

## **List of Suggested Reviewers or Reviewers Not To Include (optional)**

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### **SUGGESTED REVIEWERS:**

Not Listed

### **REVIEWERS NOT TO INCLUDE:**

Not Listed

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**(a) Collaborators** (previous 48 months)

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n/a

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Peter Perrino (PhD expected '21)  
Amanda Rendall (PhD expected '17)  
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#### **(e) Postdoctoral scholars supervised**

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## **Collaborators and Other Affiliations – Emily Myers**

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Julia Irwin (Southern Connecticut State University)  
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James Magnuson (University of Connecticut)  
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## COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./DUE DATE <b>NSF 16-503</b> <b>02/07/17</b>		<input type="checkbox"/> Special Exception to Deadline Date Policy		FOR NSF USE ONLY <b>NSF PROPOSAL NUMBER</b>	
FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.) <b>DGE - NSF Research Traineeship (NRT)</b>					
DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				<b>614209054</b>	
EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN) <b>060772160</b>		SHOW PREVIOUS AWARD NO. IF THIS IS <input type="checkbox"/> A RENEWAL <input type="checkbox"/> AN ACCOMPLISHMENT-BASED RENEWAL		IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES <input type="checkbox"/> NO <input checked="" type="checkbox"/> IF YES, LIST ACRONYM(S)	
NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE <b>University of Connecticut</b>		ADDRESS OF Awardee Organization, including 9 digit ZIP CODE <b>University of Connecticut 438 Whitney Road Ext. Storrs, CT. 062691133</b>			
AWARDEE ORGANIZATION CODE (IF KNOWN) <b>0014175000</b>					
NAME OF PRIMARY PLACE OF PERF <b>University of Connecticut</b>		ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE <b>University of Connecticut 406 Babbidge Road Storrs, CT, 062691020, US.</b>			
IS Awardee Organization (Check All That Apply) <input type="checkbox"/> SMALL BUSINESS <input type="checkbox"/> MINORITY BUSINESS <input type="checkbox"/> IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE <input type="checkbox"/> FOR-PROFIT ORGANIZATION <input type="checkbox"/> WOMAN-OWNED BUSINESS					
TITLE OF PROPOSED PROJECT <b>NRT-UtB-DESE: Science of learning, from neurobiology to real-world application: a problem-based approach</b>					
REQUESTED AMOUNT \$ <b>2,999,853</b>	PROPOSED DURATION (1-60 MONTHS) <b>60</b> months	REQUESTED STARTING DATE <b>07/01/17</b>	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE		
THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW <input type="checkbox"/> BEGINNING INVESTIGATOR <input type="checkbox"/> DISCLOSURE OF LOBBYING ACTIVITIES <input type="checkbox"/> PROPRIETARY & PRIVILEGED INFORMATION <input type="checkbox"/> HISTORIC PLACES <input type="checkbox"/> VERTEBRATE ANIMALS IACUC App. Date _____ PHS Animal Welfare Assurance Number _____ <input checked="" type="checkbox"/> TYPE OF PROPOSAL <b>Research</b>					
<input type="checkbox"/> HUMAN SUBJECTS Human Subjects Assurance Number _____ Exemption Subsection _____ or IRB App. Date _____ <input type="checkbox"/> INTERNATIONAL ACTIVITIES: COUNTRY/COUNTRIES INVOLVED _____ <input checked="" type="checkbox"/> COLLABORATIVE STATUS <b>A collaborative proposal from one organization (PAPPG II.D.3.a)</b>					
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## CERTIFICATION PAGE

### Certification for Authorized Organizational Representative (or Equivalent) or Individual Applicant

By electronically signing and submitting this proposal, the Authorized Organizational Representative (AOR) or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding conflict of interest (when applicable), drug-free workplace, debarment and suspension, lobbying activities (see below), nondiscrimination, flood hazard insurance (when applicable), responsible conduct of research, organizational support, Federal tax obligations, unpaid Federal tax liability, and criminal convictions as set forth in the NSF Proposal & Award Policies & Procedures Guide (PAPPG). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U.S. Code, Title 18, Section 1001).

### Certification Regarding Conflict of Interest

The AOR is required to complete certifications stating that the organization has implemented and is enforcing a written policy on conflicts of interest (COI), consistent with the provisions of PAPPG Chapter IX.A.; that, to the best of his/her knowledge, all financial disclosures required by the conflict of interest policy were made; and that conflicts of interest, if any, were, or prior to the organization's expenditure of any funds under the award, will be, satisfactorily managed, reduced or eliminated in accordance with the organization's conflict of interest policy. Conflicts that cannot be satisfactorily managed, reduced or eliminated and research that proceeds without the imposition of conditions or restrictions when a conflict of interest exists, must be disclosed to NSF via use of the Notifications and Requests Module in FastLane.

### Drug Free Work Place Certification

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent), is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Proposal & Award Policies & Procedures Guide.

### Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency?

Yes ☐

No ☒

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Proposal & Award Policies & Procedures Guide.

### Certification Regarding Lobbying

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding \$100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding \$150,000.

### Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

- (1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.
- (3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

### Certification Regarding Nondiscrimination

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Proposal & Award Policies & Procedures Guide.

### Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

- (1) community in which that area is located participates in the national flood insurance program; and
- (2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

- (1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
- (2) for other NSF grants when more than \$25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

### Certification Regarding Responsible Conduct of Research (RCR)

**(This certification is not applicable to proposals for conferences, symposia, and workshops.)**

By electronically signing the Certification Pages, the Authorized Organizational Representative is certifying that, in accordance with the NSF Proposal & Award Policies & Procedures Guide, Chapter IX.B., the institution has a plan in place to provide appropriate training and oversight in the responsible and ethical conduct of research to undergraduates, graduate students and postdoctoral researchers who will be supported by NSF to conduct research. The AOR shall require that the language of this certification be included in any award documents for all subawards at all tiers.

**CERTIFICATION PAGE - CONTINUED****Certification Regarding Organizational Support**

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that there is organizational support for the proposal as required by Section 526 of the America COMPETES Reauthorization Act of 2010. This support extends to the portion of the proposal developed to satisfy the Broader Impacts Review Criterion as well as the Intellectual Merit Review Criterion, and any additional review criteria specified in the solicitation. Organizational support will be made available, as described in the proposal, in order to address the broader impacts and intellectual merit activities to be undertaken.

**Certification Regarding Federal Tax Obligations**

When the proposal exceeds \$5,000,000, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal tax obligations.

By electronically signing the Certification pages, the Authorized Organizational Representative is certifying that, to the best of their knowledge and belief, the proposing organization:

- (1) has filed all Federal tax returns required during the three years preceding this certification;
- (2) has not been convicted of a criminal offense under the Internal Revenue Code of 1986; and
- (3) has not, more than 90 days prior to this certification, been notified of any unpaid Federal tax assessment for which the liability remains unsatisfied, unless the assessment is the subject of an installment agreement or offer in compromise that has been approved by the Internal Revenue Service and is not in default, or the assessment is the subject of a non-frivolous administrative or judicial proceeding.

**Certification Regarding Unpaid Federal Tax Liability**

When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal Tax Liability:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has no unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

**Certification Regarding Criminal Convictions**

When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Criminal Convictions:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has not been convicted of a felony criminal violation under any Federal law within the 24 months preceding the date on which the certification is signed.

**Certification Dual Use Research of Concern**

By electronically signing the certification pages, the Authorized Organizational Representative is certifying that the organization will be or is in compliance with all aspects of the United States Government Policy for Institutional Oversight of Life Sciences Dual Use Research of Concern.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE		SIGNATURE		DATE
NAME				
TELEPHONE NUMBER	EMAIL ADDRESS		FAX NUMBER	



## PROJECT SUMMARY

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### Overview:

Learning is the basis for virtually every human activity, from in utero development of neural pathways, to the simplest perception and action of a newborn, to acquiring a language as a child or adult, mastering basic math, or pursuing a PhD. However, the study of learning in diverse disciplines (neuroscience, linguistics, psychology and education) is fractionated, with little contact between scientists working at different scales (gene, synapse, neural circuits, psychology lab, classroom, workplace). This impedes progress towards deep understanding of whole-system principles that underlie stability and plasticity as children and adults master simple or complex domains. Our NRT focuses on the potential for new, interdisciplinary approaches to the science of learning while immersing trainees in the art of communication. Our "SLAC" (Science of Learning and Art of Communication) NRT will prepare 50 PhD students (25 fellows, 25 associates) from diverse fields (education, genetics, linguistics, four subfields of psychology, neuroscience, and speech-language-hearing sciences) for interdisciplinary collaboration. Research teams will bring cutting-edge knowledge and techniques from these fields to bear on learning and memory in several domains (e.g., language and problem-based learning). Our NRT builds on our successful IGERT (Language Plasticity: Genes, Brain, Cognition, Computation) and transcends it in several ways.

### Intellectual Merit:

Conventional courses can efficiently prepare trainees with needed content knowledge, but are not as effective as hands-on experience in preparing learners to apply and generalize that knowledge. In our IGERT, we found that the most robust learning happened as trainees engaged in interdisciplinary research challenges. Thus, in SLAC we emphasize a problem-based learning (PBL) approach at multiple scales. In the SLAC Seminar, faculty guide trainees in developing PBL approaches to interdisciplinary science of learning content. In the SLAC Practicum, trainees form Challenge Teams and take on small-scale, real-world challenges solicited from expanding circles of communities (team, SLAC, UConn, local and regional public, nonacademic partners in industry and policy) that require an interdisciplinary approach. Challenge Teams follow principles of efficient management and collaboration, and are extended to larger-scale research projects among SLAC faculty and trainees, instituting a culture of transparent, productive interdisciplinary collaboration. Our Challenge Team principles are designed to afford faster progress, help avoid conflicts over division of labor and credit, and free time for innovation and discovery. Our approach will provide new insights into learning at a variety of levels (from gene to behavior) and a variety of settings (from bench to behavioral lab to classroom to workplace). Rather than expecting individual trainees to become experts in every participating domain, they build on a common core of knowledge (from the SLAC Seminar) and acquire knowledge and skills as needed in Challenge Teams. Given the continuing shift to a model of team science, the skills trainees will acquire in interdisciplinary collaboration and team leadership will be as valuable as the content areas they train in.

### Broader Impacts:

We will prepare our trainees for diverse career paths in areas of national need, including Understanding the Brain, education, and technology. In addition to the practice of team science, three program elements prepare trainees for multiple career paths. (1) Our emphasis on the art of communication (the idea that fundamental principles of communication can be codified and taught, but true mastery emerges from traditional training techniques from the arts) will prepare trainees for clear spoken, written, and digital communication with everyone from specialist peers to school children. (2) We address Data Enabled Science & Engineering through Data Stewardship modules (and an optional graduate certificate in Data Science) that prepare trainees to engage in high quality data science with data big (e.g., neuroimaging, genetics, corpus linguistics) or small (e.g., case studies). (3) Internships with industry, professional associations, and state government provide trainees with concrete ways to explore diverse career pathways. Diversity has been a particular success in our IGERT, with significant impact on participating PhD programs. We will continue successful practices and implement new ones to promote success in recruiting, mentoring, and retention.

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## 4. PROJECT DESCRIPTION

### 4A. CORE PARTICIPANTS

NAME	AFFILIATION	EXPERTISE
Scott W. Brown	EDPSY; IBACS	Problem-based learning; graduate pedagogy
Stormy Chamberlain	GGS; ISG; IBACS	Genetics, genomics, human stem cell models of neurodevelopmental disorders
Marie Coppola	DEV; LING; IBACS; NBL	Development of language and number cognition
Inge-Marie Eigsti	CLIN; IBACS; NBL	Language, communication, & optimal outcomes in autism spectrum disorders (ASD), neuroimaging
R. Holly Fitch	BNS; ISG; IBACS; NBL	Animal models of cognitive development and developmental disorders
James Magnuson, <i>PI</i>	LC; IBACS; ISG; NBL	Neurobiological bases of adult and child language learning and processing; graduate training
Betsy McCoach <i>Evaluator</i>	EDPSY; IBACS	Quantitative research methods and evaluation; statistical modeling; measurement & assessment
Tim Miller	UConn Digital Media Ctr.	Science communication; data visualization
Emily Myers	SLHS; LC; IBACS; NBL	Neural basis of typical and aphasic speech
William Snyder	LING; IBACS; NBL	Language acquisition; formal linguistic theory

**Table 1.** *BNS*=Behavioral Neuroscience; *CLIN*=Clinical Psych.; *DEV*=Developmental Psych.; *EDPSY*=Educational Psych.; *GGS*=Genetics & Genomic Sciences; *IBACS*=Institute for the Brain and Cognitive Sciences; *ISG*=Institute for Systems Genomics; *LC*=Language & Cognition; *LING*=Linguistics; *SLHS*=Speech, Language & Hearing Sciences; *NBL*=Neurobiology of Language (IGERT). *BNS*, *CLIN*, *DEV*, and *LC* are in the Department of Psychological Sciences. (*NB*: Team members represent segments of Brain and Cognitive Sciences; another ~30 faculty will be active contributors. An external assessment consultant will provide annual audits.)

**4B. THEME, VISION AND GOALS.** We learn constantly. Without awareness, you are learning right now; internal estimates of the probability of words and phrases are updated infinitesimally as you read. Prior knowledge related to content is "primed", mostly below the level of awareness, preparing your brain to integrate new information with what you already know. Such *implicit*, *incidental* learning enables subtle adaptations to changing conditions. *Explicit*, *intentional* learning and teaching are also crucial. As a species, we have sought effective methods for instruction and self-tutoring for millennia.

Given the ubiquity of learning and the dependence of individuals and society on effective teaching and learning (from *in utero* neural organization to learning a language, learning a workplace skill, or advanced academic studies) and the severe negative impact of developmental learning disorders like dyslexia, or acquired learning disorders (e.g., effects of traumatic brain injury), learning remains a grand challenge for 21st century science, with opportunities for experts in learning to contribute in a diverse variety of fields and careers. There are obvious childhood educational implications and challenges. Can we find more effective teaching and studying methods for schools? How can we get kids to apply the best evidence-based study strategies, which require challenging self-testing? Why do some kids fail to "respond to intervention" when the best evidence-based treatments are applied with, e.g., struggling readers?

There are also challenges for life-long learning. Adults, especially as we reach middle age, struggle to learn new workplace or recreational (e.g., musical) skills, and eagerly pay handsomely for 'brain training games' (sharpbrains.com, a market research company, estimates consumers spent \$715M on brain training apps in 2013 and are on track to spend over \$3B annually by 2020) to improve or preserve intelligence, despite the fact that such tools have been soundly discredited (Melby-Lervåg & Hulme, 2013; Redick et al., 2013). Counter-intuitively, while "brain training" exercises do not impact general intelligence or learning ability or decrease risk of dementia (though they do improve performance on the specific task practiced), *physical* exercise does (Roig et al., 2013), as does engaging in months-long learning of

complex new skills (e.g., digital photography or quilting; Park et al., 2013).

The discovery of low-level bases for learning can be accelerated by interdisciplinary approaches. For example, animal models have been instrumental in deciphering complex genetic and neural bases of the impacts of physical exercise and complex, open-ended learning (using "environmental enrichment" with mice) on memory and learning in aging (Voss et al., 2013) and in uncovering developmental plasticity of learning (Hensch, 2004). These examples illustrate the power of interdisciplinary approaches, which draw on a broad range of approaches to human and animal learning: genetic, cellular, neural circuits, and rich assessments of behavior and environment. However, such an approach becomes more challenging as we move from general intelligence to more complex types/settings of human learning (e.g., language and number) in "the wild" (home, playground, classroom, or workplace). Several members of our NRT team have been part of an IGERT team that has made great strides in developing such an interdisciplinary approach to *NeuroBiology of Language* ("NBL" from here on; see §4I and §4J).

In NBL, PhD trainees and faculty from genetics, neuroscience, linguistics, communication disorders, and cognitive, clinical and developmental psychology strive towards a whole-system (gene-neuron-brain-behavior-cognition-environment), lifespan approach to language development. We were motivated by the realization that researchers in our community were working on language at very different levels, from gene to neural circuits to animal and human behavior, computational models, and formal linguistic theory, but we were barely communicating, let alone collaborating. The biggest obstacles were speaking each others' (scientific) languages, lack of students eager to bridge disciplines, and lack of resources to launch collaborations. IGERT funding allowed us to break through these barriers and create an integrated training and research program devoted to a whole-system, species-comparative approach to language.

How does one explore seemingly human-specific skills like language in animal models? One way is to identify candidate genes associated with language, and then examine other traits those genes associate with, which might be logical components of language (e.g., auditory discrimination), a morphological trait (e.g., rotation of ears), or neural abnormalities (e.g., "ectopias" consistent with atypical neuronal migration in some cases of dyslexia). Genes can then be up- or down-regulated in mice, allowing true experimental manipulations. When associations are confirmed, other traits affected in mice afford causal predictions for humans (see Galaburda et al., 2006; Rendall et al., 2015, is a recent example from our team). Of course, there are other opportunities to bring an interdisciplinary approach to bear, for example via tools of cognitive neuroscience (e.g., EEG [electroencephalography] or fMRI [functional magnetic resonance imaging]) to examine cortical circuits underlying complex abilities. Such approaches nearly always require (or at least are significantly enhanced by) interdisciplinary teams, in order to assemble deep expertise in content areas, levels of analysis (e.g., behavior vs. brain vs. neuron vs. gene), and tools.

Our IGERT-NBL program has succeeded beyond our expectations. Several cohorts of trainees and many faculty are now scientifically multilingual; they understand enough fundamentals across domains that they can read each others' literatures and conduct productive interdisciplinary collaborations: 80+ collaborations and 40+ trainee publications emerged in 4.5 years. NBL is transitioning to a permanent Graduate Certificate program. NBL is also indirectly supported by external grant activity it has catalyzed; our faculty and students have submitted 65 grant or fellowship applications stemming wholly or partially from NBL (9 funded [\$8.1M], 24 pending). In our IGERT proposal, we said that if NBL were successful, it should provide a model for synthesizing cognitive and biological approaches to complex human abilities. Our aim in this NRT is to use NBL as a model, building on successful elements, and experimenting with new approaches to elements that were not as successful as we had hoped, to develop a new cognitive-biological approach to learning focused on domains including language, number, and pedagogy.

We were drawn to learning as a theme when we realized that many NBL collaborations focus on aspects of learning (e.g., Earle & Myers, 2014; Richie et al., 2014), but we were only scratching the surface of the science of learning. It was also apparent that linking basic science with societal challenges in education and technology would require expanding the team to include **Education** (Co-PI **McCoach**, Co-I **Brown**). In IGERT-NBL we made inroads in outreach, but in SLAC we will provide trainees and faculty with deep communication training. We recruited Co-PI **Miller** (an expert in science communication) to lead communication training plans that will produce NRT trainees who are not just scientifically multilingual, but able to speak plainly and clearly to scientists, non-scientists, and children using a variety of formats and media (in-person, print, video, web).

**Towards a cognitive-biological synthesis of the science of learning.** Like language, the study of learning is fractionated, with scientists working at varying levels (from gene to behavior to computational models) in varying domains (language, number, memory, instruction, among many others). Over time,

fields have developed theories, paradigms, tools, and approaches in isolation from others, often to such a degree that communication (let alone interaction) is rare and difficult. Even simple contact (attending talks, reading articles) is impeded by cultural differences (domain-specific terminology, assumptions about what counts as valid and valuable research, standards of evidence, and analytical approaches). Lack of interaction delays interdisciplinary knowledge transfer, and opportunities where interdisciplinary teams could accelerate progress on scientific and societal challenges are lost.

This proposal brings together trainees working on the **science of learning** in varying disciplines to work in collaborative *Challenge Teams* (§4C, §4D), tackling real-world challenges in new ways, while equipping them with essential soft skills (teamwork, communications, social media), and *data stewardship* skills (§4C) transferable across diverse career paths. We focus on the **art of communication**, premised on the need for clear communication to dissolve disciplinary boundaries and communicate with audiences ranging from specialist peers to policy makers and children. We abbreviate the program as "SLAC" (*Science of Learning and Art of Communication*). Our vision for transforming graduate training through an integrated program of education and research follows from innovations in 5 domains (see Table 2).

	TRAINING FOCUS	RESEARCH OUTCOME
CONTENT	Common base of knowledge of diverse interdisciplinary science of learning	New discoveries in the science of learning and <b>understanding the brain</b>
CULTURE	Challenge Teams and <i>problem-based learning</i> as models for interdisciplinary collaboration	Skills in interdisciplinary project management allow teams to tackle real-world challenges
COMMUNICATION	<i>Art of Communication</i> infused throughout training	Crucial for interdisciplinary collaboration, dissemination, and community engagement
CAREER PREPARATION	Training in <i>Data Stewardship and Data Science</i> (addressing <b>data enabled science &amp; engineering</b> ), project management, and team science apply in academia and beyond; Internships and mentors open diverse career pathways	Interdisciplinary learning challenges require team science, analytic skills;  Cooperative research with nonacademic partners opens new avenues for research
DIVERSITY	Recruit, mentor and retain diverse student body	Diverse backgrounds and perspectives promote innovation

**Table 2: Innovation domains.** The "4 Cs" and diversity.

**Content: Interdisciplinary science of learning.** Our trainees will receive deep, specialist expertise in home PhD programs augmented by targeted training in science of learning across all domains in the *SLAC Seminar* (§4C), and secondary depth in one or more areas through experience in developing, participating in, and leading interdisciplinary Challenge Teams.

**Culture: Problem-based learning and Challenge Teams.** Two aspects of our IGERT-NBL were particularly salient. (1) Course-based training helped build a common base of knowledge among trainees, but the most robust learning emerged when trainees were actively engaged in interdisciplinary research projects. (2) We took an 'emergent' approach to interdisciplinary collaborations; provide training and support for research (via fellowships and *innovation incentive funds* for pilot research), and projects will emerge. This worked surprisingly well, with 80+ collaborations emerging from 56 trainees (28 fellows, 28 associates). But there were 3 significant challenges as well. First, trainees face pressure in home PhD programs to engage in disciplinary research as soon as possible. While many trainees engaged in interdisciplinary collaborations early on in NBL, others began with a disciplinary focus and struggled to find opportunities for interdisciplinary work (although all eventually did). Second, depth of trainees' interdisciplinary experiences varied, with some leading collaborations, but some playing only minor roles. Third, "long-distance" collaborations (e.g., involving linguists and neuroscientists) emerged, but were rare.

Robust learning from tackling an open-ended research challenge is an expected outcome given research on **problem-based learning (PBL)**. PBL results in similar mastery of knowledge as in conventional learning paradigms, but also greatly enhances skill development and ability to transfer knowledge and skills beyond specific examples presented in learning (Bransford, et al., 1989; Koschmann, et al., 1996; Lawless et al., 2016; Mergendoller, et al., 2000, 2006). PBL is central to our course-based strategies, and trainees and faculty will be trained in this approach (§4C). *Challenge Teams* are our mechanism for promoting interdisciplinary research and PBL. They embrace the learning and growth that emerges from engaging in interdisciplinary research, and address the 3 challenges above. They will establish a culture of productive collaboration through principles that promote good project

management and open discussion of responsibilities, credit, and authorship. Trainees are introduced to small-scale Challenge Teams in the *SLAC Practicum* (§4C). Trainees take the practicum twice, with the expectation that they will assume a leadership role the second time (ensuring each trainee gets team leadership experience). At the same time, larger-scale, open-ended Challenge Teams will pursue our major research efforts (§4D). We have organized several Challenge Teams to be in place when our NRT launches, providing trainees options of joining interdisciplinary research teams from their first day. The existing Challenge Teams include "long-distance" collaborations, ensuring we will span those more difficult disciplinary boundaries. Finally, the set of organized teams are not meant to supplant *emergent* collaborations; rather, they provide scaffolding and examples that will help effective new teams emerge.

**Communication.** Clear communication is essential in virtually every aspect of academic and nonacademic work. Successful teaching requires us to make complex concepts accessible. Clarity in public or written research reports for specialist peers enhances impact (Kroll et al., 2014). Launching interdisciplinary collaborations requires team members to escape from the "curse of knowledge" (forgetting how challenging it was to first master familiar concepts). There is growing need for communication to audiences ranging from specialist peers to the general public, using conventional and emerging media, such as short- or long-form blogs and micro-form tweets. In most of these cases, clear communication is not just about making complex concepts accessible, but is also about constructing clear *narratives* and making effective use of data visualization, graphics, and video. Helping trainees achieve mastery of these tools while they grapple with their own courses and PhD research is a tall order.

