. 15. 2014 10:40AM) * * *

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STATE OF CONNECTICUT
OFFICE OF HEALTH CARE ACCESS

FAX SHEET

TO: MS.SALAFIA

FAX: 860.486.4369

AGENCY: UCONN

FROM: OHCA

DATE: 05/15/14 **Time:**

NUMBER OF PAGES: 10
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