Our approach is to begin with principles from the limited empirical literature on best practices for scientific communication (e.g., National Academies, 2016), but also to emphasize the *art of communication*. As argued by Co-PI **Miller** (2015), true mastery requires going beyond principles and rules; for example, techniques from traditional conservatory training in performing arts can transform scientists' ability to make their work engaging and accessible. Miller brings considerable expertise to our team. He has background in physics, engineering, film, theater, and journalism, making him uniquely qualified to guide communication training. Our plans include infusing courses with communication training, as well as emphasizing communication in regular talk series and other special events (see §4C).

**Career preparation (training needs and workforce needs).** There are several markets for PhDs in our participating domains. Tenure-track positions are on the rise in the cognitive and neural sciences as the economy continues to recover. There are more and more opportunities for tech-related research positions at companies like Microsoft (see letter of support), growing demand in fields like educational measurement and technology (see letters from Rosetta Stone, ETS, and InSync), scientific instrument development and sales (see letters from EGI and SR Research), data science, and usability. Conventional PhD training focuses on academic preparation, and does not address many essential skills needed in a tenure track position and other diverse career paths. We devote considerable effort to innovating in diverse career path preparation. In addition to team science, project management, and communication skills, we describe *Data Enabled Science & Engineering* (DESE) components in §4C: a rich set of course offerings to prepare trainees for deep expertise in data science, including novel *data stewardship* modules that cover best practices for data planning, acquisition, analysis, storage, privacy, and sharing. A *SLAC Skills* seminar covers standard professional development topics, along with "missing manuals" for financial management, grant writing, web presence, academic and nonacademic career paths, and internships (see letters of support from technology and education companies, professional organizations active in public policy, and our local representative to the CT state legislature).

**Diversity.** We will build on successful NBL efforts to recruit and retain students from underrepresented groups (URGs; we grew from 0% in year 1 to currently 28% [33% among IGERT fellows]). We are committed to increasing participation from URGs as a matter of equity, and note that unrepresentative participation reflects a significant loss of talent and workforce (since 2012, <50% of children born in the US have been white; US Census Bureau Release CB12-90, May, 2012). Notably, diversity in background and perspective promotes creativity and productivity (Nisbett & Ross, 1980; Thomas & Ely, 1996).

**Value added.** SLAC adds value by providing hands-on experience in team science; infrastructure for interdisciplinary training and research; and preparation for non-academic careers (via communication training, *Data Stewardship* modules, and nonacademic mentor connections and internship opportunities).

**Foundations in place.** Our proposed NRT complements and builds efforts to improve STEM graduate education at UConn; in particular, our IGERT-NBL certificate program, and an *Innovations in Graduate Education* NRT at UConn (*NRT-IGE: Training STEM Graduates to Communicate in the Digital Age, and Measuring Whether It Works*, Margaret Rubega [UConn Ecology & Evolutionary Biology], PI, 2015-18).

NBL has led to significant infrastructure we will capitalize on, such as dedicated space for PhD students working in interdisciplinary programs (§4F). Crucially, it has catalyzed a cultural shift: interdisciplinary collaborations initiated by students are now the norm. As NBL will continue as a certificate program, we expect that some students will do both programs, given new training opportunities in communication and data science in SLAC. The learning focus of our NRT will continue our interdisciplinary momentum while engaging a broader array of scientists, particularly by engaging 2 additional PhD programs (Educational Psychology and Genetics & Genomic Sciences). The science communication NRT-IGE already in place will provide an enrichment option for our NRT trainees. The innovative NRT-IGE pairs STEM graduate students with journalism students to help both learn to communicate with each other.

**Scalability and sustainability.** Again, we expect 25 fellows and 25 associate trainees (50 total) to participate during the funding period. Also, each training element is designed with scalability in mind (how could each element generalize to other areas? How could we infuse other courses with PBL?). In some cases, elements will be made publically available online (e.g., digital tutorial modules students develop in the SLAC Seminar), while others are experiments in graduate education (e.g., problem-based practica) that we will describe in blog posts and journal articles so that other graduate programs can learn from our successes and failures. Given that we have similar institutional commitment for this NRT as we had for our IGERT NBL program, we are confident that this new effort will be sustained past NSF funding.

#### 4C. EDUCATION AND TRAINING

We focus not just on “what is lacking in STEM graduate education,” but on what is lacking and hard to achieve in interdisciplinary graduate training. Our NRT addresses those gaps to prepare PhD trainees from diverse fields for a full range of career pathways by emphasizing *transferable skills*, via mechanisms designed to achieve interdisciplinary breadth and specialist depth without increasing time-to-degree.

Our IGERT program used conventional seminars for content training, with 5 courses covering the full breadth of participating areas. This provided trainees from diverse programs sufficient competence that they could participate in collaborative teams including any or all areas. In our NRT, we take a streamlined approach. Again, we observed that breadth emerged most robustly “on the job” as trainees engaged in interdisciplinary projects, guided by students or faculty specialists from another discipline. This is a real-world example of *Problem-Based Learning* (PBL; Hmelo-Silver, 2004; Jonassen, 2009; Savery & Duffy, 1995). In PBL, knowledge of an area develops as the learner (or a group of learners) grapples with a challenging, ill-defined problem. Unsurprisingly, hands-on training leads to better ability to *apply* knowledge; perhaps surprisingly, it *can* be equally effective as a conventional format for learning content knowledge (Lawless et al., 2016). In PBL, content is encountered informally, as it becomes relevant, via peers with greater knowledge and/or an expert mediator. Careful guidance from the tutor/facilitator is needed to avoid weaker content acquisition than in a conventional approach (Gijbels et al., 2005), e.g., by augmenting PBL with conventional content coverage (see *Augmented PBL* Challenge Team in §4D). Indeed, peer-to-peer tutoring in PBL has benefits for both tutors and learners (Bene & Bergus, 2014; Clark et al., 2008). PBL training also naturally inculcates collaboration and teamwork skills (Lawless et al., 2016), and promotes persistence and rate of progress (Severiens & Schmidt, 2009).

In our NRT, we will experiment with a PBL approach that cuts across course-based training as well as major research efforts (§4D). The primary vehicle for both will be **Challenge Teams**, introduced in §4B.

<b>Formation</b>	One or more individuals select a challenge and recruit team members with needed expertise.
<b>Organization</b>	Teams adopt an initial organizational structure: PI-, committee- or consensus-based leadership. Members agree to roles and provisional/anticipated position in authorship list.
<b>Design</b>	Teams collaborate to create a <i>Project Design Document</i> , including concrete goals, and assessment of resources needed to complete the project (space, instruments, and money).
<b>Logistics</b>	Team members are designated to acquire all appropriate permissions (human and/or animal subjects), access to space and instruments, and to apply for research funding from SLAC, other internal mechanisms, or, for more open-ended projects, possibly foundations or federal agencies.
<b>Management</b>	Team members collaborate on a preliminary project management plan, breaking ultimate goals into manageable subgoals with realistic goal dates, following the principle of <i>backward planning</i> .
<b>Data</b>	Construct a data plan consistent with principles of <i>Data Stewardship</i> (described below).
<b>Dissemination</b>	Plan at least two forms of dissemination: academic and public-accessible (e.g., a blog).

**Table 3: Challenge Team stages and principles.**



This name reminds us what science is about: solving challenges. It also connects from a novel plan to solicit challenges from *expanding circles of community*: team members, SLAC, UConn, local and regional educators and public, and state and federal policy makers (see *Science of Learning Challenge* in §4F).

Challenge Teams will be organized at 2 levels: time- and scope-limited teams in the SLAC Practicum (described below) and our full-scale research efforts (§4D). Often, interdisciplinary collaborations falter due to miscommunication. To avoid such pitfalls, Challenge Teams will follow a set of flexible organizational guidelines (Table 3) based on principles of sound project management, especially *backward planning* (setting long-term goal dates and then iteratively working backward setting subgoals), a strategic management approach that leads to more realistic planning and better obstacle anticipation than traditional forward planning or open-ended planning (“next thing next”; Lewis, 2002; Wiese et al., 2016).

We acknowledge there will be significant challenges to overcome and risks to face with our emphasis on PBL and Challenge Teams. We are not aware of PBL being used to the extent we propose in graduate courses (aside from medical education, e.g., Schmidt et al., 2006); e.g., Bosque-Pérez et al. (2016) focus on problem-focused research training rather than PBL for course content. This will require true buy-in from faculty (which we have) and trainees, and will require innovations in evaluation to track efficacy in comparison with conventional course formats (§4H). Challenge Teams are meant to shake up “standard” (i.e., idiosyncratic) approaches to research teams and project management, and will also require sustained commitment from faculty in particular. Again, evaluation innovations are needed to track our progress with this attempt at cultural change (§4H), but based on our NBL experience, the key test will be whether principles in Table 3 lead to better outcomes (e.g., project efficiency and productivity). After a few teams demonstrate success with this model, experience suggests buy-in will naturally follow. The 5 Challenge Teams we have organized in advance of funding (§4D) will be key in setting such examples.

**Training depth** (primary and secondary areas): specialist depth is attained in home PhD programs. Trainees will attain significant depth in at least one other area by participating in open-ended Challenge Teams. Trainees may also freely register for electives outside their home PhD selected to build depth.

**Training Breadth** is achieved through 6 mechanisms with core coursework during the fellowship / traineeship year (typically the 2nd year of the PhD), and Data Stewardship modules taken any time.

(1) A year-long **SLAC Seminar** (Fall and Spring of the fellowship year) serves as the keystone of the curriculum, providing introductions to key content and training in writing, presentation, and peer-to-peer tutoring. Content will include learning from the perspective of (a) neuroscience and genetics, (b) cognitive psychology and cognitive neuroscience, (c) psycholinguistics (cognitive and developmental psychology and linguistic approaches to first and second language acquisition), (d) population comparative approaches (acquired and developmental learning disorders, age-related changes in learning), (e) application of learning principles in the classroom and workplace, and (f) computational approaches (models of cognition and development, deep learning, computer-based adaptive tutoring). Faculty will facilitate, but trainees will lead ~half the sessions as *Peer Tutors*. Peer Tutors will create a PBL lesson plan with a faculty moderator. Our PBL approach will follow criteria outlined by Zepkey and Leach (2010) and *high-impact educational practices* (HIPs) espoused by the Assoc. of American Colleges & Universities (AACU; Kuh, 2008) for engaging postsecondary students. To acquire the substantial faculty expertise PBL requires, **Brown** will introduce best practices to faculty in summer workshops.

**Communication training** is an integral part of the SLAC seminar, focusing on skills needed to share research findings both within the research community and with a broader audience successfully. The fundamentally transdisciplinary nature of our NRT means that trainees must be able to communicate effectively with experts across the range of disciplines. We will prepare them by devoting a substantial portion of seminar time to best practices in communication. Anticipated topics include writing, public speaking, and graphical representations in traditional, on-line, and digital media (video and audio).

Our approach is informed by the limited empirical literature on best practices in communication training (e.g., National Academies, 2016). While some effective principles can be identified and taught, our approach also recognizes that an individual trainee can never *master* communication solely by studying such principles. True excellence in communication remains an art, and we will apply the traditional training found in artistic conservatories to the development of communication skills, building on the rich background of core faculty member **Miller** (formerly of the Alan Alda Ctr. For Communicating Science) in communication, film, and digital media (see **Miller**, 2015). Communication training will culminate in trainee teams developing digital tutorial modules that cover major topics introduced in the course, with the aim of making those modules available to future trainees and online. We will also partner with the existing IGE-track NRT at UConn on science communication mentioned above, and make use of some elements



	ELEMENT	CONTENT	OUTCOMES
REQUIRED	SLAC Seminar	2-semester overview of interdisciplinary science of learning, infused with art-of-communication training	<ul style="list-style-type: none"> <li>• Students master material through PBL</li> <li>• Students learn to design PBL-based lessons</li> <li>• Students develop communication mastery necessary for interdisciplinary collaboration</li> </ul>
	SLAC Practicum	Students form Challenge Teams and take on a concrete interdisciplinary science of learning challenge; emphasis on project management and planning	<ul style="list-style-type: none"> <li>• Students learn principles of project management and get hands-on experience conducting interdisciplinary science of learning research</li> <li>• Taken in SLAC Year 1 of program and again in Year 2 or 3 (in leadership role)</li> </ul>
	SLAC Skills Seminar	RCR, professional development, and 'soft skills' – a "missing manuals" course covering teaching, mentorship, lab management, etc.	<ul style="list-style-type: none"> <li>• Students train in key aspects of academic and non-academic careers normally learned 'on the job'</li> </ul>
	Outreach Seminar	Principles of communication for non-scientific audiences culminating in actual outreach activity	<ul style="list-style-type: none"> <li>• Students get actual experience and contact with non-scientific audience</li> <li>• Enhances SLAC-community connections</li> </ul>
	Challenge Teams	Open-ended research teams of faculty and students following common organization & management principles	<ul style="list-style-type: none"> <li>• Discovery in the interdisciplinary science of learning</li> <li>• Dissemination of research in academic and non-academic media</li> </ul>
	Talk Shop	Weekly meeting focused on SLAC; mainly student research presentations	<ul style="list-style-type: none"> <li>• Supportive environment promotes scientific communication skills</li> <li>• Meeting of full SLAC community builds morale</li> </ul>
OPTIONAL	Data Stewardship	Principles of data science and data management	<ul style="list-style-type: none"> <li>• All trainees get fundamentals through PhD program requirements supplemented by annual workshops</li> <li>• Option to pursue graduate certificate in <i>Data Science and Data Stewardship</i></li> </ul>
	January-Term Primers	Annual week of workshops, talks, and tutorials organized by trainees	<ul style="list-style-type: none"> <li>• Mechanism for enhancing training, team building</li> </ul>
	Annual Theme	Year-long focus on chosen theme, with speakers and workshops throughout the year, culminating in a conference	<ul style="list-style-type: none"> <li>• Fosters strong sense of community</li> <li>• Builds program reputation</li> <li>• Mechanism for enhancing training, team building</li> </ul>
	Nonacademic mentor connection	Individual students or groups connected to a mentor outside academia	<ul style="list-style-type: none"> <li>• Informational interviews demystify careers</li> <li>• Connections may promote specific career paths</li> </ul>
	Nonacademic internships	Opportunities for internships in industry, policy and government	<ul style="list-style-type: none"> <li>• Hands-on experience promoting true understanding of alternative career paths</li> </ul>

**Table 4:** SLAC training elements.

of their program (e.g., they collect attempts at 3-minute research description videos from 100s of UConn STEM trainees at various training stages, providing a rich base of comparison for our own trainees).

(2) The 1-semester **SLAC Practicum** is a project-based learning seminar where students conduct time-limited projects in Challenge Teams. Trainees participate in this course twice: once as a team member (Year 2), and a second time (in Year 3 or 4) as a team (co-)leader. The Practicum provides concrete experience in interdisciplinary collaboration. Challenges may be generated by the teams, or may come from the *UConn Science of Learning Challenge* (§4F). Faculty moderators will work with teams to help them select or modify challenges appropriate for a semester-long effort. Teams will apply for *innovation incentive fund* (IIF) support (§4D) to fund projects. See §4F for examples of challenges.

(3) A 1-credit **Outreach Seminar** (pioneered by **Fitch** in our IGERT-NBL program, to be enhanced by **Miller**) culminating in presentations to K-12 students, educators, policy makers, and/or the general public.

(4) A 1-credit **SLAC Skills Seminar** includes standard professional development and ethics training, but also serves as a "missing manual" to topics essential in PhD careers but seldom addressed in training (e.g., managing time, projects, and budgets; teaching; grant writing; reviewing; networking, etc.). Trainees take the full seminar once for credit, and can "drop-in" for topics of interest throughout their training.

(5) **January-Term (J-Term) Primers**. In the last week of the winter break, NBL trainees organize (and often teach) an intensive series of workshops, talks and crash courses designed to fill gaps left in conventional graduate training. These include technical skills (e.g., programming Python or R), methods (e.g., fMRI, EEG, eye tracking, CRISPR), and specialized scientific domains (e.g., phonology, neurodevelopment). These primers have been instrumental in developing a sense of community and a

culture of peer-to-peer tutoring and mentoring. SLAC trainees will join NBL trainees to organize J-Term, which will also provide a venue for SLAC-specific topics that generalize beyond SLAC (e.g., Challenge Team principles, implications of science of learning for psycholinguistics, communication workshops).

(6) **SLAC Annual Theme Workshop.** Each year, a theme will be chosen for the *SLAC Workshop*, a year-long series of activities (e.g., talks, reading groups) culminating in a *SLAC Workshop Conference* with several external and internal speakers at the end of Spring semester. Each spring, we will hold a competition for proposals for the following year's workshop. Teams will submit proposals and make brief presentations to the community in Talk Shop. SLAC trainees and faculty will vote for the next theme. Example themes might be: *Multilingualism and Learning* or *Optimizing Learning in the Real World*. The Theme Workshop will be central to sustaining commitment to SLAC themes and building community.

(7) **DESE components: Data Stewardship/transferable technical skills.** SLAC courses and Challenge Teams will be infused with a *Data Stewardship* approach stemming from a few basic premises (good data begins with good design and collection; research teams need plans for data archiving, security/privacy, and sharing before a study begins; and scientists need to master basic data science skills, including fundamentals of programming and analysis). In combination with conventional statistical training, fundamental data science skills can be acquired through workshops (e.g., J-Term Primers) and self-tutoring (we also provide courses and other opportunities to develop advanced data science mastery). Although scientists in our participating fields must handle enormous amounts of diverse data, most PhD students receive little or no formal training in *data curation*, *programming* essential for data analysis, establishing *reproducible analysis pipelines*, *version control*, or *data security and sharing*. Why is this? First, an amazing array of mostly open-source tools for data analysis and programming has become available in recent years (e.g., the rise of R and Python). Professors trained a decade or more ago were trained in a qualitatively different computational environment. Many of us have fallen behind as new tools have emerged, with little understanding of new standards for best practices. Second, at least in some fields, data management practices can vary dramatically between or even within labs, with individual researchers developing their own idiosyncratic approaches “that work for them”, with little or no awareness for the kinds of best practices that are enforced in many fields and corporate environments.

This has many negative consequences. Most benignly, individual scientists waste time because they cannot automate time-consuming aspects of analysis, and they frequently have to approach their own data “forensically” because they have not documented every step of analysis. A greater hazard is actual data loss or corruption, e.g., when criteria for data cleaning are not tracked. This can make the transition from a lab-specific culture to another setting (especially in industry) unnecessarily challenging.

We will provide several ways for all trainees to learn best practices for Data Stewardship, as well as develop an optional comprehensive graduate certificate in Data Science and Data Stewardship (with fundamental statistics prerequisites up to multiple regression [already required under all participating PhD programs] and then 9 credits including the Data Science course and two others from Table 5).

EDUCATION	LIBERAL ARTS & SCIENCES	UCONN HEALTH CENTER
Data Science	Applied Longitudinal Analysis	Computational Genomics
Hierarchical Linear Modeling	Time Course Data Acquisition & Analysis	Machine Learning for Genomics
Structural Equation Modeling	Neuroimaging Analysis	Applied Bioinformatics
Latent Variable Modeling	Simulation-based Computational Modeling	Computational Neuroscience
SLAC DATA MODULES		
R Programing Fundamentals	Python Programming Fundamentals	Version Control and Data Archiving
Advanced R Programming	Advanced Python Programming	Data Stewardship I, II, & III

**Table 5: Data Stewardship and Data Science offerings and examples of SLAC modules.**

Trainees will also have priority access to School of Education summer workshops that provide cutting-edge training and contact with top-level innovators, including the annual *Modern Modeling Methods conference* (with sessions on the latest statistical and psychometric modeling methods). Trainees will also be able to further develop their statistical modeling capabilities via opportunities to attend tutorial workshops in cutting edge statistical modeling. *Data Analysis Training Institute of Connecticut (DATIC) summer workshops*, a series of week-long workshops focusing on quantitative analysis. Typical offerings include three 1-week-long workshops: *Hierarchical Linear Modeling*, *Structural Equation Modeling*, *Dyadic Analysis*, and one three-day workshop (*Longitudinal Modeling Using Mplus*).

**Logistics.** A challenge in IGERT-NBL was a heavy course load begun in Year 1 of PhD training, when some programs have heavy course requirements (still, we project a mean NBL time-to-degree [TTD] of 5.1 years). We will ease logistical pressures on SLAC trainees by (a) having them apply in Year 1 to join the program in Year 2, and (b) modest NRT course requirements (*SLAC Seminar* and *SLAC Practicum* taken in Year 2 and 1-credit *Outreach Seminar* and *SLAC Practicum* [again] in Year 3 or 4). Because SLAC courses can count as breadth electives for PhD programs, we will not increase TTD. Admissions decisions will be made by the Executive Committee (§4F) based on a statement of research and training interests submitted by candidates in spring semester of their first year of PhD training. We will recruit trainees by inviting them to key SLAC events (Talk Shop, J-Term, Annual Theme Workshop). The possibility of joining SLAC will also be a key to recruiting students to participating PhD programs.

**Assessing competence.** A challenge in interdisciplinary training is assessing success in providing trainees adequate competence in breadth domains. It can be a challenge to even specify precise expectations. Bibliographies typically "over-cover" areas beyond the minimum intended expertise). Our NBL solution is to develop *competence questions* trainees should be able to answer if they have achieved sufficient mastery (annotated with readings and courses that cover relevant material). These are more specific than a bibliography and are easy for faculty to generate. We do not formally test trainees with these questions; rather, they provide trainees with a guide for self-assessment and self-tutoring. In §4D we describe a Challenge Team that will investigate the efficacy of competence questions.

**Preparing for non-academic careers.** Mentoring and vocational counseling are key concerns (see §4g). We have identified several internships in industry and policy, through companies like Rosetta Stone (language-learning software), Microsoft Research (NYC), SR Research (an eye tracking hardware and experimental control software firm that employs many cognitive scientists), EGI (EEG equipment and software), ETS and InSync, and policy opportunities with the Assoc. for Psychological Science, the American Speech-Language-Hearing Assoc., and the Linguistic Society of America. Contacts at most sites have agreed to provide mentoring in nonacademic careers, ranging from phone-based informational interviews to inviting trainees to visit their offices or visiting UConn to meet with larger groups.

**Innovation skills.** We will conduct regular innovation training, primarily through annual workshops conducted by Dr. Kristian Simsarian, chair of the Interaction Design program at the California College of the Arts, and a fellow at IDEO (an internationally renowned innovation consulting firm). Dr. Simsarian has helped our NBL maximize our innovation environment, teaching concrete skills (e.g., best practices for brainstorming), and the power of *permission to fail* to catalyze innovation.

#### **4D. MAJOR RESEARCH EFFORTS**

As described in §4C (*SLAC Seminar*), our core faculty conduct research related to science of learning in 6 areas: (a) neuroscience and genetics, (b) cognitive psychology/ neuroscience, (c) psycholinguistics (cognitive and developmental psychology and linguistic approaches to 1<sup>st</sup> and 2<sup>nd</sup> language acquisition), (d) population comparative approaches (acquired and developmental learning disorders, age-related changes in learning), (e) application of learning principles in the classroom and workplace, and (f) computational approaches (models of cognition and development, deep learning, computer-based adaptive tutoring). A primary goal of SLAC is to accelerate progress in the science of learning by training PhD students to work in collaborative teams that span 2 or more areas. The primary mechanism for achieving this will be hands-on research, both in courses and as part of interdisciplinary research teams.

From our experience with NBL, we know that with a few key ingredients collaborative research projects emerge organically. These are: community commitment to a common theme, funding for interdisciplinary students, and modest funds for pilot research. This model was highly effective for NBL. In our NRT, we will provide key those ingredients, but also complementary top-down structure described in §4B and §4C, via Challenge Teams. Trainees will get formal training in principles of project management as applied to Challenge Teams in the *SLAC Practicum*. Faculty and interested current PhD students have begun organizing Challenge Team workshops to infuse principles into our community beginning in summer, 2017, before our NRT funding would begin (so that we will be ready to launch this fall, should we be so fortunate as to be funded) and during J-Term Primers (§4C) in subsequent years. We will describe specific examples of Challenge Teams that are already formed or planned for the near future. But first, we will describe the key ingredients that nurture and facilitate interdisciplinary collaborations.

**Key ingredients promoting interdisciplinary collaboration.** Community commitment to a shared research theme. Our core team members are deeply committed to our SLAC theme; indeed, new collaborations are already emerging. In addition, we each represent larger constituencies with about 20 faculty members from participating PhD program eager to join. Freeing trainees to commit to the research

*theme*. Before our IGERT funding, faculty working on language from diverse perspectives would brainstorm about possible collaborations that were never launched for lack of students with interest in cross-disciplinary research and the freedom to pursue it (since most students were funded on specific research projects). In addition, students and advisors were wary of risky interdisciplinary collaborations that might slow PhD progress. Fellowship funding provides a breakthrough; students join the program *in order to pursue unconventional interdisciplinary research*, and are crucial bridges between labs. A critical mass of funded students catalyzed a cultural shift: students were eager to join NBL even without fellowships, and NBL momentum and productivity eased faculty concerns about impeding PhD research. Program support from UConn (RAships) will also allow us to provide modest support for associate trainees. *Seed funds for pilot research: Innovation Incentive Funds*. Modest funding is a key enabler of student-initiated collaborations. The NBL *Innovation Incentive Fund* (IIF) transformed our graduate training culture. PhD students conceived their own projects and could carry them out, even if they were unrelated to their advisors' funded research programs or interests. This led to a more active and collaborative research culture, and has seeded external funding applications from students and faculty. We will continue the IIF mechanism under SLAC. We have budgeted \$1350 per trainee per year to be used for any innovative purpose related to SLAC, but the funds will be awarded (somewhat) competitively. Trainees will request IIF funding with a short application describing the research/innovation question/goal, team members, scope of work, and budget justification. A small committee will review proposals to ensure ideas are sound, as 2 key elements promoting innovation are (a) rapid implementation and (b) permission to fail (see "innovation training" under §4C).

**Challenge Teams: principles and timing.** *Challenge Teams* are the organizing mechanism that guides SLAC training and research. Challenge Teams are organized following the principles laid out in §4C (Table 3). When trainees apply to SLAC, they will be encouraged to explore existing Challenge Teams (or to organize a new one), and to join at least one team the semester they join SLAC.

**Challenge Teams: existing and developing teams.** As examples of the kind of research our program will foster, we describe 5 existing and developing Challenge Teams. Faculty names are in bold if they are core NRT faculty, and names of other UConn faculty committed to SLAC are underlined.

(1) Data mining naturalistic learning records. **Myers** (SLHS), **McCoach** (EDPSY), **Snyder** (LING), **Magnuson** (LC), Kevin Brown (Biomedical Eng.), **Scott Brown** (EDPSY), Joel Fagot (U. Aix-Marseille, France). This team will focus on 2 large archives of naturalistic learning records: humans studying foreign languages using online software (archives of Rosetta Stone online users) and baboons learning a wide variety of tasks (including lexical decisions: distinguishing written English words from non-word letter strings [Grainger et al., 2012]). Rosetta Stone archives include usage data from over 100,000 users. These data include trial-by-trial performance on language training games, exercises, and human coaching, as users learn a variety of 2<sup>nd</sup> languages (Hindi, English, Spanish, Pashto, Japanese, etc.). Collaborators may pursue questions with this data with Rosetta Stone approval and certificates of confidentiality. This rich dataset opens a wide array of questions about 2<sup>nd</sup> language learning, including whether massed vs. spaced training schedules or certain task orders yield better outcomes, and whether individual differences in learning are predicted demographic information participants provide.

The baboon archives are made available to us by Joel Fagot, who has developed a unique facility (Fagot & Paleressompoulle, 2009), where baboons move freely through outdoor space, living quarters and testing 'cabins'. The animals learn that by interacting with the displays, they can receive food rewards (snacks; the animals are never food-deprived, time spent in cabins is voluntary). Animals are recognized by implanted ID chips, allowing appropriate training trials to be loaded when an animal enters a cabin. Language-related tasks have been conducted, as well as a variety of others (memory, category learning, etc.). Animals visit the booths at will, and vary in the schedules they adopt (some visit at similar times every day, some visit at night, some adopt random schedules).

Similar questions can be addressed with both data archives: what kinds of schedules do individuals adopt? What schedules best promote robust learning? Other questions are archive-specific. For Rosetta Stone, participants choose type of practice from a menu of options, and we have predictors of individual differences such as age time of day. For the baboon archive, multiple tasks and domains can be analyzed (allowing us to examine generality of principles of self-scheduling). A key question is simply how principles from the animal learning literature scale to the more cognitive tasks that have been used with this troop, as well as how principles from human studies "scale down" to a non-human primate. Of course, one thing we may learn is that both species consistently choose maladaptive study strategies. Research suggests that ideal schedules need to promote "desirable difficulties" (Bjork, 1994), such as challenging

tests where one struggles to generate correct answers. However, individuals strongly prefer review strategies that provide a sense of mastery (the “illusion of knowing” when one recognizes rather than generates or recalls information). Research also suggests that studying near a period of sleep is advantageous because it minimizes interference from other experience before sleep-based consolidation can occur (e.g., Walker & Stickgold, 2004). We can examine how often humans choose challenging tasks and the impact on learning, as well as how time-of-day impacts learning (both species). We may discover that principles from short, lab-based studies do not generalize to learning extending over many sessions, or that they do and so should be emphasized for learning in general. This team will also promote internship opportunities with Rosetta Stone (see letter of support) and coordinate with leaders of Data Stewardship modules to provide interesting data, examples, archival challenges, etc.

(2) Phonological learning, sleep, and interference. This team includes speech-language-hearing scientists (**Myers**, Rachel Theodore), educational (**Brown**), cognitive (Gerry Altmann, **Magnuson**), and developmental (Nicole Landi, **Coppola**) psychologists, neuroscientists (James Chrobak, **Fitch**), and linguists (**Snyder**). This team brings together expertise in neuroimaging (Myers, Altmann, Landi, Magnuson), speech perception (Myers, Magnuson, Theodore), neuroscience of the hippocampus (Chrobak), and education in order to take a new look at an old problem: the tremendous difficulty adults have acquiring phonological contrasts that don't exist in their native language (the English /r/-/l/ distinction for Japanese adults is the most famous example). **Myers** and her students have been examining the positive impact of studying such contrasts in the evening, using a Hindi dental vs. retroflex stop contrast that both sound like /d/ to naïve English speakers (e.g., Earle & Myers, 2015; extensions of this work are supported by Myers' NSF CAREER grant). Studying in the evening could be more effective because of proximity to sleep, when crucial memory consolidation occurs in the medial temporal lobe and hippocampus, or because this minimizes amount of English heard before sleep. The team has replicated work in other domains to demonstrate the key role of simple proximity to sleep, but have also shown how the specific content of English experienced after study can interfere with learning (e.g., hearing many words with /d/ interferes much more than hearing many words with /b/). This team will build on those foundational results in several ways. The Chrobak lab has been achieving exquisite tracking of sensitivity to specific memories along the rat hippocampus linked to neural oscillations hypothesized to bind emergent memory representations. The Altmann lab has been using cutting-edge MRI-based techniques to image the human hippocampus with extremely fine resolution. The Landi group brings expertise in human EEG measures, which can be used to track neural oscillations. Together, the team will use high-density MRI-compatible EEG available in our *Brain Imaging Research Center* to investigate neural activation and oscillation patterns linked to successful vs. unsuccessful learning in the Myers task. Studies so far suggest an optimal schedule of study late in the day to minimize interference from post-study activities and to minimize time until sleep. A key question is whether this finding generalizes to the real world: do individuals who attend language classes in the evening show superior performance to those who attend morning classes? Do effects of scheduling (study relative to sleep, etc.) begin to diminish over time (e.g., does repeated studying eventually catch up in efficacy)? Is there interference from one type of study (e.g., Calculus) to another (e.g., Italian vocabulary)? These questions have implications for our understanding of non-native language acquisition, specifically, but also have potentially broad-reaching implications for academic success. For example, how should students schedule study time when they are studying multiple subjects at once? What practical advice could we offer people with challenging schedules (e.g., students who work or have kids)? Co-PI Brown and Magnuson will lead efforts to test such questions with real-world learning (e.g., college or K-12 students).

(3) Augmenting problem-based learning (PBL). This team brings together expertise in education (**Brown**, especially in PBL specifically, **McCoach**), cognition (**Magnuson**), and communication (**Miller**) to investigate ways to improve PBL. As reviewed in §4B, conventional approaches to classroom-based training sometimes result in greater mastery of content knowledge compared to PBL, but PBL promotes much better transfer of skill and knowledge beyond classroom examples. In open-ended PBL, content coverage varies depending on problem specifics and team member (or tutor/mediator) expertise, which can lead to weaker content learning (Gijbels et al., 2005). A solution to this dilemma is to combine PBL with conventional lectures. An alternative might be to create libraries of brief, focused online modules related to specific content we want students to acquire. Also, lecture formats are more effective when combined with frequent testing requiring students to generate responses. The effort of *generating* (rather than recognizing content as familiar) is a powerful way of introducing “desirable difficulties” for learning (Bjork, 1994). A related approach we have experimented with in our NBL program is the use of

competence questions (§4C) as a guide for students as to what they are expected to know in various domains. Competence questions may provide an additional way to augment PBL, by alerting students to concepts they should be watching for as they proceed in a PBL challenge. But how effectively?

This team will examine the relative efficacy of combinations of PBL, conventional lecture, online modules, testing, and competence questions. Miller will provide vital expertise for creating effective online modules. We will conduct lab-based studies with undergraduates varying in length from a single session to multiple sessions over a period of weeks. Another opportunity is to partner with Brown's work on the "GlobalEd 2" project funded by IES. GlobalEd 2 uses a PBL approach with groups of ~20 middle school classrooms, each representing a specific country, who use teleconferencing, email, and other online communication to conduct simulations in international cooperation. A scenario identifies a global problem impacting participating countries (e.g., pollution), and teams research assigned countries' economies, health, human rights, and environment, and work towards negotiating an agreement good for their team's country with at least one other. Teams follow principles similar to those in Table 3, dividing responsibility and labor to address the challenge. GlobalEd 2 has significant impact on content learning, communication, and writing skills (Brown et al., 2013). Outcomes have implications for PBL generally, and for our own training program, given our reliance on PBL and competence questions.

(4) Individual differences in response to Intervention. This team brings together cognitive (Jay Rueckl, **Magnuson**), clinical (**Eigsti**, D. Fein) and educational psychologists (**Brown**, Devin Kearns, Michael Coyne), speech-language-hearing scientists (**Myers**, Rachel Theodore), neuroscientists (**Fitch**) and geneticists (**Chamberlain**) to approach a vexing problem in education and developmental disorders that has deep implications for the basic science of learning. *Response to intervention (RTI)* is an adaptive educational approach designed to identify children in need of different levels of instructional intensity (typical, small group, one-on-one; Fletcher & Vaughn, 2009). Individual differences in RTI, and especially "non-responders", frustrate educators and clinical practitioners. For example, reading specialists report children who show typical gains during intervention, but nearly zero retention even the next day. There appear to be gradations in RTI rather than bimodal distributions of responders and non-responders.

There is a similar phenomenon in Autism Spectrum Disorders. **Eigsti** and colleagues have been documenting cases of "optimal outcomes" in ASD (e.g., Orinstein et al., 2014). These are cases where children clearly met criteria for an ASD diagnosis at a young age, but no longer meet diagnostic criteria in adolescence. Such cases are rare (estimated at 8-20% of children receiving services for ASD), but have similarities (e.g., in types, amounts, and onset age of intervention). However, a conundrum is that optimal outcomes remain probabilistic; there are other children with similar intervention histories and similar cognitive and ASD profiles who do not show significant change in ASD severity.

Individual differences in RTI pose fascinating challenges for the basic science of learning, with great potential for educational impact. Determining the bases for individual differences in RTI, both between extremes (strong responders vs. non-responders), and along the continuum, has important implications for intervention and understanding learning more generally. Although the theory of learning styles has largely been discredited (e.g., Rohrer & Pashler, 2012), it may be that for people on the low end of the RTI spectrum, a variety of interventions must be attempted. It may also be that neuroimaging or genetic analysis could provide insight: are there differences in cortical organization or genetic variations that predict degree of RTI? Finally, anecdotal reports of children who improve in intervention sessions but lose all gains overnight suggest a potential connection to memory consolidation; might the locus of learning difficulties in poor responders be atypical sleep-based consolidation?

This team is poised to examine the genetic factors underlying differences in RTI in ASD (**Eigsti**, **Chamberlain**, and colleagues have secured funding to examine possible genetic factors associated with *optimal outcomes*), connections to sleep-based consolidation (Rueckl is PI or Co-I on two grants that include studies designed to uncover links between consolidation and reading interventions, and Myers' NSF CAREER award focuses on the role of consolidation in acquiring non-native phonological contrasts), and our education group has access to large, school-based samples of children undergoing reading interventions. **Fitch** contributes the possibility of mice studies using a variety of cutting-edge learning paradigms in the new *Murine Behavioral Neurogenetics Facility* she directs (e.g., studies allowing careful tracking of individual differences in the impact of timing of training relative to sleep). Together, the team is equipped to tackle a novel, interdisciplinary systems view of individual differences in RTI.

(5) Genes, cognition, and learning. **Fitch**, **Chamberlain**, **Eigsti**. This group will embark on several interdisciplinary approaches to understanding the roles of 2 genes critical for aspects of complex, higher-order learning. This group brings together molecular geneticist **Chamberlain's** expertise in induced



pluripotent stem cells (which permit the study of molecular [cell-level] changes in learning mechanisms), Eigsti's expertise in clinical assessment of human learning, and Fitch's expertise in developing murine analogues of human learning tasks. This approach has already been fruitful in Fitch and Eigsti's mouse knock-out model studies of *Cntnap2* (Truong et al., 2015, Rendall et al 2015), a gene linked to language learning and to autism spectrum disorder (ASD) in humans. This gene is associated with auditory enhancements in mice similar to enhancements observed in some humans with ASD. Our broader goal is to study mouse knock-out models to determine how genetic markers influence higher-order learning, in part via influence on sensory processing. Mutant and 'wild-type' mice will complete behavioral measures of sensory processing, and receptive and expressive communication, modeled on human tasks, allowing us to further examine cellular correlates of human learning and memory.

**4E. BROADER IMPACTS.** We anticipate significant broader impacts in at least 7 dimensions.

**Research advances.** The Challenge Team approach will provide a model for efficient team science, and uniquely prepare our trainees to further the science of learning in ways possible only through interdisciplinary teams. If the Challenge Team model proves successful, we will disseminate our experiences within UConn through presentations via our Institute for the Brain and Cognitive Sciences (impacting other disciplines), and beyond via online descriptions (on our program website) and journal articles (impacting beyond UConn). Our innovation incentive fund (\$4D) will jumpstart projects that would otherwise be infeasible without external funding, even when the needed funds are modest.

**Graduate training advances.** Our PBL approach has the potential to transform our model of graduate education, and the infusion of communication training throughout SLAC will result in trainees prepared to communicate clearly with a broad range of audiences using a broad range of media. Our "missing manuals" approach to professional development in the SLAC Skills Seminar will prepare trainees with skills for working in and/or leading teams that normally have to be acquired after graduation "on the job."

**Faculty and cultural transformation.** Our experience with IGERT funding predicts at least three transformations among faculty and in our research and training culture. First, fellowships designated for PhD students motivated to bridge diverse fields are exceptionally powerful for dissolving disciplinary boundaries and forging lasting connections between labs, departments, and campuses within a university. NRT funding will further solidify connections among the 6 PhD programs that are part of NBL, and create new connections with Educational Psychology and Genetics & Genomic Sciences. Second, even faculty who do not serve as instructors or attend courses are influenced by the training their students receive. Third, empowering students and sharing ownership of the program with them positively disrupts academic hierarchy; in our experience, treating trainees as colleagues as much as apprentices accelerates their development and therefore research progress. Finally, adopting a culture of assessment will push us to base graduate training practices upon evidence rather than convention or intuition.

**Communication, dissemination, and outreach.** Communication training will prepare students to write and speak clearly for a range of audiences with a range of media. Trainees and faculty will disseminate research findings *and* graduate training outcomes through conference presentations and journal articles, but also less formal and more accessible means (blogs, podcasts, videos, social media). We will build on outreach activities launched under NBL to connect educators, K12 students, and policy makers with our scientists and research (including continuing our *Brain and Cognitive Sciences Research Digest* for policy makers and general audiences, prepared wholly by trainees).

**Trainee diversity.** We will extend successful recruiting and retention efforts under NBL (which boosted participation from members of underrepresented groups from 0% in Year 1 [among 4 fellows and 7 associates; 11% in participating programs] to 28% overall and 33% among IGERT fellows, 16% in participating programs, with most change attributable to NBL). We will increase our participation in outreach events with our Graduate Diversity office (e.g., attending conferences for URMs, and engaging directly with cultural centers on campus). We will continue to make our graduate training environment accessible and welcoming for people with disabilities. An additional emphasis outside the NSF definition of diversity is making our environment accessible and welcoming for international students, who face additional challenges, and whose participation enriches the experience of US citizens and permanent residents, by exposing them to ideas and approaches that may be outside the US experience.

**Diverse career preparation.** We embrace the NRT aim of preparing trainees for careers in and out of academia. This requires a cultural shift among our faculty: we must communicate clearly that non-academic career paths are highly valued. Program elements promoting diverse career path preparation (*Data Stewardship*, SLAC Skills "missing manuals", internships) will also strengthen academic career

<b>Executive</b>	<ul style="list-style-type: none"> <li>• Admissions</li> <li>• Review progress of other committees and maintain global view of program</li> <li>• Recommend actions in response to ongoing evaluations</li> </ul>
<b>Academics</b>	<ul style="list-style-type: none"> <li>• Negotiate scheduling with instructors and departments</li> <li>• Work with instructors to improve courses based on student feedback</li> <li>• Establish graduate certificate programs in SLAC and Data Stewardship and Data Science</li> </ul>
<b>Research</b>	<ul style="list-style-type: none"> <li>• Catalyze collaborations through events like data blitzes and organizing joint lab meetings</li> <li>• Manage innovation incentive funds, including the rapid review process</li> </ul>
<b>Assessment</b>	<ul style="list-style-type: none"> <li>• Coordinate internal and external reviews, monitor best practices among other NRTs</li> </ul>
<b>Diversity and mentoring</b>	<ul style="list-style-type: none"> <li>• Work with Graduate School diversity officer on external recruiting efforts</li> <li>• Work with cultural and international student centers to provide support to students from underrepresented minorities, people with disabilities, and international students</li> <li>• Organize training in mentoring for faculty and students</li> </ul>
<b>Communication and outreach</b>	<ul style="list-style-type: none"> <li>• Organize communication training opportunities outside SLAC seminar</li> <li>• Build and nurture relationships with local and regional communities</li> <li>• Organize the “Science of Learning Challenge”</li> </ul>
<b>Events</b>	<ul style="list-style-type: none"> <li>• Organize annual retreats, J-Term Primers, and academic + social evenings</li> </ul>

**Table 6: Committees and their missions.**

preparation. We also intend and expect a knock-on effect on trainees who pursue academic careers, in that they will be better able to help prepare their own students for academic and non-academic careers.

**Scalability and sustainability: impact beyond funded fellows.** Based on our NBL experience, we expect to easily recruit similar numbers of fellows and associates (25 of each over 5 years). Based on our successful transition to sustaining NBL post-IGERT, we expect to sustain SLAC post-NRT. We anticipate that this will result in sustained impact of the SLAC program on approximately 12 trainees per year after NRT funding. We also anticipate impacts beyond direct trainees. For example, trainees’ communication training will allow them to serve (implicitly) as models of clear communication outside SLAC. If PBL-based Challenge Teams succeed as we anticipate, that model can be adopted by others in our community and beyond. Dissemination aims described above are motivated by our goal to ensure impact beyond UConn.

#### **4F. ORGANIZATION AND MANAGEMENT**

PI Magnuson has the scientific experience (e.g., publications on human learning and computational modeling) and administrative experience (as PI of an IGERT) to successfully lead this NRT. He will have ultimate responsibility for daily operations, communication with NSF, and liaising with UConn administration. Co-PIs will assist in liaising with their departments and colleges.

An innovation we plan is to involve trainees in committee leadership (with 1 or 2 faculty members and 3-4 trainees on each committee; exceptions are the Executive and Assessment committees, which will be led by Magnuson and McCoach, respectively). This is a model we implemented in NBL, and the results were remarkable. Trainee perspectives shifted from that of clients to stakeholders and colleagues. Given the chance, they took real ownership of committees, which was a scary thing at first for faculty to allow. It was eye-opening that committees became more active and efficient. Problems were rare and outright failures rarer, but trainees were able to correct problems and recover from failures. Trainee morale was markedly boosted. We will follow this model, while acknowledging that the first cohort of trainees must be eased into this role, with a gradual transition from faculty leading committees to trainee leadership. Six committees (Table 6) will report to the Executive Committee, which will maintain a global view of the program. To maintain a view of global progress, the PI or program coordinator will attend all meetings.

**Fostering community.** Several aspects of our plans, in addition to student leadership in committees, mindfully foster community. **Shared space.** Co-presence and face-to-face contact are key elements promoting emergence of collaboration (and have significant impact on scientific productivity: Lee et al., 2010). We will work to foster community through shared space for trainees (a large common workroom and a variety of shared laboratories; see *Facilities, Equipment & Other Resources*). These shared spaces promote regular, informal contact which in turn sparks conversations and collaborations.

**Regular in-person events.** The weekly Talk Shop series brings most program participants together on



a regular basis, but interactions are limited. The Events committee will organize annual retreats (held on UConn's seaside Avery Point campus), the Annual Theme Workshop and J-Term Primers (\$4C), and frequent academic/social evenings. Academic/social evenings are effective in promoting contact and conversation. They typically feature wine and cheese, along with a discussion theme, data blitz (e.g., 10 students each get 1 slide and 2 minutes to describe an aspect of their work), or brainstorming session.

*Inter-campus connections.* A key challenge we face is the distance between the Storrs campus and the UConn Health Center (UCHC, where Chamberlain and students in Genetics & Genomic Sciences are located), a 35-minute drive. Given lab and other duties, it will not be practical for UCHC students to spend considerable time in Storrs. We will consolidate course and talk scheduling to minimize trips needed to Storrs (though there are daily shuttle buses between campuses). To maximize accessibility of Storrs events for UCHC personnel (and vice-versa), we will make use of high-end teleconferencing facilities on both campuses. Although the logistics are challenging, they provide an opportunity for our trainees and faculty to become adept at collaborating over a distance. Given that science is more and more often conducted in a team science mode, and that teams often involve members in different states or countries, this is will be valuable experience. Given commitments from participating faculty, we are confident we can successfully coordinate training between campuses.

*Expanding circles of community.* A crucial broader impact is connecting science and scientists with nonscientists, from school children and average citizens to educators, policy makers, and industry. Our *Outreach Seminar* aids in this mission. A SLAC element designed to connect to *expanding circles of community* (SLAC, SLAC PhD programs, UConn, local and regional schools and public, state legislature, and nonacademic mentors and internship sites) is our **UConn Science of Learning Challenge**. We will solicit research challenge ideas from those communities (via email, social media, and physical posters). The *Communication & Outreach* committee will organize review of submitted challenges, with the aim of finding challenges that have reasonable scope (can be addressed in a modest time frame with available resources) and encourage SLAC Practicum and open-ended Challenge Teams to consider them. Examples we could imagine include: *What is the impact of physical activity on neural readiness for learning 5th-grade math? What is the role of sleep in consolidating representations of foreign speech sounds? How can college foreign language curricula be structured to lead to better memory for new vocabulary? How do individual differences in auditory acuity impact language acquisition?*

**Advisory panel.** Panelists representing key areas will visit annually to review our progress through written reports we will provide and meetings with students and faculty. This peer evaluation provides a crucial complement to our internal and external evaluations, as panelists have deep experience in training and research from multiple areas. Panelists who have agreed to participate: Sheila Blumstein (cognitive neuroscientist, Brown U.), BJ Casey (developmental psychobiologist, Yale), Elissa Chessler (neuroscience & genetics, The Jackson Laboratory, Bar Harbor), David Francis (expert in measurement, data analysis, and reading, U. Houston), and Colin Phillips (linguist/cognitive neuroscientist, PI of an NRT at U. MD). We will add experts in computational modeling and science communication.

#### 4G. RECRUITMENT, MENTORING AND RETENTION

Our approach to draws heavily on “promising practices” from the *Council of Graduate Schools Completion Project* (Council of Graduate Schools, 2008; [www.phdcompletion.org](http://www.phdcompletion.org)), a 7-year study of PhD programs in 24 fields. We adopted most of these practices for NBL, which has improved our programs in all 3 dimensions. We will continue and extend these approaches in several ways.

	Applicants			Admitted			Matriculated			Completed	Mean TTD	Left w/o degree	Estimated completion rate
	Total	Women	URG	Total	Women	URG	Total	Women	URG				
BIO	202.2	118.4	12.6	52.2	28.4	3.2	18.2	10.4	0.8	18.2	5.3	2.6	85.7
BNS	34.0	18.6	4.2	4.8	3.0	0.6	3.4	1.8	0.2	4.4	5.5	0.8	76.5
CLIN	352.8	283.4	56.8	10.6	8.6	2.0	8.2	6.6	1.4	6.6	6.2	0.2	97.6
DEV	24.4	19.8	5.2	4.2	4.0	1.2	2.8	2.6	1.2	1.8	6.4	0.2	92.9
EDPSY	36.8	23.8	4.0	14.4	8.4	2.4	8.6	4.4	1.8	3.4	4.6	1.7	80.8
LC	27.4	17.4	7.8	5.4	3.2	2.2	4.0	2.2	2.0	2.6	5.7	0.4	90.0
LING	82.4	44.8	3.4	13.4	7.6	0.2	5.8	2.6	0.2	4.0	6.7	2.0	65.5
<b>AVG</b>	<b>108.6</b>	<b>75.2</b>	<b>13.4</b>	<b>15.0</b>	<b>9.0</b>	<b>1.7</b>	<b>7.3</b>	<b>4.4</b>	<b>1.1</b>	<b>5.9</b>	<b>5.8</b>	<b>1.1</b>	<b>84.1</b>

**Table 7:** Recruitment and retention averages 2011-12 to 2015-16. URGs include URMs and people with disabilities. BIO = Biological Sciences at UCHC (of which Genetics & Genomics is part). For other abbreviations, see Table 1. Completion rate is estimated as  $([1 - \text{number left w/o degree}] / [\text{number matriculated}]) \times 100$ . These numbers come from different cohorts, but given that these are 5-year averages, this provides reasonable estimates.

**Recruitment.** Our IGERT has improved applicant pool quality, and has had a remarkable impact on diversity. Prior to IGERT, 11% of matriculated PhD students in participating programs were from underrepresented groups (URGs, including underrepresented minorities [URMs] and individuals with disabilities). None of our first cohort of IGERT-NBL trainees were from UGs (4 fellows and 3 associates). At the time, those 7 trainees comprised 8% of matriculated students in the participating PhD programs. Now, current IGERT trainees (27 fellows, 20 associates) comprise 33% of students in participating PhD programs. 28% of current IGERT trainees are from underrepresented groups (33% of fellows), and 16% of students (IGERT and non-IGERT) in participating programs are from URGs (57% of whom are IGERT trainees). The proportion of women (~60%) has not changed notably during IGERT funding.

It is clear that our recruiting efforts in general and for URGs specifically under IGERT funding were effective, and we will emulate them but also expand them under SLAC. For recruiting in general, publicity is key. We will use internet tools to publicize SLAC quickly, including a website, Facebook page, and postings from SLAC faculty and affiliated PhD students to social media and relevant listservs. We will also use conventional means, such as letters and brochures to colleagues and relevant departments, other targeted mailings (e.g., to undergraduate cognitive science groups), and announcements at conferences. Co-PI McCoach was PI of a GAANN training grant (\$41) in EDPSY with a special emphasis on attracting and retaining students from URGs; the program achieved URG participation of 29%.

**Diversity.** We will also devote substantial effort to attracting students from URGs. Efforts that we will continue from IGERT include the following 3 primary efforts.

(1) Partnering with our Graduate Diversity Officer, Charmane Thurmand, who connects us to regional and national resource such as the Northeast Alliance for Graduate Education and the Professoriate (NEAGEP, an organization launched with NSF funding that connects regional universities with minority serving institutions), LSAMP (Louis Stokes Alliance for Minority Participation), and sending faculty and/or students with Ms. Thurmand to represent UConn and SLAC at multiple national conferences for academics from underrepresented groups such as ABRCMS (Annual Biomedical Research Conference for Minority Students). (NB: these activities are prominent among 'promising practices' for diversity recruiting; Council of Graduate Schools, 2008.) We will also advertise the availability to undergraduate McNair Fellows, either via their website or through their listserv/ mailing list.

(2) We have an uncommon ability to welcome Deaf PhD students. **Coppola** and several faculty are fluent signers. The ability to communicate directly with faculty members in ASL is an important consideration for prospective Deaf students. UConn has invested heavily in Deaf access (in large part in response to successful recruiting under NBL), with a full-time interpreting coordinator and multiple full-time staff interpreters, and has become truly accessible to Deaf individuals. We target relevant listservs (SLLS-list [Sign Language Linguistics Society] and SLLING-list [Sign Linguistics]), and the Theoretical Issues in Sign Language Research conference. We also make recruiting visits to schools with substantial populations of Deaf students, including Gallaudet University and the Rochester Institute of Technology.

(3) We will partner with the UConn *Women in Math, Science and Engineering* (WiMSE) program for undergraduates (**Fitch** and **Eigsti** are active members), and invite WiMSE students to work in SLAC labs. Recruiting efforts for women will include outreach to organizations such as the *Association for Women in Science*, the *Association for Women in Computing*, and on-campus Psi Chi, and honors organizations serving undergraduate women in STEM nationally, and contacts with service and education groups within prominent professional societies, such as *Women in Neuroscience* and *Women in Cognitive Science*.

**Mentoring.** Trainees will begin *Individual Development Plans* in their first semester. These will help students complete NRT and PhD requirements on time, as well as prepare for individual career paths. We will build on a successful model used by **Brown** to pair students with academic and/or nonacademic external mentors with whom students will meet at least twice per year (in-person or by phone or skype). Most internship sites have agreed to help find relevant personnel who could be potential mentors. Faculty will assist advisees in finding external academic mentors. We will also implement 2 types of mentoring training. (1) SLAC faculty must commit to attending a short series of mentoring workshops the year before or the semester when their first SLAC trainee begins. In coordination with the Graduate School Diversity Office, we are developing sessions covering a broad variety of mentorship, including challenges specific to students from URMs, students with disabilities, and international students. (2) The SLAC Skills Seminar covers mentoring to prepare trainees to serve as mentors.

**Retention and completion.** Retention in IGERT-NBL exceeds national averages (we are on track for 93% completion rate, vs. national rates of only 59-65% in our participating domains [*Council of Graduate Schools Completion Project*, [www.phdcompletion.org](http://www.phdcompletion.org)]) and mean time-to-degree of 5.1 years (vs. 54%

10-year completion rate for IGERT fellows nationwide [Carney et al., 2011]). Table 7 shows that retention and time-to-completion in our participating PhD programs compare favorably to national averages.

Best practices for retention include anticipating challenges before they happen, which requires planning and open communication between trainees and faculty. For all students, Independent Development Plans (IDPs, <http://myidp.sciencecareers.org>) are essential for making progress in PhD training as smooth as possible. They help students develop a “backward planning” mindset (Lewis, 2002; Wiese et al., 2016): setting long-term goals and then enumerating short- and intermediate-term subgoals and the timing required to achieve long-term goals. To achieve our aims of 100% retention and 100% completion in 5 years, SLAC trainees will meet with their advisor and/or another SLAC faculty member to set up IDPs the year before entering SLAC (or at the beginning of their first SLAC semester at the latest). Executive Committee members (§4F) will conduct annual progress meetings with trainees to provide frank, constructive feedback based on student reviews and ongoing assessments (§4H) (meetings are with individuals rather than the full committee to reduce the potential for anxiety, and with faculty from outside the home PhD to encourage more frank student reports). Trainees (and faculty) also have the option of providing anonymous feedback via the external assessment consultant.

Three particularly powerful ways to promote retention (CGSCP, 2008) are (a) providing financial support like fellowships, (b) programming social events for PhD trainees and faculty (§4F), and (c) co-locating trainees (see shared space in §4F). However, these elements can result in conflict when there are substantial disparities in funding levels or funding-related responsibilities (e.g., fellowships vs. teaching assistantships). There is no easy way around the fact that our programs cannot afford to pay all trainees at the NRT stipend level. However, we will mitigate this by (a) following effective practices from our IGERT experience (e.g., treating fellows and associates as equally as possible; e.g., only publicly distinguishing between fellows and associates when absolutely necessary, as in NSF annual reports, and providing associates access to Innovation Incentive Funds), and (b) using internal PhD program mechanisms to fund associate trainees (with combinations of RAships and TAs).

Another major aspect of retention is anticipating challenges specific to some individuals, such as trainees from underrepresented minorities, trainees with disabilities, trainees from low-SES backgrounds, women, and international students. Our Diversity Committee will follow effective practices from our IGERT experience to support these groups, e.g., by working with the Graduate Diversity Officer, cultural centers on campus, the UConn Center for Students with Disabilities, and WiMSE. Given the substantial proportion of women in our programs, it may seem surprising that we identify women as a group that can benefit from such support. However, proportions of women in training pools tend to be much higher than proportions in faculty in the same areas, women tend to be paid less than male counterparts in and out of academia, behavior admired in men is often discouraged in women, and there are various cultural biases that tend to pressure women towards lower-status committees and lower-status committee roles. We will address these concerns through diversity workshops at retreats and J-Term for both men and women.

#### **4H. PERFORMANCE ASSESSMENT / PROJECT EVALUATION.**

Given the importance and centrality of ongoing program evaluation and performance assessment, we have enlisted Co-PI **McCoach**, a professor in *Measurement, Evaluation, and Assessment* within EDPSY, to serve as the internal evaluator and core team member. We will also contract an external evaluator (Dr. Mariko Chang, external evaluator for NBL) to conduct an objective annual review. Our program evaluation plan incorporates both formative and summative assessment and serves to evaluate individual success of fellows and the effectiveness of the program as a whole. Our plans are aligned with project goals, activities, and outcomes. Quantitative and qualitative data collection is conducted on an ongoing basis (e.g., surveys deployed once per semester) to ensure that fellows’ individual needs can be better met and the program can be refined as needed. McCoach will coordinate with faculty to inform them on best practices for incorporating formative assessment in courses (that can also aid program evaluation).

Dr. McCoach will design, administer, and analyze results of brief, formatively oriented online surveys, which will be administered to fellows and affiliates twice a year. Dr. McCoach will share results with SLAC faculty on an ongoing basis, and she will share formative evaluation results with trainees at the end of each semester to ensure that the formative assessments aid in continuous improvement efforts. Dr. McCoach and Dr. Chang will work together to develop annual comprehensive summative online surveys (1 for students, 1 for faculty) to track progress toward program goals. Summative surveys will ask stakeholders to self-assess their knowledge and skill development in the key areas outlined in the grant and assess the extent to which the program has provided opportunities to develop these key skills. Dr.

Chang will conduct annual focus groups with faculty, fellows and associates, work with Dr. McCoach on the development of surveys, and independently analyze survey data. It is crucial for the outside evaluator to conduct the focus groups and interviews with students, faculty, and other key stakeholders, given that Dr. McCoach is a SLAC faculty member. To complement self-assessment data, student self-evaluations of ability to answer *competence questions* (§4C) will inform us as to efficacy of breadth training efforts.

In addition, Dr. Chang and Dr. McCoach will collect information on comparison students from affiliated departments who are not participating in SLAC to help evaluate program impact. We will invite all 1<sup>st</sup>, 3<sup>rd</sup>,

	GOAL	MECHANISM	FORMATIVE ASSESSMENT	SUMMATIVE ASSESSMENT
CONTENT	Deep expertise in home domain	Home PhD courses	Ongoing faculty evaluations of students	Faculty evaluations of students; 'Competence questions'
	Moderate expertise in 2-3 others	SLAC Seminar + Challenge Teams	Ongoing faculty evaluations of students	Faculty evaluations of students; 'Competence questions'
CULTURE	Master PBL as participant and teacher	SLAC Seminar	Peer evaluations of PBL exercises in SLAC Seminar	Faculty evaluations of students
	Use PBL to train on content	SLAC Seminar	Comparisons of impact of PBL vs. conventional formats in seminar	Comparisons of SLAC Seminar and comparable, non-PBL courses
	Adopt good project management principles	SLAC Practicum + Challenge Teams	Competence questions on project management	Presentations + papers produced
			Track progress of Challenge Teams (met goals; research products)	Surveys and focus groups: self ratings of success
	Increase interdisciplinary research activity	Courses, Challenge Teams, Innovation Incentive funds	Track progress of Challenge Teams (met goals; research products)	Number of interdisciplinary presentations and papers
	Foster strong sense of community	Talk Shop, J-Term Primers, Annual Workshop	Attendance at events like Talk Shop	Surveys and focus groups
COMMUNICATION	Clear communication with specialist peers, nonspecialist peers, nonacademics, children	Communication training in SLAC Seminar, J-Term Primers, special workshops	Peer evaluations of course or Talk Shop presentations	Number of presentations; evidence of growth in formative evaluations
	Ability to develop outreach activities	Outreach Seminar	Peer, faculty, and audience evaluations of outreach activity	Number of presentations; evidence of growth in formative evaluations
CAREER PREP	Data Science skills	Data Science & Stewardship courses and modules	Instructor feedback and student self-evaluation in courses, workshops	Competence questions for Data Science at beginner, intermediate, and expert levels
	Professional development + soft skills	SLAC Skills Seminar	Instructor feedback and student self-evaluation in courses, workshops	Annual evaluation by faculty; surveys and focus groups
	Academic placement	Standard academic prep, travel funding	Track job applications and internship applications and placements	Track post-graduation placements
	Nonacademic placement	Nonacademic mentor connection & internships	Track job applications and internship applications and placements	Track post-graduation placements
DIVERSITY	Recruit & retain diverse trainees	Partner with Grad School Diversity Office for recruiting and mentoring training	Quarterly check-ins with the Diversity Committee	Compare NRT diversity to home departments  Applications, admission & matriculation stats by group
	Make environment more supportive	Mentoring training for faculty & trainees  SLAC connections to cultural centers	Pre- and posttest attitudes surveys, workshop evaluations  Quarterly check-ins with the Diversity Committee	Annual Surveys and focus groups
	Enhance awareness of URG challenges	Diversity workshops	Pre- and posttest attitudes surveys, workshop evaluations	Annual Surveys and focus groups
	Enhance awareness of gender inequity	Diversity workshops	Pre- and posttest attitudes surveys, workshop evaluations	Annual Surveys and focus groups

**Table 8: Assessment and evaluation framework.**

and 5<sup>th</sup> year PhD students in those departments to complete an online survey annually. The survey will ask students to self-assess preparation for PhD-level professional positions, ability to communicate research to both scientific and lay audiences, data related skills, interest and experience in conducting interdisciplinary research, and satisfaction with their graduate program. Then, to supplement the summative evaluation, we will conduct a small-scale quasi-experimental study to evaluate the impact of the program. We will match comparison students to SLAC students based on GRE scores, undergraduate GPA, gender, and ethnicity. We will collect information about students' research productivity (presentations, publications, external funding), completion rates, time to degree, and first post-doctoral position, and we will compare these outcomes across the treatment and comparison groups. In addition, we will compare the two groups of students' responses on the online surveys.

A particular concern is our heavy emphasis on PBL and Challenge Teams. McCoach will assist SLAC Seminar and Practicum instructors to develop brief formative assessments (for students) of each topic covered in a course session, and combine these with faculty analyses of session content (topics covered via PBL vs. conventional formats). This will allow us to assess the relative impact of PBL vs. conventional information coverage. Ongoing surveys will include items regarding Challenge Team buy-in, and items assessing the degree to which teams actually follow the principles in Table 3. (McCoach will also participate in the *Augmented PBL Challenge Team*, §4D, which may also provide insights for evaluating PBL and Challenge Team approaches.)

Chang will provide a summative evaluation report each year, shared with SLAC advisory panelists, faculty, and trainees, with essential details included in annual reports to the NSF. Dr. McCoach will share the formative and interim evaluations with faculty on an ongoing basis and will provide bi-annual internal evaluation reports. In addition, we will share assessment and evaluation results with the nationwide NRT community (e.g., via the *NRT Evaluators* blog) as well as with the broader community of graduate faculty in STEM related fields. We will present analyses of our program evaluation results and their implications for best practices at professional meetings. Potential outlets include the annual meetings of the AAAS and the American Evaluation Association. Table 8 outlines our project evaluation and assessment plan.

#### **4I. RECENT STUDENT TRAINING EXPERIENCES**

Team members have participated in 2 major recent graduate training experiences: the IGERT-funded *Neurobiology of Language* (NBL) program to which we have referred throughout the application, and a Department of Education *Graduate Assistance in Area of National Need* (GAANN) in Educational Psych.

**IGERT: Neurobiology of Language**, 2012-17, PI Magnuson. We have discussed throughout this proposal how SLAC emulates NBL strengths and experiments with alternatives to weaker elements. See §4J for explicit discussion of overlap between NBL and SLAC.

Impact beyond fellowships: we had funding for 28 fellows; in addition, 28 associates signed on to complete the full program. Participating programs report that applicants cite NBL as a significant attraction when they apply to UConn, even if they do not qualify for fellowships. The strong participation from associates demonstrates scalability beyond fellows and intrinsic value evident to trainees. Once trainees are in the program, fellows and associates are treated identically as much as possible. They are not distinguished publicly with the exception of NSF reports. While individual associates are surely keenly aware that they do not have IGERT fellowships, faculty and students from different cohorts report that they are unsure which trainees are fellows. Thus, we have achieved our aim of providing equivalent, if not perfectly equal (in terms of fellowships and NSF resources) NBL training to associates and fellows. Catalyzing interdisciplinary research and community: We claimed in our IGERT proposal that the culture and infrastructure our program would create would lead to the emergence of new interdisciplinary collaborations. We hoped that there would be at least one new collaboration per trainee. In fact, we have surpassed that hope, with 82 interdisciplinary collaborations involving trainees launched in our first 4.5 years. In addition, weekly Talk Shop attendance has grown from ~20 to ~80; this is the primary venue where faculty and students who are not working together interact, and has been the catalyst for several collaborations. High productivity: Publication and presentation rates have grown each year, most recently from 73 publications in Year 3 to 112 in Year 4. Diversity: As noted in §4g, participating PhD programs moved from 11% URM participation pre-IGERT to 33% among fellows and 28% overall currently. Community outreach: Prior to IGERT, a handful of faculty conducted occasional outreach. The NBL *Outreach Seminar* has significantly extended outreach. The seminar culminates with teams of students conducting enrichment sessions in elementary and middle schools. Sustainability: The UConn Board of Trustees approved our proposal for a *Neurobiology of Language* graduate certificate in 2014. Our faculty



and participating PhD programs are committed to continuing the program beyond IGERT funding. NBL will be an important model for and complement to SLAC. Boosted morale: Annual external assessments indicate high morale among faculty and trainees. Several faculty report that NBL has changed their research trajectory via interdisciplinary collaborations that would not have happened without it.

**Graduate Assistantship in Areas of National Need**, 2012-16. The purpose of this award was to increase the number of highly trained PhD-level researchers in *Measurement, Research Methods, Statistics and Evaluation*. The program (1) provided Fellows with training and experience in teaching measurement, quantitative methods, and evaluation courses, (2) engaged Fellows in relevant research projects; and (3) provided opportunities for Fellows to engage in real-world measurement, quantitative methods, and evaluation practice through ongoing research projects, and internships with the CT Department of Education, testing organizations, and/or research and evaluation organizations, and (4) provided fellows with the opportunity to conduct independent research under faculty mentorship. In addition, the GAANN grant required all students to complete training in teaching pedagogy and to complete a supervised teaching experience in MEA. We were able to fund 11 students for a total of 22 fellowship years, far exceeding our grant obligations. Of 11 fellows, 2 are employed in post-doctoral research, 7 passed qualifying exams and are working on dissertations, and 1 left the program.

#### **4J. RESULTS FROM PRIOR NSF SUPPORT**

**(1) NSF1144399, "IGERT: Language Plasticity - Genes, Brain, Cognition, Computation"**, 05/31/12-07/31/16, James **Magnuson** (PI), R. H. **Fitch**, W. **Snyder**, K. Pugh, C. Coelho (Co-PIs) transformed graduate education in neurobiology of language (NBL) by providing PhD students from 6 domains (neuroscience, linguistics, clinical-, cognitive-, and developmental-psychology, and speech and hearing sciences) sufficient course- and lab-based experience with each domain to allow them to work in collaborative teams towards a deeper, multi-level and multidisciplinary understanding of language development throughout the lifespan. Major achievements: broader impacts include significant trainee diversity (28% of trainees [33% of fellows] from URGs), and substantial outreach activities by faculty and trainees. Major achievements: intellectual merit. NBL has stimulated collaboration (82 interdisciplinary projects launched with trainees), and productivity (42 publications directly related to the project with trainee co-authors over 4 years; see NBL section under *References Cited*). Projects include new collaborations merging genetics, cognition, and development to study co-development of cognitive and linguistic abilities (Kornilov publications), and others among neuroscientists and psychologists that are uncovering new insights into the genetics of autism spectrum disorders (Rendall publications below). The first cohort will not complete their PhDs until Spring, 2017, but associate trainees who have graduated have gone on to postdocs at Baylor/U. Houston, Brandeis, Penn State, Rutgers, Wisconsin, and Yale).

**(2) NSF1553589, "CAREER: The Impact of Language Experience on Number Representations in Deaf, Hard of Hearing, and Hearing Children"**, 02/01/16-01/31/21, Marie **Coppola** (PI). This award addresses the large achievement gap in math between deaf and hard of hearing (DHH) children and normally hearing children, and their consequent severe underrepresentation in STEM fields. Prior findings suggest that language input during early development is critical for acquiring a count list (e.g., "one", "two", "three", etc.) and forming number concepts (e.g., exactly 7). We will test for a causal link between number concepts and mathematical knowledge via a training study. Major achievements: intellectual merit. Coppola has presented aspects of the project to 8 audiences including academic, medical, educational, and interpreting professionals. Major achievements: broader impacts. We are developing an assessment to allow direct vocabulary comparisons of DHH children (in ASL) with normally hearing peers (in English). No such instrument exists, creating barriers to determining whether DHH children's language development is age-appropriate. Relevance to SLAC is apparent in our emphasis on interaction between biological sensitive periods and environmental input, and impact on classroom learning.

**(3) NSF1554810 "CAREER: Optimizing Non-Native Speech Sound Learning"** 6/1/16-5/31/21. **Emily Myers** (PI). A series of projects address a key question: why do most adults struggle to learn the sounds of a new language, and what can be done to maximize learning success? Projects are motivated by recent work by Myers suggesting that *memory consolidation during sleep* plays a key role in non-native sound acquisition. Major achievements: intellectual merit. Preliminary reports of this key result were presented at 3 conferences. Major achievements: broader impacts will include development of techniques to streamline online collection perceptual data and allow broader community participation in research. Relevance to SLAC. The interdisciplinary approach of this grant, integrating techniques from neuroscience, behavioral psychophysics, and exploration of 'big data,' echoes the interdisciplinary links that are the focus of the current proposal.

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[james.magnuson@uconn.edu](mailto:james.magnuson@uconn.edu)<http://magnuson.psy.uconn.edu/>**(a) Professional preparation**

University of Chicago	Chicago, IL	Linguistics	A.B., with honors, 1993
University of Rochester	Rochester, NY	Brain & Cognitive Sciences	Ph.D., 2001

**(b) Appointments**

University of Connecticut	Professor	Psychology	8/14-Present
University of Connecticut	Associate Professor	Psychology	2008-2014
University of Connecticut	Assistant Professor	Psychology	2004-2008
Haskins Laboratories	Senior Scientist		2004-Present
Columbia University	Assistant Professor	Psychology	2001-2004
Advanced Telecom. Research (ATR)	Jr. Research Scientist	Spoken language group	1993-1995

**(c) Publications****i. Related to the project**

1. Collisson, B. A., Grela, B., Spaulding, T., Rueckl, J. G., & **Magnuson, J. S.** (2015). Individual differences in the shape bias in preschool children with Specific Language Impairment and typical language development: Theoretical and clinical implications. *Developmental Science*, 18:3, 373-388.

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**ii. Other significant publications**

1. Kukona, A., Fang, S., Aicher, K. A., Chen, H., & **Magnuson, J. S.** (2011). The time course of anticipatory constraint integration. *Cognition*, 119, 23-42.

2. **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.

3. Mirman, D., Graf Estes, K., & **Magnuson, J.S.** (2010). Computational modeling of statistical learning: Effects of transitional probability vs. frequency and links to word learning. *Infancy*, 15, 471-86.

4. 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.

5. 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.

#### (d) Synergistic activities

1. **Innovations in graduate training:** I am PI of an IGERT-funded training program (*Language Plasticity: Genes, Brain, Cognition, Computation*) that brings together students and faculty from cognitive and biological disciplines to train and work in collaborative teams to achieve integrative, interdisciplinary approaches to understanding language, from behavior to genetic basis. This effort includes many unconventional elements, such as annual intensive short courses during our winter break (January-Term Primers), and a unique 5-seminar training sequence that is succeeding in catalyzing interdisciplinary work at the intersection(s) of psychology (clinical, developmental, cognitive), neuroscience, linguistics, and communication disorders.

2. **Building infrastructure and community for interdisciplinary research locally and internationally.** Locally (within UConn), I have been active as a leader or team member in numerous efforts that have improved and energized infrastructure for and in interdisciplinary research among faculty, graduate students, and undergraduate students. These include (a) serving as a co-investigator and core writing-team member of an ARRA-funded center grant that allowed us to hire two outstanding junior faculty cross-appointed in multiple departments, and put in several mechanisms for promoting interdisciplinary community that are still active (e.g., an annual internal conference); (b) leading the IGERT training program mentioned above; (c) being an active member of the team that led development of our new brain imaging research center; and (c) leading the effort to found our Connecticut Institute for the Brain and Cognitive Sciences and the effort to recruit our director, Gerry Altmann, and serving as associate director. My international efforts include being an active team member along with colleagues at UConn and Haskins who are building a multilingualism and literacy network (involving scientists in France, Spain, Finland, the Netherlands, Israel, Taiwan, China, Japan, India, Canada and the US). Several of these partners are host sites for international research internships for trainees in our IGERT program.

3. **Outreach.** A crucial aspect of my responsibilities as IGERT PI and Institute associate director is outreach. I have helped lead the development of a formal outreach course for our PhD students, and am organizing faculty from throughout the university to provide lectures and workshops for Connecticut educators and policy makers as well as students from K-12 and the lay community in general. We do not advocate for UConn, but rather serve an educational service role. A meeting I organized between our PhD students and our local representative to the state legislature led to a PhD student team (that I supervised) who have begun to publish a “Brain and Cognitive Sciences Research Digest” suggested by the legislator.

4. **Software.** My lab released **jTRACE**, a cross-platform (Java) reimplementation of the TRACE model of speech perception and word recognition (freely available from our lab website). Our team occasionally conducts jTRACE tutorials (e.g., twice at the Cognitive Science Society), and we published a paper in *Behavioral Research Methods* (Strauss, Harris, & Magnuson, 2007, *BRM*, 39, 391-409). This project was motivated by the observation that many seemingly logical predictions about how computational models *should* work if they were applied to a particular experiment turn out to be dramatically wrong when simulations are actually conducted (as reviewed by: 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.).

5. **Editorial activities.** **Associate Editor, *Cognitive Science* and *Journal of Memory and Language*** (both 2009-2013); member, **editorial board, *Cognition***, since 2008. I also recently co-edited a 2-issue tribute to Carol Fowler in *Ecological Psychology* (2016, v. 28, issues 3 and 4).

**Biographical Sketch****Stormy J. Chamberlain**

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**(a) Professional Preparation**

<u>College/University</u>	<u>Location</u>	<u>Major</u>	<u>Degree &amp; Year</u>
Princeton University	Princeton, NJ	Molecular Biology	BA, 1997
University of Florida	Gainesville, FL	Genetics	PhD, 2003
University of North Carolina	Durham, NC	Genetics	2003-2008
University of Connecticut Health Ctr.	Farmington, CT	Gen. and Dev. Biol.	2008-2009

**(b) Academic/Professional Appointments**

Assistant Professor, University of Connecticut Health Center

Postdoctoral Fellow, University of Connecticut Health Center, Lab of Marc Lalande

Postdoctoral Fellow, University of North Carolina, Lab of Terry Magnuson

**(c) Publications****(i) Publications Most Closely Related to Proposal**

1. **Chamberlain SJ.** (2016). Disease modelling using human iPSCs. *Human Molecular Genetics*, 25(R2), R173-R181.
2. **Chamberlain SJ** (co-corresponding author), Chen, P-F, Ng KY, Bourgois-Rocha F, Lemtiri-Chlieh F, Levine ES, and Lalande M. (2010). Induced pluripotent stem cell models of the genomic imprinting disorders, Angelman and Prader-Willi syndromes. *Proceedings of the National Academy of Sciences*, 107(41), 17668-73.
3. Germain ND, Chen PF, Plocik AM, Glatt-Deeley H, Brown J, Fink JJ, Bolduc KA, Robinson TM, Levine ES, Reiter LT, Graveley BR, Lalande M, **Chamberlain SJ.** (2014). Gene expression analysis of human induced pluripotent stem cell-derived neurons carrying copy number variants of chromosome 15q11-q13.1. *Molecular Autism*, 5, 44. doi: 10.1186/2040-2392-5-44.
4. King IF, Yandava CN, Mabb AM, Hsiao JS, Huang HS, Pearson BL, Calabrese JM, Starmer J, Parker JS, Magnuson T, **Chamberlain SJ**, Philpot BD, Zylka MJ. (2013). Topoisomerases facilitate transcription of long genes linked to autism. *Nature*, 501(7465), 58-62. doi: 10.1038/nature12504.
5. Martins-Taylor K, Hsiao JS, Chen PF, Glatt-Deeley H, De Smith AJ, Blakemore AI, Lalande M, **Chamberlain SJ.** (2014). Imprinted expression of UBE3A in non-neuronal cells from a Prader-Willi syndrome patient with an atypical deletion. *Human Molecular Genetics*, 23(9), 2364-73. doi: 10.1093/hmg/ddt628.

**(ii) Other Significant Publications**

1. **Chamberlain SJ**, Brannan CI. (2001). The Prader-Willi syndrome imprinting center activates the paternally expressed murine Ube3a antisense transcript but represses paternal Ube3a. *Genomics*, 73(3), 316-22.
2. **Chamberlain SJ**, Germain ND, Chen PF, Hsiao JS, Glatt-Deeley H. (2016). Modeling Genomic Imprinting Disorders Using Induced Pluripotent Stem Cells. *Methods in Molecular Biology*, 1353, 45-64. doi: 10.1007/7651\_2014\_169.

3. **Chamberlain SJ**, Johnstone KA, DuBose AJ, Simon TA, Bartolomei MS, Resnick JL, Brannan CI. (2004). Evidence for genetic modifiers of postnatal lethality in PWS-IC deletion mice. *Human Molecular Genetics*, 13(23), 2971-7.
4. Chen PF, Hsiao JS, Sirois CL, **Chamberlain SJ**. RBFOX1 and RBFOX2 are dispensable in iPSCs and iPSC-derived neurons and do not contribute to neural-specific paternal UBE3A silencing. (2016). *Scientific Reports*, 6, 25368. doi: 10.1038/srep25368.
5. LaSalle JM, Reiter LT, **Chamberlain SJ**. (2015). Epigenetic regulation of UBE3A and roles in human neurodevelopmental disorders. *Epigenomics*, 7(7), 1213-28. doi: 10.2217/epi.15.70.

#### **(d) SYNERGISTIC ACTIVITIES**

1. I developed induced pluripotent stem cell technology at University of Connecticut Health Center and trained members of our Stem Cell Core, which now provide iPSC production as a service, as well as other individuals on our campus.
2. I have generated human iPSC models of Angelman syndrome, Dup15q syndrome and Prader-Willi syndrome and have distributed these cells to many different labs worldwide.
3. I serve on the Professional Advisory Board for the Dup15q Alliance and the Scientific Advisory Committee for the Angelman Syndrome Foundation, parent-led patient advocacy groups.
4. As a member of the UConn-Wesleyan Stem Cell Core Outreach program, I give talks to promote stem cell research to high school students, local colleges, and community groups to disseminate information about the state's stem cell research program and the work it funds.
5. I serve as the Associate Director of the Genetics and Developmental Biology area of concentration in the Biomedical Sciences Graduate Program at the University of Connecticut Health Center and co-direct the comprehensive first year graduate course, Foundations for Biomedical Science.

## Biographical Sketch

### D. Betsy McCoach, Ph.D.

Professor, Educational Psychology, Measurement, Evaluation, and Assessment program

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### A. Professional Preparation

University of Delaware	Newark, DE	Economics and French	B.A. 1991
Lehigh University	Bethlehem, PA	Secondary Education	M.A. 1993
University of Connecticut	Storrs, CT	Education; School Psychology	M.A. 2001
University of Connecticut	Storrs, CT	School Psychology	6 <sup>th</sup> Year Certificate 2002
University of Connecticut	Storrs, CT	Educational Psychology	Ph.D. 2003

### B. Appointments

2014-present	Professor, Educational Psychology Department, University of Connecticut
2008-2014	Associate Professor, Educational Psychology Department, University of Connecticut
2003-2008	Assistant Professor, Educational Psychology Department, University of Connecticut

### C. Publications

#### *Five most closely related to the proposed project*

1. **McCoach, D. B.**, Gable, R. K., & Madura, J. (2013). *Instrument design in the affective domain. (Third Edition)*. New York: Springer.
2. **McCoach, D. B.**, Gubbins, E. J., Foreman, J., Rubenstein, L., & Rambo, K., (2014). Evaluating the Efficacy of Using Pre-differentiated and Enriched Mathematics Curricula for Grade 3 Students. *Gifted Child Quarterly*.
3. **McCoach, D. B.**, O'Connell, A. A., Reis, S. M., & Levitt, H. (2006). Growing readers: A hierarchical linear model of children's reading growth during the first two years of school. *Journal of Educational Psychology*, 98, 14-28.
4. **McCoach, D. B.**, Rambo, K., & Welsh, M. (2013). Assessing the growth of gifted students. *Gifted Child Quarterly*, 57, 56-67.
5. Rambo, K. & **McCoach, D. B.** (2014). Using summer growth patterns to assess the impact of schools on high achieving and gifted students' reading skills. *Journal of Educational Research*. DOI: 10.1080/00220671.2013.850398

#### *Five other significant products*

1. Kenny, D. A., Kaniskan, B., & **McCoach, D. B.** (2014). How small is too small? The performance of RMSEA in models with small df. *Sociological Research Methods*.
2. Kenny, D. A. & **McCoach, D. B.** (2003). Effect of the number of variables on measures of fit in Structural Equation Modeling. *Structural Equation Modeling*, 10, 333-351.
3. **McCoach, D. B.**, Black, A. C., & O'Connell, A. A. (2007). Errors of inference in structural equation modeling. *Psychology in the Schools*, 44, 461-470.



4. **McCoach, D. B. & Kaniskan, B. (2010).** Using time-varying covariates in multilevel growth models. *Frontiers in Quantitative Psychology and Measurement*, 1:17. DOI: 10.3389/fpsyg.2010.00017
5. **McCoach, D. B. & Kenny, D. A. (2014).** A Few Thoughts on the Similarities and the Differences Between Causal or Reflective Indicators of Latent Variables. *Measurement: Interdisciplinary Perspectives*, 12, 151-154.

### **Synergistic Activities**

1. **Founder and chair of the Modern Modeling Methods conference.** The Modern Modeling Methods (M3) conference is an interdisciplinary conference designed to showcase the latest modeling methods and to present research related to these methodologies. Now in its seventh year, the M3 conference brings together over 150 quantitative methodologists and modelers from around the world.
2. **Director of DATIC summer workshops at University of Connecticut.** DATIC provide multi-day statistical and methodological training courses for researchers. Courses include Structural Equation Modeling, Hierarchical Linear Modeling, Dyadic Analysis, and Longitudinal Data Analysis.
3. I served as a Member of the IES Review Panel, Reading, Writing, and Language Development Panel from 2012-2016, and I am currently serving as a Member of the IES Review Panel, Statistics and Research Methodology in Education for 2017.

## Biographical Sketch

### Timothy Miller

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### (a) Professional Preparation

Dartmouth College	Hanover, NH	Physics	A.B. <i>cum laude</i> 2002
Dartmouth College	Hanover, NH	Engineering Sciences	M.S. 2006
University of Southern California	Los Angeles, CA	Cinema Production	M.F.A. (incomplete)

### (b) Appointments

Adjunct Faculty, *University of Connecticut. Department of Digital Media & Design* - 2016  
Research Writer, *University of Connecticut Office of University Communications* 2014-2015  
Technology Writer, *University of Southern California Entertainment Technology Center* 2012-2014  
Education Associate, *Museum of Science, Boston* 2006-2009  
Research Associate, *Harvard University Department of Engineering & Applied Sciences* 2006-2009

### (c) Publications

Miller, T. (2015). *Muse of Fire: Storytelling & The Art of Science Communication*. Spoken Science Press. [www.spokenscience.com/publications](http://www.spokenscience.com/publications)

### (d) Synergistic Activities

1. **Science Communication Seminars (2009 - Present)** - I have offered science communication training seminars for students and faculty at universities, professional societies, museums and other venues, including the University of Wisconsin-Madison, Northwestern University, University of Notre Dame, the Materials Research Society, and the National Institute for Standards and Technology.
2. **Faculty Media Training Program (2014-2015)** I developed and offered a university-wide media training program for faculty members at the University of Connecticut.
3. **Creative Science Studio (2010)** I was hired by the NSF Office of Legislative and Public Affairs to lead early development of an institutional partnership between NSF and the School of Cinematic Arts at the University of Southern California designed to partner arts students with NSF funded researchers to create public science communication products.
4. **NISE Network Programs (2006-2009)** Through the Nanoscale Informal Science Education Network (NSF Award # 0940143) I authored several public programs about current science and technology, and trained museum educators nationwide through a series of regional conferences in best practices regarding engagement of diverse public audiences.

## Biographical Sketch

### William Snyder

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#### (a) Professional Preparation

MIT, Cambridge, MA Computer Science & Engineering, and Brain & Cognitive Sciences S.B., 1989  
MIT, Cambridge, MA Cognitive Science and Linguistics Ph.D., 1995

#### (b) Appointments

Full Professor	University of Connecticut (Linguistics)	2012-Present
Associate Professor	University of Connecticut (Linguistics)	2002-2012
Research Affiliate	Haskins Laboratories	1998-Present
Assistant Professor	University of Connecticut (Linguistics)	1995-2002
Research Intern (Neurology)	Massachusetts General Hospital	1989-1990

#### (c) Publications

##### (i) Five publications most closely related to the proposed project:

- 1) Grela, B., **Snyder, W.** and Hiramatsu, K. (2005) The production of novel root compounds in children with Specific Language Impairment. *Clinical Linguistics & Phonetics* 19:701-715.
- 2) **Snyder, W.** (2007) *Child Language: The Parametric Approach*. Oxford University Press.
- 3) **Snyder, W.** (2011) Children's Grammatical Conservatism: Implications for syntactic theory [Plenary Address]. In N. Danis et al. (eds.) *BUCLD 35: Proceedings of the 35th annual Boston University Conference on Language Development, Volume I*, 1-20. Cascadilla Press.
- 4) **Snyder, W.** (2016) How to set The Compounding Parameter. In *Proceedings of GALANA 6 (Generative Approaches to Language Acquisition - North America)*. Cascadilla Press.
- 5) **Snyder, W.** and Hyams, N. (2015) Minimality effects in children's passives. In E. Di Domenico et al. (eds.) *Structures, Strategies and Beyond*. John Benjamins.

##### (ii) Five other significant publications:

- 1) Lidz, J., **Snyder, W.**, and Pater, J. (eds.) (2016) *The Oxford Handbook of Developmental Linguistics*. Oxford University Press.
- 2) **Snyder, W.** (2001) On the nature of syntactic variation: Evidence from complex predicates and complex word-formation. *Language* 77:324-342.
- 3) **Snyder, W.** (2012) Parameter theory and motion predicates. In V. Demonte and L. McNally (eds.) *Telicity, Change, and State: A Cross-Categorical View of Event Structure*. Oxford University Press.
- 4) **Snyder, W.**, Senghas, A., and Inman, K. (2001) Agreement morphology and the acquisition of noun-drop in Spanish. *Language Acquisition* 9:157-173.
- 5) **Snyder, W.** and K. Stromswold (1997) The structure and acquisition of English dative constructions. *Linguistic Inquiry* 28:281-317.

**(d) Synergistic Activities**

1. Co-Editor, *Language Acquisition*. 2004-2012.
2. Editorial Boards: *Language Acquisition* (2012-present). *English Linguistics* (2010-present), *Snippets* (2000-present).
3. Guest instructor: LSA Linguistic Institute, University of Michigan, 2013; LOT Winter School, Vrije Universiteit, Amsterdam, 2010; LSA Linguistic Institute, Stanford University, 2007; Lectures in psycholinguistics, University of Massachusetts-Amherst, 2004; Cultural and Linguistic Studies, Keio University, Tokyo, 2003.
4. Co-organizer: Generative Approaches to Language Acquisition-North America (GALANA 3), 2008; Semantics and Linguistic Theory (SALT 17), 2007; UConn/UMass/Smith-College Language Acquisition Workshop (UUSLAW), 1997-Present.

**Scott W. Brown, Ph.D.**

**Biographical Sketch**

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**(a) Professional Preparation**

Boston University	Boston, MA	Psychology	B.A., 1974
Montana State University	Bozeman, MT	Psychology	M.S., 1975
Syracuse University	Syracuse, NY	Psychology	Ph.D., 1980

**(b) Appointments**

Professor of Educational Psychology (1992-Present)  
Director of the GlobalEd 2 Project at UConn (2008-present)  
Assistant Professor of Educational Psychology (1980-86)

**(c) Publications**

**(i) Five publications most closely related to the proposed project:**

1. **Brown, S.W.**, Lawless, K.A. & Boyer, M.A. (2015). The GlobalEd 2 simulations: Promoting positive academic dispositions in middle school students in a web-based PBL environment (p. 147-159). In A. Walker, H. Leary, C. Hmelo-Silver & P. Ertmer (Eds.). *Essential readings in problem-based learning*. Purdue University Press: West Lafayette, IN.
2. **Brown, S.W.**, Lawless, K.A. & Boyer, M.A. (2013). Promoting positive academic dispositions using a web-based PBL environment: The GlobalEd 2 Project. *Interdisciplinary Journal of Problem-based Learning*, 7(1), 67-90. Available at: <http://dx.doi.org/10.7771/1541-5015.1389>
3. Ioannou, A., **Brown, S.W.**, & Artino, A.R. (2015). Wikis and forums for collaborative problem-based activity: A systematic comparison of learners' interactions. *The Internet and Higher Education*, 24 p. 35-45. DOI: 10.1016/j.iheduc.2014.09.001
4. Lawless, K.A., **Brown, S.W.**, & Boyer, M.A. (2016). Educating students for STEM literacy: GlobalEd 2. In R.D. Lansiquot (Ed.) *Technology, theory and practice in interdisciplinary STEM programs: Connecting STEM and non-STEM approaches*. p. 53-82. Palgrave Macmillan: New York, NY. ISBN 978-1-137-56738-3. DOI 10.1057/978-1-137-56739-0.
5. Lawless, K.A. & **Brown, S.W.** (2015). Developing scientific literacy skills through interdisciplinary, technology-based Global simulations: GlobalEd 2. *The Curriculum Journal 1*, p.1-22. DOI: 10.1080/09585176.2015.1009133

**(ii) Five other significant publications:**

1. Boyer, M.A. & **Brown, S.W.** (2016). Scholarly learning in an ecological setting: Applying the knowledge, attitudes, and behaviors framework to perceived outcomes from participation in the Long-Term Ecological Research Program (Chapter 41; p. 397-410). In M.R. Willig & L.R. Walker (Eds.). *Long-Term Ecological Research: Changing the Nature of scientists*. Oxford University Press: Oxford, England. ISBN: 9780199380213.

2. **Brown, S.W.**, Lawless, K.A. & Boyer, M.A. (2013). Promoting positive academic dispositions using a web-based PBL environment: The GlobalEd 2 Project. *Interdisciplinary Journal of Problem-based Learning*, 7(1), 67-90. Available at: <http://dx.doi.org/10.7771/1541-5015.1389>
3. Lang, H.G., LaPorta-Huper, M., Monte, D., Scheifele, P., **Brown, S.W.**, & Babb, I.G., (2007). A study of technical signs in science: Implications for lexical database development. *Journal of Deaf Education and Deaf Studies* 12, 1, 66-79. doi: 10.1093/deafed/enl018
4. Lawless, K. A., & **Brown, S. W.** (2016). Listening to the teachers: Using weekly online teacher logs for ROPD to identify teachers' persistent challenges when implementing a blended learning curriculum. *Journal of Online Learning Research* 2(2), 169-200. Available at: <http://www.editlib.org/p/171358>
5. Picho, K. & **Brown, S.W.** (2011). Can Stereotype Threat be measured? A validation of the Social Identities and Attitudes Scale (SIAS). *Journal of Advanced Academics*, 22(3), 374-411.

#### (d) Synergistic Activities

1. **Brown, S.W.** (2006-08). Producer and interviewer for podcasts for the Teachers for a New Era project, also available as podcasts on iTunes. Conducted multiple interviews in support of the Carnegie Corporation as part of the national Teachers for a New Era Project.
2. United Nations Development Program (UNDP) project. Consultant to the DOVES Olympic Movement Project, Cyprus. Implementing PBL training and simulations in Cyprus to reduce inter-group conflict. November 2006 – March 2007.
3. NSF: Computing Education for the 21<sup>st</sup> Century. (2011, Jan-Feb) Educational researcher providing feedback and research agendas for computer science engineers. New Orleans, LA and online.
4. **Brown, S.W.** & Lawless, K.A. (2015, May). *Preparing Students for the 21st Century: The GlobalEd 2 Project*. Invited presentation at The Conference on World-Class, Global Minds: Using Cognitive/Psychological Science for 21st Century Schools. New York City. Provided a presentation on PBL to educational leaders.
5. Riel, J., Lawless, K.A., & **Brown, S.W.** (2016, October). *Listening to the teachers: Identifying challenges to blended learning implementation through journaling and ROPD*. Michigan Virtual Learning Research Institute Webinar Series. Webinar presentation for higher education professionals.

## Biographical Sketch

### Marie Coppola

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<http://slam.uconn.edu/>

## A. PROFESSIONAL PREPARATION

Massachusetts Institute of Technology	Cognitive Science and Spanish	S.B.	1991
University of Rochester	Brain & Cognitive Sciences	Ph.D.	2002
University of Chicago	Psychology, Gesture Studies	Postdoc	2002-2009

## B. APPOINTMENTS

Faculty Affiliate, *Connecticut Institute for the Brain and Cognitive Sciences*, 2016

Faculty Affiliate, *El Instituto: [Institute of Latina/o, Caribbean, and Latin American Studies](#)*, University of Connecticut

Assistant Professor, Developmental Division, University of Connecticut, 2010-Present

Research Associate, University of Chicago, 2006-2009

## C. PRODUCTS

### *Five most closely related to the proposed project*

1. Brentari, D., **M. Coppola**, A. Jung, and S. Goldin-Meadow. (2013). Acquiring word class distinctions in American Sign Language: Evidence from handshape. *Language Learning & Development*, 9(2): 130-150. [doi:10.1080/15475441.2012.679540](https://doi.org/10.1080/15475441.2012.679540)
2. Carrigan, E. M., and **M. Coppola**. (2017). Successful communication does not drive language development: Evidence from adult homesign. *Cognition*, 158, 10-27.
3. **Coppola, M.**, E. Spaepen, and S. Goldin-Meadow. (2013). Communicating about number without a language model: Number devices in homesign grammar. *Cognitive Psychology*, 67, 1-25. <http://dx.doi.org/10.1016/j.cogpsych.2013.05.003>
4. Spaepen, E., **M. Coppola**, M. Flaherty, E. Spelke, S. Goldin-Meadow. (2013). Generating a lexicon without a language model: Do words for number count? *Journal of Memory and Language*, 69(4), 496-505.
5. Spaepen, E., **M. Coppola**, E. Spelke, S. Carey, and S. Goldin-Meadow. (2011). Number without a language model. *Proceedings of the National Academy of Sciences*, 108(8): 3163-3168. [doi: 10.1073/pnas.1015975108](https://doi.org/10.1073/pnas.1015975108)

### *Five other significant products*

1. Brentari, D., **M. Coppola**, P. W. Cho, and A. Senghas. (2016). Handshape complexity as a precursor to phonology: Variation, emergence, and acquisition. *Language Acquisition*. DOI:10.1080/10489223.2016.1187614
2. **Coppola, M.** and D. Brentari. (2014). From iconic handshapes to grammatical contrasts: Longitudinal evidence from a child homesigner. *Frontiers in Psychology*, 5, 830. [doi: 10.3389/fpsyg.2014.00830](https://doi.org/10.3389/fpsyg.2014.00830). Also published as an E-book: *Language by mouth and by hand*.

3. **Coppola, M.** & E. L. Newport. (2005). Grammatical Subjects in Home Sign: Abstract linguistic structure in adult primary gesture systems without linguistic input. *Proceedings of the National Academy of Sciences*, 102(52): 19249-19253.
4. Richie, R., C. Yang, and **M. Coppola**. (2014). Modeling the emergence of lexicons in homesign systems. *Topics in Cognitive Science*, 6(1), 183-195. DOI: 10.1111/tops.12076
5. Senghas, A. & **M. Coppola**. (2001). Children creating language: How Nicaraguan Sign Language acquired a spatial grammar. *Psychological Science*, 12(4): 323-328.

#### **D. SYNERGISTIC ACTIVITIES**

1. **Undergraduate Education & Outreach Training (2013-Present)**. I catalyzed the formation of, and am the Faculty Adviser for *Language for All*, an undergraduate student organization that advocates quality linguistic input for deaf, bilingual, low-SES, and other children at risk for poor language development and academic outcomes.
2. **Community Advocacy and Education Reform (1998-present)**. I am Executive Director and Founder of the non-profit organization **Manos Unidas**, whose mission is to promote equal access to educational and vocational opportunities for deaf children and young adults in Nicaragua by providing access to sign language, Spanish literacy, numeracy, and real-life job skills.
3. **Grant Consultant, NSF "Science of Learning - Network Collaboration: The role of gesture in mathematics learning: from research to practice"**. PIs: S. Goldin-Meadow & R. B. Church (September 1, 2016 - August 31, 2019).
4. **Review Editor in Special Educational Needs (2016-present)**. *Frontiers in Education*.



## Biographical Sketch

### Inge-Marie Eigsti, Ph.D.

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### (a) Professional Preparation

University of Chicago	Chicago, IL	Linguistics	A.B <i>cum laude</i> , 1993
University of Rochester	Rochester, NY	Brain and Cognitive Sciences	M.A., 1999
University of Rochester	Rochester, NY	Clinical Psychology	M.A., 2000
Columbia University	New York, NY	Pediatric Neuroimaging	Post-doc, 2001- 2004

### (b) Appointments

Faculty Affiliate, *Connecticut Institute for the Brain and Cognitive Sciences*, 2016

Faculty Affiliate, *Center on Postsecondary Education and Disability, Neag School of Education*, 2013

Associate Professor, *Clinical Division, Psychological Sciences*, University of Connecticut, 2011 – present

Research Scientist, *Haskins Laboratories*, 2009

Licensed Psychologist, State of Connecticut (#2675), 2006-present

Assistant Professor, *Clinical Division, Psychology*, University of Connecticut, 2004-2011

Post-doctoral Research Fellow in Pediatric Neuroimaging, *Sackler Institute for Developmental Psychobiology*, Columbia University, 2001- 2004

Clinical Psychology Internship (APA accredited), *Department of Psychiatry (Child and Adolescent Division)*, University of Rochester School of Medicine, 2000-2001

### (c) Publications

#### (i) Five publications most closely related to the proposed project:

1. de Marchena, A., & Eigsti, I. M. (2015). The art of common ground: emergence of a complex pragmatic language skill in adolescents with autism spectrum disorders. *Journal of Child Language*, 24, 1-38.
2. Eigsti, I. M., Stevens, M., Schultz, R., Barton, M., Kelley, E., Naigles, L. R., Orinstein, A., Troyb, E., Fein, D. A. (2016). Language comprehension and brain function in individuals with optimal outcomes from autism. *NeuroImage: Clinical*, 10, 182-91.
3. Hall, M. L., Eigsti, I. M., Bortfeld, H., & Lillo-Martin, D. (in press). Auditory deprivation does not impair executive function, but language deprivation might: Evidence from a parent-report measure in Deaf native signing children. *Journal of Deaf Studies and Deaf Education*.
4. Irvine, C. A., Eigsti, I. M., & Fein, D. A. (2016). Uh, Um, and autism: Filler disfluencies as pragmatic markers in adolescents with optimal outcomes from autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 46, 1061-70.
5. Schuh, J. M., Eigsti, I. M., & Mirman, D. (in press). Referential communication in autism spectrum disorder: The roles of working memory and theory of mind. *Autism Research*.

#### (ii) Five other significant publications:

1. Eigsti, I. M., & Fein, D. A. (2013). More is less: pitch discrimination and language delays in children with optimal outcomes from autism. *Autism Research*, 6(6), 605-613. doi: 610.1002/aur.1324. Epub 2013 Aug 1008.

2. **Eigsti, I. M.**, Rosset, D., Col Cozzari, G., da Fonseca, D., & Deruelle, C. (2015). Effects of motor action on affective preferences in autism spectrum disorders: different influences of embodiment. *Developmental Science*. doi:10.1111/desc.12278
3. **Eigsti, I. M.**, Schuh, J. M., Mencl, E., Schultz, R. T., & Paul, R. (2012). The neural underpinnings of prosody in autism. *Child Neuropsychology*, 18(6), 600-617.
4. Fifer, W. P., Byrd, D. L., Kaku, M., **Eigsti, I. M.**, Isler, J. R., Grose-Fifer, J., & Balsam, P. D. (2010). Newborn infants learn during sleep. *Proceedings of the National Academy of Sciences of the United States of America*, 107, 10320-10323.
5. Masino, S. M., Kawamura, M., Jr., Plotkin, L. M., Svedova, J., DiMario, F. J., Jr., & **Eigsti, I. M.** (2011). Exploring 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

#### (d) Synergistic Activities

1. Eigsti developed a new seminar course, *Autism and Developmental Disorders*, that blends a traditional didactic/academic approach to instruction with a more clinically-focused component, in which UConn undergraduates serve as peer mentors to young adults with developmental disabilities.
2. Eigsti has been instrumental in developing research tools. With graduate student Bean-Jaworski, she developed the **Joint Attention (JTAT)** assessment measure (Bean & Eigsti, 2012; Jaworski & Eigsti, 2015) to evaluate social attention skills in older and higher-functioning individuals. This tool clearly fills an important gap in the field, as it has been adopted by eight external projects to date. Eigsti and student Canfield are currently evaluating the psychometrics of another research tool, the **Gesture Comprehension (GeCo)** task (Canfield Ph.D. thesis).
3. Eigsti has been committed to mentoring undergraduates in excellence. She has supervised 11 undergraduate honors theses to date, most of which have been supported by UConn OUR, SURF or University Scholar Awards. The lab uses a “vertical team” mentorship model, in which senior graduate students mentor more junior students, and grad students mentor undergraduates, providing experience with mentoring across the board. Both undergraduate and graduate students have successfully sought positions or graduate training in academia, as well as jobs in clinical fields, non-profit organizations, and industry. In addition to lab mentorship, Eigsti serve as a member of the campus Fulbright Review Committee, which helps students to successfully apply for external fellowships to study abroad.
4. In addition to training graduate students within the lab, Eigsti is centrally involved in graduate training across the University. Eigsti organizes the *Graduate Seminar in Clinical Research*, in which we host external speakers from academic and professional institutions to discuss research and professional development topics. She has hosted three international (Denmark, Holland, and the UK) graduate students to date, with a fourth planning a lab rotation in 2017. She has been a key member of the IGERT training program (NSF, PI, J. Magnuson), serving on the ExCom and co-teaching one of the five required Foundational courses.
5. Eigsti contributes to the broader field through editorial service as a board member to four academic journals (*Journal of Speech Language and Hearing Research*; *Journal of Autism and Developmental Disabilities*; *Development and Psychopathology*; *Autism and Developmental Language Impairments*), two academic conferences (*International Meeting for Autism Research*; *Boston University Conference on Language Development*), and ad-hoc review panel member for NIH Study Section (*Child Psychopathology and Developmental Disabilities*).

## Biographical Sketch

### Roslyn Holly Fitch, Ph.D.

Professor, Behavioral Neuroscience, Dept. of Psychological Sciences  
Director, Murine Neurobehavioral Phenotyping Facility  
Institute for Systems Genomics; Institute for Brain and Cognitive Sciences  
University of Connecticut, 406 Babbidge Rd., Storrs, CT, 06269  
860-486-2554  
[roslyn.h.fitch@uconn.edu](mailto:roslyn.h.fitch@uconn.edu)  
[www.Fitchlab.com](http://www.Fitchlab.com)

### (a) Professional Preparation

Institution	Location	Major	Degree and Year
Duke University	Durham, NC	Zoology & Psychology	B.S., 1984
University of Connecticut	Storrs, CT	Dev Psychobiology & Biobehavioral Sciences	Ph.D., 1990

### (b) Appointments

Director, *Murine Behavioral Neurogenetics Facility*, 2015 - present.  
Professor, University of Connecticut, 2013 – present.  
Associate Professor, University of Connecticut, 2007 – 2103.  
Associate Research Professor, University of Connecticut, 2004 – 2007.  
Assistant Research Professor, University of Connecticut, 1997 - 2004.  
Research Associate, Rutgers University, Center for Molecular & Behavioral Neuroscience, 1994-1996.  
Postdoctoral Fellow, Rutgers University, Center for Molecular & Behavioral Neuroscience, 1990-1994.  
Predoctoral Research Fellow, University of Connecticut, Developmental Psychobiology Laboratory, 1985-1990.  
Research Technician, Duke University Hospital, Laboratory of Neuro-ophthalmology, 1984-1985.  
Undergraduate Research Assistant, Duke University, 1982-1984.

### (c) Publications

#### (i) Five publications most closely related to the proposed project:

1. **Fitch, R.H.**, Alexander, M. & Threlkeld, S.W. 2013. Early neural disruption and auditory processing outcomes in rodent models: Implications for developmental language disability. *Frontiers in Systems Neuroscience*, 7, 58.
2. Rendall, A., Tarkar, T., Contreras-Mora, H.M., LoTurco, J.J. & **Fitch, R.H.** 2015. Deficits in learning and memory in mice with a mutation of *Dyx1c1*. *Brain and Language, Special Issue*, S0093-934X(15)00102-9.
3. Rendall, AR, Truong, DT, **Fitch, RH.** 2016. Learning Delays in a mouse model of Autism Spectrum Disorder. *Behavioral Brain Research*, 303, 201-207.
4. Truong, DH & **Fitch, RH.** 2014. Behavioral consequences of early disruption and injury to the developing brain: studying rodent models. In *The Maze Book* (Bimonte-Nelson, H., Ed), Neuromethods Series. Springer Press, New York. p. 93-120 (CH 4).
5. Truong, DT, Rendall, A., Castelluccio, B., Eigsti, IM, **Fitch, R.H.** 2015. Auditory processing anomalies in *Cntnap2* mutant mice. *Behavioral Neuroscience*, 129 (6), 731 – 743.

#### (ii) Five other significant publications:

1. **Fitch, R.H.** 2013. Language Impairment. In *Neural Circuit Development and Function in the Healthy and Diseased Brain - Comprehensive Developmental Neuroscience, Volume 3*, Rakic, P. & Rubenstein, J.(Eds.), Elsevier Press, Oxford, UK. P. 795 – 808.
2. Smith, A.L., Hill, C.A., Alexander, M., Szalkowski, C.E., Chrobak, J.J., Rosenkrantz, T.E. & **Fitch, R.H.** 2014. Spatial working memory deficits in male rats following neonatal hypoxic ischemic brain injury can be attenuated by task modifications. *Brain Sciences*, 4, 240-272.
3. Szalkowski, C.E., Booker, A.B., Truong, D.T., Rosen, G.D., & **Fitch R.H.** 2013. Knockdown of the candidate dyslexia susceptibility gene homolog *Dyx1c1* in rodents: Effects on rapid and complex auditory processing, visual attention, and cortical and thalamic anatomy. *Developmental Neuroscience*, 35 (1), 50-68.
4. Truong, DH, Bonet, A., Rosen, GD, & **Fitch, RH.** 2013. A behavioral evaluation of sex differences in a mouse model of severe neuronal migration disorder. *PLoS One*, 8, e73144.
5. Truong, DT, Che, A, Rendall, AR, Szalkowski, CE, LoTurco, JJ, Galaburda, A. & **Fitch, RH.** 2014. Mutation of *Dcdc2* in mice leads to impairments in auditory processing and memory ability, *Genes, Brain and Behavior*, 13 (8), 802 - 811.

#### (d) Synergistic Activities

1. **Fitch** proposed and developed a new Murine Neurobehavioral Genetics Facility at the University of Connecticut, which provides inter-disciplinary collaborative behavioral assessment services to colleagues interested in the impact of genetic manipulations on behavioral/cognitive outcomes in mice. Fitch serves as the Director of the facility, along with Co-Director Joe LoTurco of Physiology and Neurobiology. The MBNF has provided phenotyping services for a half-dozen inter-disciplinary and cross-Departmental projects since inception (July 2015).
2. **Fitch** developed a new Outreach class instructing Graduate Students in the provision of science-based learning enrichments in local school K-8 systems. Seven classrooms were visited as part of the initial course offering (Spring 2016), with highly positive feedback from students (grades 2-4), school systems (teachers, principals), and the graduate participants themselves.
3. **Fitch** has developed novel new behavioral assessment tasks for the purpose of translational evaluation of animal models, focusing on higher-order functions relevant to human populations (typical and atypical), including language and communication. New tasks amenable to use in rodents include complex acoustic assessments that can access fundamental skills in language-relevant brain circuitry, as well as visual motion processing tasks used to assess skills pertinent to reading and reading disorders. These tasks can also be used with mouse models that express knock-outs or mutations for risk genes associated with disorders such as SLI, ASD and dyslexia.
4. **Fitch** provides an extensive training program within her lab that includes undergraduates (freshmen to seniors) and graduate students in collaborative research training. The model allows more senior graduate students to directly mentor undergraduates, who in turn mentor newer undergraduates and high school students. Undergraduates training in the lab consistently receive awards through the Dept of Psychological Sciences, as well as the Office of Undergraduate Research, to support various academic year and summer research projects (e.g., the Fitch lab has sponsored 4 SURF Fellowships over the past 5 years). Findings are consistently presented at the *University of Connecticut Frontiers Symposium for Undergraduates*, as well as *Neuroscience at Storrs*, and several undergraduates have attended *SFN* to aid in poster presentations. The lab provides a particularly focused recruiting and support system for young women in STEM, with 70% of undergraduates working in the lab (including those receiving OUR, SURF and University Scholar Awards) being young women.
5. **Fitch** has been a key member of the IGERT training program (NSF, PI, J. Magnuson), serving on the ExCom and teaching one of the five required Foundational courses.

## Biographical Sketch

### Emily Myers

Department of Speech, Language and Hearing Sciences

Department of Psychology

University of Connecticut

Storrs, CT 06269-1020, U.S.A

emily.myers@uconn.edu

## (a) Professional Preparation

University of Iowa	Iowa City, IA	Spanish and Linguistics	B.A.	1999
Brown University	Providence, RI	Cognitive Science	Ph.D.	2005
Brown University	Providence, RI	Cognitive Science	Postdoc	2005-2008

## (b) Appointments

Associate Professor	University of Connecticut	2016-Present
Staff Scientist	Haskins Laboratories	2012-Present
Assistant Professor	University of Connecticut	2010-2016
Assistant Professor, Research	Brown University	2009-2015

## (c) Publications

### (i) Five publications most closely related to the proposed project:

1. Earle, F.S., Landi, N., and **Myers, E.B.** (EPub ahead of print). Sleep duration predicts behavioral and neural differences in adult speech sound learning. *Neuroscience Letters*. doi: 10.1016/j.neulet.2016.10.044.
2. Earle, F. S., & **Myers, E. B.** (2015). Sleep and native language interference affect non-native speech sound learning. *Journal of Experimental Psychology. Human Perception and Performance*, 41(6), 1680–1695. <http://doi.org/10.1037/xhp0000113>
3. **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.
4. **Myers, E. B.**, & Mesite, L. M. (2014). Neural systems underlying perceptual adjustment to non-standard speech tokens. *Journal of Memory and Language*, 76, 80-93.
5. **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.

### (ii) Five other significant publications:

1. 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 Neuroscience* 17(9), 1353-66.
2. Drouin, J. R., Theodore, R. M., & **Myers, E. B.** (2016). Lexically guided perceptual tuning of internal phonetic category structure. *The Journal of the Acoustical Society of America*, 140(4), EL307-EL313.
3. Earle, F. S., & **Myers, E. B.** (2015). Overnight consolidation promotes generalization across talkers in the identification of nonnative speech sounds. *The Journal of the Acoustical Society of America*, 137(1), EL91.
4. **Myers, E.B.** (2007). Dissociable effects of phonetic competition and category typicality in a phonetic categorization task: An fMRI investigation. *Neuropsychologia* 45:1463-1473.

5. **Myers, E.B.** (2014). Emergence of category-level sensitivities in non-native speech sound learning. *Auditory Cognitive Neuroscience*, 8, 238.

**(d) Synergistic Activities**

1. I developed an fMRI protocol including tutorials for performing standard fMRI preprocessing and statistical analysis. This protocol has been used for the past five years in training fMRI novices at Brown University, in my graduate lab and other labs, and has recently been developed into a 'wiki' site to educate new investigators on the analysis stream.
2. I developed a team-taught course in the Cognitive Neurobiology of Language together with Nicole Landi (UConn). This course's goal was to provide interdisciplinary training on the cognitive neuroscience of language to students with diverse backgrounds, including students from Linguistics, Speech, Language, and Hearing Sciences, and Psychology.
3. I often serve the scientific community as a grant review panel member, and have recently been appointed to a six-year term as a member of an NIH study section (Language and Communication).

# SUMMARY PROPOSAL BUDGET

YEAR 1

ORGANIZATION <b>University of Connecticut</b>				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>James S Magnuson</b>				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>James S Magnuson - PI</b>				0.00	0.00	1.00	
2. <b>Scott Brown - Collaborator</b>				0.00	0.00	0.25	
3. <b>Marie Coppola - Collaborator</b>				0.00	0.00	0.25	
4. <b>Inge-Marie Eigsti - Collaborator</b>				0.00	0.00	0.25	
5. <b>Roslyn Fitch - Collaborator</b>				0.00	0.00	0.25	
6. ( 4 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	2.50	<b>27,554</b>
7. ( 9 ) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	4.50	<b>59,149</b>
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( 0 ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	<b>0</b>
2. ( 0 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	<b>0</b>
3. ( 0 ) GRADUATE STUDENTS							<b>0</b>
4. ( 0 ) UNDERGRADUATE STUDENTS							<b>0</b>
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							<b>0</b>
6. ( 1 ) OTHER							<b>30,000</b>
TOTAL SALARIES AND WAGES (A + B)							<b>89,149</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							<b>33,413</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							<b>122,562</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							<b>0</b>
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)							<b>7,125</b>
2. INTERNATIONAL							<b>0</b>
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ <b>170,000</b>							
2. TRAVEL <b>10,000</b>							
3. SUBSISTENCE <b>3,000</b>							
4. OTHER <b>111,500</b>							
TOTAL NUMBER OF PARTICIPANTS ( 5 ) TOTAL PARTICIPANT COSTS							<b>294,500</b>
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							<b>0</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							<b>0</b>
3. CONSULTANT SERVICES							<b>8,000</b>
4. COMPUTER SERVICES							<b>0</b>
5. SUBAWARDS							<b>8,640</b>
6. OTHER							<b>5,250</b>
TOTAL OTHER DIRECT COSTS							<b>21,890</b>
H. TOTAL DIRECT COSTS (A THROUGH G)							<b>446,077</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) <b>MTDC (Rate: 59.5000, Base: 142939)</b>							
TOTAL INDIRECT COSTS (F&A)							<b>85,049</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							<b>531,126</b>
K. SMALL BUSINESS FEE							<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							<b>531,126</b>
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$			
PI/PI NAME <b>James S Magnuson</b>				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

1 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

# SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION <b>University of Connecticut</b>				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>James S Magnuson</b>				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>James S Magnuson - PI</b>				0.00	0.00	1.00	
2. <b>Scott Brown - Collaborator</b>				0.00	0.00	0.25	
3. <b>Marie Coppola - Collaborator</b>				0.00	0.00	0.25	
4. <b>Inge-Marie Eigsti - Collaborator</b>				0.00	0.00	0.25	
5. <b>Roslyn Fitch - Collaborator</b>				0.00	0.00	0.25	
6. ( 4 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	2.50	<b>28,932</b>
7. ( 9 ) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	4.50	<b>62,108</b>
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( 0 ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	<b>0</b>
2. ( 0 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	<b>0</b>
3. ( 0 ) GRADUATE STUDENTS							<b>0</b>
4. ( 0 ) UNDERGRADUATE STUDENTS							<b>0</b>
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							<b>0</b>
6. ( 1 ) OTHER							<b>31,500</b>
TOTAL SALARIES AND WAGES (A + B)							<b>93,608</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							<b>36,335</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							<b>129,943</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							<b>0</b>
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)							<b>7,268</b>
2. INTERNATIONAL							<b>0</b>
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ <b>170,000</b>							
2. TRAVEL <b>20,000</b>							
3. SUBSISTENCE <b>3,060</b>							
4. OTHER <b>125,460</b>							
TOTAL NUMBER OF PARTICIPANTS ( 5 ) TOTAL PARTICIPANT COSTS							<b>318,520</b>
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							<b>0</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							<b>0</b>
3. CONSULTANT SERVICES							<b>8,000</b>
4. COMPUTER SERVICES							<b>0</b>
5. SUBAWARDS							<b>8,899</b>
6. OTHER							<b>5,250</b>
TOTAL OTHER DIRECT COSTS							<b>22,149</b>
H. TOTAL DIRECT COSTS (A THROUGH G)							<b>477,880</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) <b>MTDC (Rate: 59.5000, Base: 150460)</b>							
TOTAL INDIRECT COSTS (F&A)							<b>89,524</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							<b>567,404</b>
K. SMALL BUSINESS FEE							<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							<b>567,404</b>
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$			
PI/PI NAME <b>James S Magnuson</b>				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

2 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET



# SUMMARY PROPOSAL BUDGET

YEAR 3

ORGANIZATION <b>University of Connecticut</b>				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>James S Magnuson</b>				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>James S Magnuson - PI</b>				0.00	0.00	1.00	
2. <b>Scott Brown - Collaborator</b>				0.00	0.00	0.25	
3. <b>Marie Coppola - Collaborator</b>				0.00	0.00	0.25	
4. <b>Inge-Marie Eigsti - Collaborator</b>				0.00	0.00	0.25	
5. <b>Roslyn Fitch - Collaborator</b>				0.00	0.00	0.25	
6. ( 4 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	2.50	<b>30,379</b>
7. ( 9 ) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	4.50	<b>65,213</b>
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( 0 ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	<b>0</b>
2. ( 0 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	<b>0</b>
3. ( 0 ) GRADUATE STUDENTS							<b>0</b>
4. ( 0 ) UNDERGRADUATE STUDENTS							<b>0</b>
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							<b>0</b>
6. ( 1 ) OTHER							<b>33,075</b>
TOTAL SALARIES AND WAGES (A + B)							<b>98,288</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							<b>38,482</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							<b>136,770</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							<b>0</b>
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)							<b>7,413</b>
2. INTERNATIONAL							<b>0</b>
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ <b>170,000</b>							
2. TRAVEL <b>30,000</b>							
3. SUBSISTENCE <b>3,121</b>							
4. OTHER <b>139,429</b>							
TOTAL NUMBER OF PARTICIPANTS ( 5 ) TOTAL PARTICIPANT COSTS							<b>342,550</b>
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							<b>0</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							<b>0</b>
3. CONSULTANT SERVICES							<b>8,000</b>
4. COMPUTER SERVICES							<b>0</b>
5. SUBAWARDS							<b>9,253</b>
6. OTHER							<b>5,250</b>
TOTAL OTHER DIRECT COSTS							<b>22,503</b>
H. TOTAL DIRECT COSTS (A THROUGH G)							<b>509,236</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) <b>MTDC (Rate: 61.0000, Base: 157434)</b>							
TOTAL INDIRECT COSTS (F&A)							<b>96,035</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							<b>605,271</b>
K. SMALL BUSINESS FEE							<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							<b>605,271</b>
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$			
PI/PI NAME <b>James S Magnuson</b>				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

3 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

# SUMMARY PROPOSAL BUDGET

YEAR 4

ORGANIZATION <b>University of Connecticut</b>				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>James S Magnuson</b>				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>James S Magnuson - PI</b>				0.00	0.00	1.00	
2. <b>Scott Brown - Collaborator</b>				0.00	0.00	0.25	
3. <b>Marie Coppola - Collaborator</b>				0.00	0.00	0.25	
4. <b>Inge-Marie Eigsti - Collaborator</b>				0.00	0.00	0.25	
5. <b>Roslyn Fitch - Collaborator</b>				0.00	0.00	0.25	
6. ( 4 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	2.50	<b>31,898</b>
7. ( 9 ) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	4.50	<b>68,474</b>
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( 0 ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	<b>0</b>
2. ( 0 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	<b>0</b>
3. ( 0 ) GRADUATE STUDENTS							<b>0</b>
4. ( 0 ) UNDERGRADUATE STUDENTS							<b>0</b>
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							<b>0</b>
6. ( 1 ) OTHER							<b>34,729</b>
TOTAL SALARIES AND WAGES (A + B)							<b>103,203</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							<b>40,754</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							<b>143,957</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							<b>0</b>
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)							<b>7,561</b>
2. INTERNATIONAL							<b>0</b>
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ <b>170,000</b>							
2. TRAVEL <b>40,000</b>							
3. SUBSISTENCE <b>3,184</b>							
4. OTHER <b>153,408</b>							
TOTAL NUMBER OF PARTICIPANTS ( 5 ) TOTAL PARTICIPANT COSTS							<b>366,592</b>
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							<b>0</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							<b>0</b>
3. CONSULTANT SERVICES							<b>8,000</b>
4. COMPUTER SERVICES							<b>0</b>
5. SUBAWARDS							<b>9,530</b>
6. OTHER							<b>5,250</b>
TOTAL OTHER DIRECT COSTS							<b>22,780</b>
H. TOTAL DIRECT COSTS (A THROUGH G)							<b>540,890</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) <b>MTDC (Rate: 61.0000, Base: 164768)</b>							
TOTAL INDIRECT COSTS (F&A)							<b>100,508</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							<b>641,398</b>
K. SMALL BUSINESS FEE							<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							<b>641,398</b>
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$			
PI/PI NAME <b>James S Magnuson</b>				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

4 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

# SUMMARY PROPOSAL BUDGET

YEAR 5

ORGANIZATION <b>University of Connecticut</b>				FOR NSF USE ONLY			
				PROPOSAL NO.	DURATION (months)		
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>James S Magnuson</b>				AWARD NO.	Proposed	Granted	
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
				CAL	ACAD	SUMR	
1. <b>James S Magnuson - PI</b>				0.00	0.00	1.00	
2. <b>Scott Brown - Collaborator</b>				0.00	0.00	0.25	
3. <b>Marie Coppola - Collaborator</b>				0.00	0.00	0.25	
4. <b>Inge-Marie Eigsti - Collaborator</b>				0.00	0.00	0.25	
5. <b>Roslyn Fitch - Collaborator</b>				0.00	0.00	0.25	
6. ( 4 ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)				0.00	0.00	2.50	<b>33,493</b>
7. ( 9 ) TOTAL SENIOR PERSONNEL (1 - 6)				0.00	0.00	4.50	<b>71,898</b>
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)							
1. ( 0 ) POST DOCTORAL SCHOLARS				0.00	0.00	0.00	<b>0</b>
2. ( 0 ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				0.00	0.00	0.00	<b>0</b>
3. ( 0 ) GRADUATE STUDENTS							<b>0</b>
4. ( 0 ) UNDERGRADUATE STUDENTS							<b>0</b>
5. ( 0 ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)							<b>0</b>
6. ( 1 ) OTHER							<b>36,465</b>
TOTAL SALARIES AND WAGES (A + B)							<b>108,363</b>
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)							<b>43,156</b>
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)							<b>151,519</b>
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)							
TOTAL EQUIPMENT							<b>0</b>
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)							<b>7,712</b>
2. INTERNATIONAL							<b>0</b>
F. PARTICIPANT SUPPORT COSTS							
1. STIPENDS \$ <b>170,000</b>							
2. TRAVEL <b>40,000</b>							
3. SUBSISTENCE <b>3,247</b>							
4. OTHER <b>153,896</b>							
TOTAL NUMBER OF PARTICIPANTS ( 5 ) TOTAL PARTICIPANT COSTS							<b>367,143</b>
G. OTHER DIRECT COSTS							
1. MATERIALS AND SUPPLIES							<b>0</b>
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION							<b>0</b>
3. CONSULTANT SERVICES							<b>8,000</b>
4. COMPUTER SERVICES							<b>0</b>
5. SUBAWARDS							<b>9,816</b>
6. OTHER							<b>5,250</b>
TOTAL OTHER DIRECT COSTS							<b>23,066</b>
H. TOTAL DIRECT COSTS (A THROUGH G)							<b>549,440</b>
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) <b>MTDC (Rate: 61.0000, Base: 172482)</b>							
TOTAL INDIRECT COSTS (F&A)							<b>105,214</b>
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							<b>654,654</b>
K. SMALL BUSINESS FEE							<b>0</b>
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							<b>654,654</b>
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>				AGREED LEVEL IF DIFFERENT \$			
PI/PI NAME <b>James S Magnuson</b>				FOR NSF USE ONLY			
ORG. REP. NAME*				INDIRECT COST RATE VERIFICATION			
				Date Checked	Date Of Rate Sheet	Initials - ORG	

5 \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

# SUMMARY PROPOSAL BUDGET

Cumulative

ORGANIZATION <b>University of Connecticut</b>				FOR NSF USE ONLY				
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR <b>James S Magnuson</b>				PROPOSAL NO.		DURATION (months)		
				Proposed		Granted		
A. SENIOR PERSONNEL: PI/PI, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)				AWARD NO.				
			NSF Funded Person-months		Funds Requested By proposer		Funds granted by NSF (if different)	
			CAL	ACAD	SUMR			
1. <b>James S Magnuson - PI</b>			0.00	0.00	5.00			
2. <b>Scott Brown - Collaborator</b>			0.00	0.00	1.25			
3. <b>Marie Coppola - Collaborator</b>			0.00	0.00	1.25			
4. <b>Inge-Marie Eigsti - Collaborator</b>			0.00	0.00	1.25			
5. <b>Roslyn Fitch - Collaborator</b>			0.00	0.00	1.25			
6. ( <b>4</b> ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)			0.00	0.00	12.50	<b>152,256</b>		
7. ( <b>9</b> ) TOTAL SENIOR PERSONNEL (1 - 6)			0.00	0.00	22.50	<b>326,842</b>		
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)								
1. ( <b>0</b> ) POST DOCTORAL SCHOLARS			0.00	0.00	0.00	<b>0</b>		
2. ( <b>0</b> ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)			0.00	0.00	0.00	<b>0</b>		
3. ( <b>0</b> ) GRADUATE STUDENTS						<b>0</b>		
4. ( <b>0</b> ) UNDERGRADUATE STUDENTS						<b>0</b>		
5. ( <b>0</b> ) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)						<b>0</b>		
6. ( <b>5</b> ) OTHER						<b>165,769</b>		
TOTAL SALARIES AND WAGES (A + B)						<b>492,611</b>		
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						<b>192,140</b>		
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)						<b>684,751</b>		
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)								
TOTAL EQUIPMENT						<b>0</b>		
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)						<b>37,079</b>		
2. INTERNATIONAL						<b>0</b>		
F. PARTICIPANT SUPPORT COSTS								
1. STIPENDS \$ <b>850,000</b>								
2. TRAVEL <b>140,000</b>								
3. SUBSISTENCE <b>15,612</b>								
4. OTHER <b>683,693</b>								
TOTAL NUMBER OF PARTICIPANTS ( <b>25</b> )			TOTAL PARTICIPANT COSTS			<b>1,689,305</b>		
G. OTHER DIRECT COSTS								
1. MATERIALS AND SUPPLIES						<b>0</b>		
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION						<b>0</b>		
3. CONSULTANT SERVICES						<b>40,000</b>		
4. COMPUTER SERVICES						<b>0</b>		
5. SUBAWARDS						<b>46,138</b>		
6. OTHER						<b>26,250</b>		
TOTAL OTHER DIRECT COSTS						<b>112,388</b>		
H. TOTAL DIRECT COSTS (A THROUGH G)						<b>2,523,523</b>		
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)								
TOTAL INDIRECT COSTS (F&A)						<b>476,330</b>		
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)						<b>2,999,853</b>		
K. SMALL BUSINESS FEE						<b>0</b>		
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)						<b>2,999,853</b>		
M. COST SHARING PROPOSED LEVEL \$ <b>0</b>			AGREED LEVEL IF DIFFERENT \$					
PI/PD NAME <b>James S Magnuson</b>			FOR NSF USE ONLY					
ORG. REP. NAME*			INDIRECT COST RATE VERIFICATION					
			Date Checked		Date Of Rate Sheet		Initials - ORG	

C \*ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

## **Budget Justification**

### Personnel

*James Magnuson, Principal Investigator* (1.0 summer months per year): PI will be responsible for overall management of all program components, liaising with UConn and NSF officials as necessary, and organizing Executive Committee responses to ongoing assessment and evaluation. Magnuson will also contribute significantly to course development, and will likely serve as the primary instructor for at least one SLAC course per year.

*Betsy McCoach, Collaborator* (1.0 summer months per year): McCoach will be responsible for designing, implementing, and analyzing ongoing assessments and coordinating with the external assessment consultant.

*Timothy Miller, Collaborator* (1.0 summer months per year): Miller will hold primary responsibility for organizing and delivering training in communication, including providing content for the SLAC Seminar, critiquing talk mechanics in the weekly Talk Shop forum, and conducting workshops during J-Term primers and SLAC retreats.

*Six other Collaborator* (0.25 summer months per year each). These are Scott Brown, Marie Coppola, Inge-Marie Eigsti, R. Holly Fitch, Emily Myers, and William Snyder (effort of the remaining co-investigator, Stormy Chamberlain, is discussed under *Subaward* below). These co-investigators will contribute substantial effort in helping organize and facilitate the committees that will run the SLAC program. Each will also commit substantial time and effort to participating in and helping organize regular events, including designing and leading workshops for J-Term Primers and SLAC retreats. In addition, they will take turns leading SLAC courses, including the SLAC Seminar, the SLAC Practicum, the SLAC Skills Seminar, and the Outreach Seminar. Salary is requested because these are significant investments of effort above and beyond normal teaching and research duties. Paid effort allows faculty to contribute more deeply and often.

*TBN, Program Coordinator*, (6.0 calendar months per year): The Program Coordinator will be responsible for day-to-day management and coordination of NRT activities, as well as coordinating several major annual events or tasks (including tracking trainee progress for the annual report to the NSF, trainee recruitment, J-Term Primers, and the SLAC Workshop). The coordinator will help the PI and core faculty with communications, basic website updates, budgeting, and financial management. The Program Coordinator will also attend the annual NRT PI meeting in Washington, DC.

### Fringe Benefits

The fringe benefit rates used in the budget are based on the anticipated FY18 rates for Year 1 and projected fringe benefit increases for future budget years.

### Travel

These funds will support the PI and Program Coordinator costs to attend the annual NRT meeting in Washington, DC (support for one trainee is included under participant costs below), budgeted as 2 x (\$400 [airfare] + \$200 [hotel] + \$100 [combined meals for 2 days]) = \$1400 per year. They also include travel costs associated with our annual advisory panel visit, budgeted to include 7 x \$500 (2 nights of hotel and meals for all 7 panelists) + 4 x \$500 (flights for 4 panelists not in driving distance) + 3 x \$75 (approximate roundtrip mileage for panelists in driving distance) = \$5725 per year. These amounts apply to year 1; we have budgeted a 2% increase each year to accommodate inflation.

### Participant Support Costs

*Stipends*: A total of \$850,000 is requested to pay 1-year stipends for 25 fellows (5 per year), with each fellow supported for 12 consecutive months at a total fellowship of \$34,000, as specified by NSF. All trainees, whether supported by NSF or other sources, will typically apply in their first year of PhD training to join the NRT program in their second year. Accepted trainees, whether supported by

NSF stipends or not, will be considered NRT trainees for the remainder of their PhD training. All trainees will be expected to complete all training elements, including participating the SLAC Practicum in two different years, and to participate regularly in enrichment events such as J-Term Primers and the Annual Workshop. We have budgeted for 25 fellowships.

*NRT Student travel:* Travel support is based on an estimate of \$1000 per trip, including average costs for conference or training registration or fees, airfare, accommodation and meals. For example, for the 2017 *Cognitive Neuroscience Society* meeting in San Francisco, registration = \$220, airfare = ~\$600, hotel + meals = ~\$700 total = \$1520, while for the 2016 *Psychonomic Society* meeting in Boston, registration = \$75, travel (mileage + parking) = \$175, hotel and meals = \$600, total = \$850. We have budgeted for 1 trip per trainee per year. We expect to have 5 fellows and 5 associates join the program each year, and to continue participating for 4 years, giving us totals of 10, 20, 30, 40 and 40 participating trainees in Years 1-5, respectively. We include trips for students on fellowships and other trainees (who are associates or fellows no longer on fellowships). We have budgeted substantial funds for conference and workshop travel because this is a crucial element of PhD training, especially for students engaged in an interdisciplinary program like SLAC. Trainees will be encouraged to attend meetings within and outside their home PhD program area of specialization. A truly crucial training goal is for trainees to have opportunities to learn to communicate about their interdisciplinary training and research with people outside the SLAC community at UConn. Conference presentations are also crucial for job placement, both for building a record of research, and making contact with colleagues from around the world. Typical conferences for our trainees would include: American Educational Research Association, American Speech and Hearing Association, Association for Psychological Science, Cognitive Neuroscience Society, Cognitive Science Society, Human Brain Mapping, Society for Research in Child Development, Society for Neurobiology of Language, and Society for Neuroscience. (Total over 5 years: \$140,000).

*Tuition, fees and health care:* The program covers full-time graduate tuition, fees, and health insurance during the NRT-funded trainees' 12 months of funding.

*Innovation Incentive Fund (NRT student research support):* We are requesting a total of \$189,000 to support trainee-initiated research, estimated at \$1350 per trainee participant per year (10, 20, 30, 40 and 40 in Years 1-5, respectively). These are for NRT training-related research, and will be used to support research projects trainees initiate for the SLAC Practicum (where they learn to work in interdisciplinary collaborative teams) or for more open-ended research projects inspired by the training program that are outside the purview of faculty research grants. Trainees will submit research proposals to the Research Committee, who will evaluate proposals for feasibility. Typical costs might include instrument fees, experimental participant fees, purchase of and care for animals for behavioral neuroscience or genetics projects, or purchase of specialized software, databases, or electronics specific to a project.

*Special Training Elements.* Two special elements of the program will be conducted annually (described below). These are special events that give trainees access to special training unavailable through typical courses, and invaluable in-person contact with leaders in the participating fields and student peers from other institutions who will participate in the Annual Workshop. As per the NRT specification under 7a (*Budget and Allowable Costs: Trainee support*), "Additional costs for trainees to participate in programmatic and training elements should be designated as Travel, Subsistence, or Other Participant Support Costs in the budget." Costs associated with meals and refreshments are listed as *Participant Subsistence*, as detailed below. Other costs associated with these events are classified as *Other Participant Support Costs*.

*J-Term Primers:* J-Term (January Term) Primers are a special event organized by trainees and faculty to provide intensive series of tutorials, workshops, and professional development sessions.

This is an event we launched under IGERT funding, and it will be conducted in coordination with the *Neurobiology of Language Graduate Certificate* program founded under IGERT funding. Costs are requested to fund SLAC participants for these events. Funds will be used for room or equipment rentals that might be required, modest honoraria or travel costs for speakers from the surrounding region, and daily coffee and refreshments and larger opening and closing events. All SLAC trainees and faculty will be expected to attend, and prospective trainees considering applying for the NRT-SLAC program will be encouraged to attend (making this an important event for recruiting NRT trainees). We anticipate approximately 75 attendees per year, including SLAC trainees, SLAC faculty, and prospective SLAC trainees. \$2000 per year is budgeted for inviting external speakers. \$3000 is listed under subsistence costs to cover coffee (\$90 x 5 days), light refreshments (\$150 x 5 days), and opening and closing events with meals (estimated at 2 x [75 participants x \$12]).

*SLAC Annual Theme Workshop:* Each year, the program will consider competitive proposals for an annual theme. The "workshop" will consist of one special 2-day event open to the university community, with invited speakers from the SLAC program (faculty or students) and external speakers and active participants (faculty or students); we anticipate ~12 speakers and 8 active participants, who will attend and contribute to discussions, increasing the impact of these events. The workshop will continue as a speaker series, with 2-3 talks per semester by external speakers (faculty and/or students) continuing on the theme. This workshop will be an opportunity to build community and maintain excitement about our shared focus on *science of learning and the art of communication*. \$21,000 is budgeted in Year 1, based on an estimate of 20 total external workshop participants, with average per-speaker costs of \$1050 (travel = \$550, hotel and meals = \$500). A 2% increase is budgeted each year to accommodate inflation.

#### Other Direct Costs

*Consultant Services:* \$8,000 is being requested each year to pay for the consultant services of an external assessment. The assessment will include a thorough evaluation of the internal evaluator's results, as well as confidential interviews with samples of trainees and faculty to elicit frank input on program progress. The cost will be at a rate of \$180 per hour.

*Honoraria for advisory panelists and external speakers:* We budget \$750 per year per panelist (7 x 750 = \$5,250) for a total of \$5,250 per year and \$26,250 over 5 years.

*Subaward:* A total of \$31,060 is being requested to pay for Uconn Health Center's cost in relation to the project. This covers 0.5 summer month effort by Co-investigator Stormy Chamberlain. Her responsibilities are the same as those of the 5 co-investigators described above as a group, with the added responsibility of liaising with the Health Center and the Institute for Systems Genomics. Other costs associated with Health Center trainees (e.g., fellowships) can be managed from the Storrs site, greatly simplifying logistics.

#### Indirect Costs

The indirect costs are 59.5% of the Modified Total Direct Costs (MTDC) in years 1 and 2 and 61% in each subsequent year, as per the DHHS letter dated August 31, 2016.

### **Budget justification - UCHC**

**Personnel:** [REDACTED]

**Stormy Chamberlain, Co-Investigator** (0.48 calendar months): Dr. Chamberlain will be responsible for 1) provide expertise and lectures in the areas of genetics and neurodevelopmental disorders as needed to support the goals of the NRT, 2) mentor students who will apply for and potentially be supported by the NRT, and 3) conduct collaborative research with other members of the NRT. Salary and fringe benefits are requested to cover her effort.

**Indirect Cost:** The indirect costs are 59.5% of the Modified Total Direct Costs (MTDC) in years 1 and 2 and 61% in each subsequent year, as per the DHHS letter dated August 31, 2016.



## Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: James Magnuson	Other agencies (including NSF) to which this proposal has been/will be submitted.
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Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Computational approaches to human spoken word recognition
Source of Support: NSF Total Award Amount: \$ 487,451 Total Award Period Covered: 09/01/17 - 08/31/20 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Sumr: 0.50

Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Nature and acquisition of the speech code and reading
Source of Support: NICHD Total Award Amount: \$ 7,230,266 Total Award Period Covered: 01/01/12 - 01/01/17 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Sumr: 1.00

Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Individual differences in learning potential for language and literacy
Source of Support: NICHD Total Award Amount: \$ 349,000 Total Award Period Covered: 04/01/13 - 03/31/17 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Sumr: 0.00

Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: IGERT: Language plasticity? Genes, brain, cognition, computation
Source of Support: NSF Total Award Amount: \$ 3,000,000 Total Award Period Covered: 07/01/12 - 06/30/17 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Sumr: 1.00

Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: NRT-UtB-DESE: Science of learning, from neurobiology to real-world application: a problem-based approach (this proposal)
Source of Support: NSF Total Award Amount: \$ 2,999,523 Total Award Period Covered: 07/01/17 - 06/30/22 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Summ: 1.00

\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

## Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Stormy Chamberlain	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: NRT-UtB-DESE: Science of learning, from neurobiology to real-world application: a problem-based approach (this proposal)  Source of Support: NSF Total Award Amount: \$ 2,999,855 Total Award Period Covered: 07/01/17 - 06/30/22 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.48 Acad:0.00 Sumr: 0.00	
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Regulation of UBE3A genomic imprinting by tissue-specific alternative splicing  Source of Support: NIH Total Award Amount: \$ 1,269,227 Total Award Period Covered: 07/01/11 - 06/30/17 Location of Project: UConn Health Person-Months Per Year Committed to the Project. Cal:0.60 Acad:0.00 Sumr: 0.00	
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Connecticut Children's Medical Center  Source of Support: Autism Research Center Total Award Amount: \$ 26,499 Total Award Period Covered: 10/01/15 - 09/30/17 Location of Project: UConn Health Person-Months Per Year Committed to the Project. Cal:1.20 Acad:0.00 Sumr: 0.00	
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Using Dup15q iPSCs to explore the genetics and synaptic pathophysiology of autism  Source of Support: Regenerative Medicine Research Fund Total Award Amount: \$ 1,100,000 Total Award Period Covered: 01/01/15 - 12/31/18 Location of Project: UConn Health Person-Months Per Year Committed to the Project. Cal:0.60 Acad:0.00 Sumr: 0.00	
Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Testing the efficacy of antisense oligonucleotides against UBE3A-ATS in human neurons  Source of Support: Angelman Syndrome Foundation Total Award Amount: \$ 200,000 Total Award Period Covered: 08/01/15 - 07/31/17 Location of Project: UConn Health Person-Months Per Year Committed to the Project. Cal:2.28 Acad:0.00 Summ: 0.00	

\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

## Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Stormy Chamberlain	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal Title: Regulation of UBE3A genomic imprinting
Source of Support: NIH	
Total Award Amount: \$ 2,641,899 Total Award Period Covered: 07/01/17 - 06/30/22	
Location of Project: Uconn Health	
Person-Months Per Year Committed to the Project. Cal:3.60 Acad:0.00 Sumr: 0.00	

Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal Title: Population-based mapping and fuctional illustration of chromatin topology structure codes
Source of Support: The Jackson Laboratory /NIH	
Total Award Amount: \$ 44,860 Total Award Period Covered: 02/01/17 - 01/31/21	
Location of Project: Uconn Health	
Person-Months Per Year Committed to the Project. Cal:0.60 Acad:0.00 Sumr: 0.00	

Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal Title: Determining the roles of individual UBE3A protein isoforms in Angelman Syndrome
Source of Support: NIH	
Total Award Amount: \$ 435,012 Total Award Period Covered: 04/01/17 - 03/31/19	
Location of Project: UConn Health	
Person-Months Per Year Committed to the Project. Cal:2.40 Acad:0.00 Sumr: 0.00	

Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal Title: Genomewide mapping of sites of RNA 2'-O-methylation in Prader-Willi Syndrome
Source of Support: NIH	
Total Award Amount: \$ 431,032 Total Award Period Covered: 04/01/17 - 06/30/19	
Location of Project: Uconn Health	
Person-Months Per Year Committed to the Project. Cal:0.24 Acad:0.00 Sumr: 0.00	

Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	Project/Proposal Title:
Source of Support:	
Total Award Amount: \$ Total Award Period Covered:	
Location of Project:	
Person-Months Per Year Committed to the Project. Cal: Acad: Summ:	

\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

## Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Dorothy McCoach	Other agencies (including NSF) to which this proposal has been/will be submitted.
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Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	
Project/Proposal Title: Collaborative Research and Development Project: School Structure and Science Success: Organization and Leadership Influences on Student Achievement	
Source of Support: NSf	
Total Award Amount: \$ 1,907,847	Total Award Period Covered: 07/01/11 - 06/30/17
Location of Project: UConn	
Person-Months Per Year Committed to the Project.   Cal:0.00   Acad:2.25   Sumr: 0.00	

Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	
Project/Proposal Title: NRT-UtB-DESE: Science of learning, from neurobiology to real-world application: a problem-based approach (this proposal)	
Source of Support: NSF	
Total Award Amount: \$ 2,999,855	Total Award Period Covered: 07/01/17 - 06/30/22
Location of Project: UConn	
Person-Months Per Year Committed to the Project.   Cal:0.00   Acad:0.00   Sumr: 1.00	

Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	
Project/Proposal Title: Exploring the Status and Impact of School-Based Behavior Screening Practices in a National Sample: Implications for Systems, Policy and Research	
Source of Support: ED/Institute of Education Sciences	
Total Award Amount: \$ 1,599,990	Total Award Period Covered: 07/01/14 - 06/30/17
Location of Project: UConn	
Person-Months Per Year Committed to the Project.   Cal:0.00   Acad:2.25   Sumr: 1.01	

Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	
Project/Proposal Title: Improving Outcomes for Students at Risk of Special Education and School Failure Through the Integration of School Climate and PBIS	
Source of Support: ED/Institute of Education Sciences	
Total Award Amount: \$ 399,035	Total Award Period Covered: 07/01/16 - 06/30/20
Location of Project: Uconn	
Person-Months Per Year Committed to the Project.   Cal:0.00   Acad:0.45   Sumr: 0.00	

Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	
Project/Proposal Title: Project PEERS: Postdoctoral Training Experiences in Education Research Focused on Special Education	
Source of Support: ED/Institute of Education Sciences	
Total Award Amount: \$ 697,220	Total Award Period Covered: 07/01/16 - 06/30/21
Location of Project: Uconn	
Person-Months Per Year Committed to the Project.   Cal:0.00   Acad:0.45   Summ: 0.00	

\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

## Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Dorothy McCoach	Other agencies (including NSF) to which this proposal has been/will be submitted.
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Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	
Project/Proposal Title: Project TEACH: Training to Evidence- and Assessment-Based Classroom Habits	
Source of Support: ED/Institute of Education Sciences	
Total Award Amount: \$ 1,399,725 Total Award Period Covered: 07/01/17 - 06/30/20	
Location of Project: UConn	
Person-Months Per Year Committed to the Project.    Cal:0.00    Acad:0.00    Sumr: 0.17	

Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	
Project/Proposal Title: Factors Affecting Comprehension by Teens During Online Reading in Science: The FACTORS Project	
Source of Support: ED/Institute of Education Sciences	
Total Award Amount: \$ 599,879 Total Award Period Covered: 07/01/17 - 06/30/19	
Location of Project: Uconn	
Person-Months Per Year Committed to the Project.    Cal:0.00    Acad:0.00    Sumr: 1.00	

Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	
Project/Proposal Title:	
Source of Support:	
Total Award Amount: \$                      Total Award Period Covered:	
Location of Project:	
Person-Months Per Year Committed to the Project.    Cal:                      Acad:                      Sumr:	

Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	
Project/Proposal Title:	
Source of Support:	
Total Award Amount: \$                      Total Award Period Covered:	
Location of Project:	
Person-Months Per Year Committed to the Project.    Cal:                      Acad:                      Sumr:	

Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	
Project/Proposal Title:	
Source of Support:	
Total Award Amount: \$                      Total Award Period Covered:	
Location of Project:	
Person-Months Per Year Committed to the Project.    Cal:                      Acad:                      Summ:	

\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

Investigator: Timothy Miller		Other agencies (including NSF) to which this proposal has been/will be submitted.	
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: NRT-UtB-DESE: Science of learning, from neurobiology to real-world application: a problem-based approach (this proposal) Source of Support: NSF Total Award Amount: \$ 2,999,855 Total Award Period Covered: 07/01/17 - 06/30/22 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Sumr: 1.00			
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:			
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:			
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:			
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Summ:			

## Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: William Snyder	Other agencies (including NSF) to which this proposal has been/will be submitted.
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Support:	<input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support
Project/Proposal Title:	NRT-UtB-DESE: Science of learning, from neurobiology to real-world application: a problem-based approach (this proposal)
Source of Support:	NSF
Total Award Amount: \$	2,999,855 Total Award Period Covered: 07/01/17 - 06/30/22
Location of Project:	UConn
Person-Months Per Year Committed to the Project.	Cal: 0.00 Acad: 0.00 Sumr: 0.25

Support:	<input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support
Project/Proposal Title:	
Source of Support:	
Total Award Amount: \$	Total Award Period Covered:
Location of Project:	
Person-Months Per Year Committed to the Project.	Cal: Acad: Sumr:

Support:	<input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support
Project/Proposal Title:	
Source of Support:	
Total Award Amount: \$	Total Award Period Covered:
Location of Project:	
Person-Months Per Year Committed to the Project.	Cal: Acad: Sumr:

Support:	<input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support
Project/Proposal Title:	
Source of Support:	
Total Award Amount: \$	Total Award Period Covered:
Location of Project:	
Person-Months Per Year Committed to the Project.	Cal: Acad: Sumr:

Support:	<input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support
Project/Proposal Title:	
Source of Support:	
Total Award Amount: \$	Total Award Period Covered:
Location of Project:	
Person-Months Per Year Committed to the Project.	Cal: Acad: Summ:

\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

## Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Scott Brown	Other agencies (including NSF) to which this proposal has been/will be submitted.
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Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: NRT-UtB-DESE: Science of learning, from neurobiology to real-world application: a problem-based approach (this proposal)  Source of Support: NSF Total Award Amount: \$ 2,999,523 Total Award Period Covered: 07/01/17 - 06/30/22 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Sumr: 0.25	
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Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: GlobalEd2: Efficacy and Replication: Goal 3  Source of Support: ED/Institute of Education Sciences Total Award Amount: \$ 3,477,944 Total Award Period Covered: 06/01/13 - 05/31/17 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:2.16 Sumr: 1.52	
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Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Project SLiC (Scientifically Literate Citizenry)  Source of Support: NSF Total Award Amount: \$ 141,934 Total Award Period Covered: 03/01/16 - 02/28/18 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.40 Acad:0.00 Sumr: 0.00	
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Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: GlobalEd2: Refinement of Curricular Intervention  Source of Support: NSF Total Award Amount: \$ 574,803 Total Award Period Covered: 07/01/17 - 06/30/20 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.75 Sumr: 0.55	
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Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:  Source of Support: Total Award Amount: \$                      Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal:                      Acad:                      Summ:	
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\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.



## Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Marie Coppola	Other agencies (including NSF) to which this proposal has been/will be submitted.
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Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: NRT-UtB-DESE: Science of learning, from neurobiology to real-world application: a problem-based approach (this proposal)  Source of Support: NSF Total Award Amount: \$ 2,999,523 Total Award Period Covered: 07/01/17 - 06/30/22 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Sumr: 0.25	
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Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: A Typological Analysis of Handshape: Gesture, Homesign and Sign Language  Source of Support: NSF Total Award Amount: \$ 84,459 Total Award Period Covered: 09/15/12 - 08/31/17 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.09 Sumr: 0.00	
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Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: CAREER: The Impact of Language Experience on the Development of Number Representations in Deaf, Hard of Hearing, and Hearing Children  Source of Support: NSF Total Award Amount: \$ 1,269,634 Total Award Period Covered: 02/01/16 - 01/31/21 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Sumr: 2.00	
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Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:   Source of Support: Total Award Amount: \$                      Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal:                      Acad:                      Sumr:	
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Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:   Source of Support: Total Award Amount: \$                      Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal:                      Acad:                      Summ:	
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\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

## Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Inge-Marie Eigsti	Other agencies (including NSF) to which this proposal has been/will be submitted.
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Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: NRT-UtB-DESE: Science of learning, from neurobiology to real-world application: a problem-based approach (this proposal)  Source of Support: NSF Total Award Amount: \$ 2,999,523 Total Award Period Covered: 07/01/17 - 06/30/22 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Sumr: 0.25	
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Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: The Low-Verbal Investigatory Screener for Autism (L-VIS) - Exploring Utility as a Measure of Verbal Capacity  Source of Support: NIH Total Award Amount: \$ 53,663 Total Award Period Covered: 07/01/17 - 06/30/19 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Sumr: 1.00	
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Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Optimal Outcomes in ASD: Adult Functioning, Predictors, and Mechanisms  Source of Support: NIH Total Award Amount: \$ 3,748,993 Total Award Period Covered: 04/01/17 - 06/30/22 Location of Project: Uconn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Sumr: 2.01	
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Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:   Source of Support: Total Award Amount: \$                      Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal:                      Acad:                      Sumr:	
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Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:   Source of Support: Total Award Amount: \$                      Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal:                      Acad:                      Summ:	
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\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

## Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Roslyn Fitch	Other agencies (including NSF) to which this proposal has been/will be submitted.
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Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	
Project/Proposal Title: NRT-UtB-DESE: Science of learning, from neurobiology to real-world application: a problem-based approach (this proposal)	
Source of Support: NSf	
Total Award Amount: \$ 2,999,523	Total Award Period Covered: 07/01/17 - 06/30/22
Location of Project: UConn	
Person-Months Per Year Committed to the Project.	Cal:0.00    Acad:0.00    Sumr: 0.25

Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	
Project/Proposal Title: Project Title: A Mouse Model for Communicative Disorders in ASD	
Source of Support: NIH	
Total Award Amount: \$ 401,746	Total Award Period Covered: 07/01/17 - 06/30/19
Location of Project: UConn	
Person-Months Per Year Committed to the Project.	Cal:0.00    Acad:0.00    Sumr: 1.00

Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	
Project/Proposal Title:	
Source of Support:	
Total Award Amount: \$	Total Award Period Covered:
Location of Project:	
Person-Months Per Year Committed to the Project.	Cal:    Acad:    Sumr:

Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	
Project/Proposal Title:	
Source of Support:	
Total Award Amount: \$	Total Award Period Covered:
Location of Project:	
Person-Months Per Year Committed to the Project.	Cal:    Acad:    Sumr:

Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support	
Project/Proposal Title:	
Source of Support:	
Total Award Amount: \$	Total Award Period Covered:
Location of Project:	
Person-Months Per Year Committed to the Project.	Cal:    Acad:    Summ:

\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

## Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Emily Myers	Other agencies (including NSF) to which this proposal has been/will be submitted.
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Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: NRT-UtB-DESE: Science of learning, from neurobiology to real-world application: a problem-based approach (this proposal)  Source of Support: NSF Total Award Amount: \$ 2,999,523 Total Award Period Covered: 07/01/17 - 06/30/22 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Sumr: 0.25	
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Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: The Role of Frontal and Temporal Brain Areas in the Perception of Phonetic Category Structure  Source of Support: DHHS/NIH/National Institute on Deafness and Other Communicat Total Award Amount: \$ 1,912,271 Total Award Period Covered: 03/01/14 - 02/28/19 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Sumr: 2.00	
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Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: CAREER: Optimizing Non-Native Speech Sound Learning: Brain, Bed, Computer and Classroom  Source of Support: NSF Total Award Amount: \$ 433,995 Total Award Period Covered: 06/01/16 - 05/31/21 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Sumr: 0.76	
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Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Determinants of Phonetic Category Structure in Language Impairment  Source of Support: NIH Total Award Amount: \$ 464,003 Total Award Period Covered: 04/01/17 - 05/31/20 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Sumr: 0.25	
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Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: Perceptual Learning and Memory Consolidation in Adults With and Without Language Impairment  Source of Support: NIH Total Award Amount: \$ 23,475 Total Award Period Covered: 07/01/17 - 06/30/19 Location of Project: UConn Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.00 Summ: 0.25	
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\*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

## FACILITIES, EQUIPMENT AND OTHER RESOURCES

**Workspace and computers.** Each academic department provides faculty offices and desktop computers. PhD trainees have dedicated workspace available in their home departments, and all have access to desktop computers in their PIs' labs or in shared departmental workrooms. There is also shared space for interdisciplinary trainees in the Connecticut Institute for the Brain and Cognitive Sciences (IBACS). This includes a 1,700 sf "Innovation Studio" dedicated to trainee workspace, outfitted with for use by ~30 trainees simultaneously, with a mix of standing desks, lounge space, and three 12' white boards. On the same corridor, there is a 1,200 sf "Instructional Studio" (a seminar room that is open for trainee work when not scheduled for classes or meetings), a small meeting room (for groups of up to about 8), a conference room (for groups of up to about 20), and a kitchen. The School of Education also provides approximately 2,000 sf of workspace for PhD trainees that will be available to SLAC trainees.

**Shared laboratory facilities.** Our trainees and faculty have access to many shared laboratories. These include the new (2015) Brain Imaging Research Center (BIRC), which houses a 3-tesla Siemens Prisma MRI, dense in- and out-of scanner EGI EEG, tDCS, TMS, and eye tracking, provides access to 3 behavioral testing rooms, a conference room, and a shared work room outfitted with high-end desktop computers for neuroimaging analysis. BIRC provides regular training opportunities and scan hours are available to trainees through a pilot scan hours program.

The Cognitive Science Shared Electrophysiology Resource Laboratory (directed by PI Magnuson), located in IBACS, is a 2,000 sf facility with 5 shared testing rooms, 2 BrainProducts EEG systems, an SR Research Eyelink 1000 Remote eye tracker, a large open space for EEG instruction, and several shared workstations for data analysis.

The Murine Behavioral Neurogenetics Facility (MBNF), located within a secure animal facility, provides 750 sf of containing state-of-the-art behavioral paradigms for mice, including an operant set-up comprised of eight touch-screen Bussey-Saksida learning chambers (rolling rack) with controlling computer and software, a mouse T-maze, two open fields, social chambers, hole board, and automated *TopScan* monitoring capabilities (with video and Dell computer) for recording all behavioral tasks (*CleverSys*). The MBNF also has isolated sound-proofing capabilities for recording of ultrasound vocalizations.

Special computing resources available through IBACS. A custom workstation for deep learning was purchased by IBACS in Fall, 2016, and will be available to all SLAC personnel. The deep learning workstation was modeled on the Nvidia Deep Learning DevBox, with some key improvements. Deep learning computation is best performed using graphics processing units (GPUs), rather than central processing units (CPUs). The deep learning workstation makes use of four Nvidia Titan X Pascal GPUs, producing 11 TFLOPS each, for a total of 44 TFLOPS of computational power (greater than the most powerful supercomputer in the world in 2003). A 512 GB SSD is used for running simulations and software while three 6 TB drives in a RAID 5 configuration provide 12 TB of failure-protected backup.

The Department of Digital Media & Design at the School of Fine Arts offers students and faculty a full complement of industry-standard hardware and software for the creation and distribution of digital media products. This includes a suite of digital filmmaking tools, audio production equipment, game development hardware, and more. Physical spaces include several computer labs where animation, modeling, game development and other software is available, an audio production studio, a video production and motion capture stage, and a laboratory space for the development of virtual reality experiences.

University of Connecticut Health Center (UCHC) and related facilities in Storrs. Through Dr. Stormy Chamberlain, SLAC faculty and students will have access to an array of facilities and resources at UCHC, the largest public biomedical research university in Connecticut. Through Chamberlain, Fitch, and Magnuson, personnel also have access to resources of the Institute for Systems Genomics. These resources include the following. Laboratory equipment. The Chamberlain lab has standard instruments for genetics research, such as centrifuges, PCR machines, freezers, etc. Core research services. UCHC also has support services that include a nucleotide sequencing and oligonucleotide synthesis facility, a Gene Targeting and Transgenic

Facility, Research Histology Core, Research Information Core, and the Cell Analysis and Modeling (CCAM) imaging facility. Center for Genome Innovation and Institute for Systems Genomics. Assays of hPSC genome integrity are performed in the laboratory of Rachel O'Neil in Beach Hall on the Storrs CT campus and is supported by instrumentation in the Center for Genome Innovation (CGI). The CGI is equipped with a range of equipment for microarray analysis including the Affymetrix CytoScan HD and a BioMark HD Reader with Auto Prep. Support services available at UCH include a next generation sequencing system (Illumina NextSeq and MiSeq). The Jackson Laboratory for Genomic Medicine - Single Cell Genomics Center. Helios, a Fluidigm CyTOF system mass cytometer located at the joint UConn/Jackson Laboratory Single Cell Analysis Center.

**Dedicated laboratory facilities.** Individual faculty (with the exception of Miller) have dedicated laboratory space appropriate for the research programs, equipped with up-to-date computers and other necessary equipment. All faculty will make their labs available for collaborations.

**Institutional program resources.** Program support from the Office of the Vice President for Research and the College of Liberal Arts and Sciences will allow the program to be extended in several ways, including providing research assistantships to approximately six associate trainees each year, resources to support pilot research by associate trainees, and facilitating external speakers and other special events.

**Administrative support.** The Department of Psychological Sciences has 7 full-time administrative staff who can help faculty and students with many administrative tasks (e.g., arranging travel, purchasing equipment) and 3 full time information technology (IT) staff who facilitate technology-related tasks, from setting up computers to advising faculty and students on advanced programming and hardware tasks. Technology support is also available via 3 full-time personnel at the School of Education.

## **DATA MANAGEMENT PLAN**

The NRT training grant itself will not directly involve data collection from human or animal subjects. That is, each true *research project* trainees and faculty engage in shall be considered an independent research project, and trainees and faculty must obtain appropriate human or non-human animal subjects approvals for any such research activities. To promote accessibility of data collected in activities related to this NRT, trainees and faculty will conform to the data management plan described here. This data management plan is designed to provide a collective means for conforming to NSF data management requirements while maximizing the utility of our training and research activities for researchers elsewhere who may be able to benefit from our results.

### **Data description**

The data that will be collected in independent research activities related to this NRT may include conventional behavioral measures (accuracy, reaction time), eye tracking data, neuroimaging, or DNA measures. Given our focus on individual differences, behavioral and imaging data will be stored at the trial level (rather than aggregated to condition-by-subject averages) whenever possible. DNA data will be in the form of digital results of genotyping and other analyses. Some aspects of our data are particularly sensitive, such as DNA data and data collected from aphasic patients. Privacy will be preserved by making data available in a format free of direct or indirect identifiers. Again, no research activities will be conducted without human or non-human animal subjects approvals, including approval for data to be included in this data management plan.

### **Access and sharing**

Archived data will be stored on a secure server in the University of Connecticut Department of Psychological Sciences. The server will be backed up regularly using a tape backup system. The Department of Psychological Sciences has a state-of-the-art backup system and data archiving plan (with rotating tapes, etc.). This server will not be accessible to anyone outside the department. A website will describe the datasets available and provide an electronic form for requesting access to datasets. The project coordinator, the PI, the Co-investigators, and the PI of any relevant lab where data was collected will determine whether the request is for legitimate scientific purposes. Data will either be burned to DVD and mailed to requesters, or in cases where datasets are of modest size, they will be made temporarily available to the requester at a secure download link.

Each laboratory PI will report annually to the executive committee of the project on data collected under the auspices of the grant. In general, lab PIs will provide data to the archive when primary planned analyses of the data have been completed. The latest point at which data will be provided to the archive is when articles using that data are accepted for publication, or at the conclusion of the NRT project (whichever comes first).

Data will be provided under the condition that redistribution will require written permission from the PI.

### **Metadata**

Metadata will be tagged in XML using the Data Documentation Initiative (DDI) format. The codebook will contain all information necessary for a secondary analyst to use the data accurately and effectively. Clinical data will be documented using CDISC metadata standards.

**Intellectual Property Rights**

The principal investigators on the project and their institutions will hold the intellectual property rights for the research data they generate.

**Ethics and privacy**

All data collection with human and animal subjects will be conducted under formal compliance of appropriate institutional review boards. All project personnel will be formally trained in the ethics human and/or animal research. For human subjects, informed consent statements will use language that will not prohibit the data from being shared with the research community. For clinical populations, data collection and record keeping will comply with HIPAA Privacy rules.

**Data formats**

Data will be archived in standard, open formats. Most data will be in the form of plain text XML files, or plain text accompanied by 'key' files describing file contents and structure. Files with non-text content will be stored in standard formats such as MPEG-4 for video, TIFF for images, AIFF or WAV for sound files.

**Archiving and preservation**

By the end of the project, data will be transferred to a data repository, such as the Data Preservation Alliance for the Social Sciences (Data-PASS), to ensure long-term preservation. We will work with University of Connecticut information technology staff to identify the best option for this stage.

**Storage and backup**

As mentioned above, a central server in the Department of Psychology will be the primary location for project data storage. The server will be backed up regularly with a state-of-the-art tape backup system. When subprojects are completed, data will be stored on the server, burned to DVD, and until data is transferred to permanent repository (see previous item), lab PIs will receive annual encrypted tape backups of their data from the server to store off campus.

**Security**

The data server will not be accessible outside the Psychology intranet. The server and intranet are protected with passwords, firewalls, and proactive defense against viruses and malicious software. The server is physically protected through surge protection, battery backup systems, and a generator.

**Responsibility**

The Principal Investigator of this project will take ultimate responsibility for the collection, management, and sharing of the research data, and as importantly, ensuring that participating faculty and students understand best practices for data management. The project coordinator will assist in these efforts.

**Budget**

Our data management plan will be supported by staff and facilities funded by the university as part of standard operations.





February 2, 2017

Laura Regassa, Program Director  
Tara L. Smith, Program Director  
Division of Graduate Education  
National Science Foundation

RE: NSF 16-503

Dear Drs. Regassa and Smith,

As senior administrators at the University of Connecticut (UConn), we are writing to confirm our strong commitment to the interdisciplinary graduate training in the cognitive and biological sciences. The proposed "*NRT UtB DESE: Science of learning, from neurobiology to real world application: a problem based approach*" will be supported by and will benefit from major investments made by UConn in recent years. These include:

- The founding of the Institute for Systems Genomics in 2012, which promotes and facilitates genetics-related research and training throughout the university.
- The founding of the Connecticut Institute for the Brain and Cognitive Sciences in 2015 (of which PI Magnuson is Associate Director), which promotes and facilitates research across a wide range of biological, physical, and social sciences, with particular emphasis on facilitating collaborations spanning the Storrs and Farmington (Health Center) campuses.
- The UConn Brain Imaging Research Center (opened in 2015), which houses state-of-the-art cognitive neuroscience instruments, including magnetic resonance imaging (MRI), transcranial magnetic stimulation (TMS), and in- and out-of MRI eye tracking, electroencephalography (EEG), and transcranial direct current stimulation (tDCS).
- The Murine Behavioral Neurogenetics Facility (MBNF) (opened in 2016), a state-of-the-art resource for behavioral neuroscience.

Additionally, UConn will provide direct support and infrastructure to the NRT proposal (which we refer to by the acronym SLAC, for *Science of Learning and Art of Communication*) in several ways:

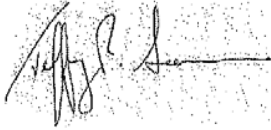
- The Graduate School has committed to ensuring tuition, fees and health benefits will be fully supported in accordance with University policy (<http://policy.uconn.edu/2011/05/31/policy-on-competitive-federal-graduate-awards/>).
- The College of Liberal Arts and Sciences and the Office of the Vice President for Research will provide support that will enable the SLAC faculty to extend critical program elements to associate trainees (e.g., by providing approximately 6 research assistantships per year for associates and facilitating pilot research), to enrich the SLAC program more generally (through retreats, special events, and external speakers), and to support recruiting efforts (with particular focus on achieving a diverse graduate student body, e.g., through recruiting

visits to colleges and conferences serving historically underserved segments of the population).

- We will facilitate SLAC faculty efforts to establish a graduate certificate in *Science of Learning and Art of Communication*, a key element of their plans to build a program that will become a permanent part of graduate training at UConn.
- We will also look forward to helping SLAC faculty find ways to sustain successful elements of the SLAC program when NSF funding is complete (as we have done with the related IGERT-funded program, *"IGERT: Language Plasticity Genes, Brain, Cognition, Computation, locally referred to as NBL"*). The NBL program is thriving as it transitions from NSF support to institutional support, and stands as an example to our commitment to sustaining training programs launched via external funding.
- The SLAC program will have access to share 1,700 square feet of space devoted to graduate trainees currently used by NBL and the 2,000 square feet of adjacent shared research facilities. Indeed, we expect interactions between NBL and SLAC trainees will be of benefit to both groups.

In closing, institutional support will allow the SLAC program to more strongly impact associate trainees and NRT fellows. Institutional support will allow this project to be sustained after award closure and we are committed to offering the support needed to ensure a successful program.


Sincerely,



Jeffrey R. Seemann, Ph.D.  
Vice President for Research  
UConn/UConn Health



Davita Glasberg  
Dean of the College of  
Liberal Arts & Sciences



Kent Holsinger  
Vice Provost for Graduate  
Education and Dean of the  
Graduate School