THE OHIO STATE UNIVERSITY

Graduate School

Curriculum Committee

250 University Hall
230 N. Oval Mall
Columbus, OH 43210

614-292-9490 Phone
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www.gradsch.osu.edu

March 6, 2014

Cynthia G. Clopper
Associate Director
Center for Cognitive and Brain Sciences

GIS Cognitive and Brain Sciences

Cynthia,

The Graduate School Curriculum Committee (GSCC) met on February 25th and considered the revised proposal to establish a new Graduate Interdisciplinary Specialization in Cognitive and Brain Sciences. Many improvements in the revised proposal were noted in the proposal such as the improved the rationale for forming the GIS, the administration of the GIS, and the relationship of the Oversight Committee and the Steering Committee. Two points remain:

- The proposal states that "other relevant courses may be approved...by the Graduate Studies Chair for the GIS." The Graduate School requires a finite master list of courses for the GIS. Additional courses are possible but would require additional approval by the Graduate School. Please modify this sentence.

- The proposal lacks a student advising sheet.

Please submit a revised copy of the proposal on curriculum.osu.edu. Once received, I will submit the proposal to Graduate Council for their review. Following Graduate Council, the proposal will be released to the Council on Academic Affairs for their review.

Please don't hesitate to contact me with questions or clarifications.

Many thanks,

Scott Herness

Scott Herness
Associate Dean
The Graduate School

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Graduate School

Curriculum Committee

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Columbus, OH 43210

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December 18, 2013

Cynthia G. Clopper
Associate Director
Center for Cognitive and Brain Sciences

GIS Cognitive and Brain Sciences

Cynthia,

The Graduate School Curriculum Committee (GSCC) met on December 11th and considered the proposal to establish a new Graduate Interdisciplinary Specialization in Cognitive and Brain Sciences. Here, I'm writing to summarize the GSCC discussion of the proposal and outline the next steps in the approval process. Part of the purpose of the GSCC is to not only review the proposal but also to help prepare and strengthen it for its future approval steps through the University. In that spirit, the GSCC had the following comments and requests for clarification and/or additional information:

- The GSCC felt that the rationale for creation of this GIS could be strengthened. While the interdisciplinarity of the field is a natural strength for a GIS, it is used almost exclusively as a rationale. Little is mentioned about the content – Cognitive and Brain Science – which might be otherwise unavailable to students in an organized fashion or to which populations of graduate students the GIS would be offered. How the creation of the GIS fills a void in the overall offerings to graduate students at our university and to whom offering this content would be beneficial would clearly strength the rationale for creating this new specialization.

- The content covered in this GIS is exceptionally broad in scope due to the inherent nature of the field. Hence a comparatively long list of elective courses is presented. Disciplines as disparate as artificial intelligence, audition, linguistics, musicology, and behavioral psychology are represented. While the breadth of this long list of electives is highly appropriate, it suggests that, for their maximum benefit, participating students should be closely advised on which electives to take in order to satisfy their personal goals. The program should develop an advising sheet for its students. Additionally, the program might consider, as part of that advising sheet, whether to request some thematic relationship of the elective courses the student may take in order to maximize their educational experience.

- It should be clearly stated in the proposal that faculty involved in administering the GIS must hold graduate faculty status with the Graduate School.

- I would suggest that you incorporate a process for a formal assessment of the GIS within its first 3 or 4 years. Such an assessment would help to ensure that the learning goals of the program are being met and might additionally review the use of offered courses and the involvement of participating faculty.

THE OHIO STATE UNIVERSITY

Please submit a revised copy of the proposal on curriculum.osu.edu. The GSCC would like to have a final look at the updated version prior to its moving forward in the approval process.

The proposal should then be ready for review by the Graduate Council. Following Graduate Council, the proposal will be released to the Council on Academic Affairs for their review.

Please don't hesitate to contact me with questions or clarifications.

Many thanks,

Scott Herness

Scott Herness
Associate Dean
The Graduate School

Status: PENDING

PROGRAM REQUEST
Cognitive and Brain Sciences

Last Updated: Herness,M Scott
04/04/2014

Fiscal Unit/Academic Org	ASC Administration - D4350
Administering College/Academic Group	Arts and Sciences
Co-adminstering College/Academic Group	
Semester Conversion Designation	New Program/Plan
Proposed Program/Plan Name	Cognitive and Brain Sciences
Type of Program/Plan	Graduate interdisciplinary specialization
Program/Plan Code Abbreviation	COGBRAI
Proposed Degree Title	

Credit Hour Explanation

Program credit hour requirements		A) Number of credit hours in current program (Quarter credit hours)	B) Calculated result for 2/3rds of current (Semester credit hours)	C) Number of credit hours required for proposed program (Semester credit hours)	D) Change in credit hours
Total minimum credit hours required for completion of program				11	
Required credit hours offered by the unit	Minimum				
	Maximum				
Required credit hours offered outside of the unit	Minimum			11	
	Maximum				
Required prerequisite credit hours not included above	Minimum				
	Maximum				

Program Learning Goals

Note: these are required for all undergraduate degree programs and majors now, and will be required for all graduate and professional degree programs in 2012. Nonetheless, all programs are encouraged to complete these now.

Program Learning Goals

- Graduate students have greater breadth of understanding of cognitive science and cognitive neuroscience.

Assessment

Assessment plan includes student learning goals, how those goals are evaluated, and how the information collected is used to improve student learning. An assessment plan is required for undergraduate majors and degrees. Graduate and professional degree programs are encouraged to complete this now, but will not be required to do so until 2012.

Is this a degree program (undergraduate, graduate, or professional) or major proposal? No

Program Specializations/Sub-Plans

If you do not specify a program specialization/sub-plan it will be assumed you are submitting this program for all program specializations/sub-plans.

Pre-Major

Does this Program have a Pre-Major? No

Status: PENDING

PROGRAM REQUEST
Cognitive and Brain Sciences

Last Updated: Herness,M Scott
04/04/2014

Attachments

- Cog Brain Letter from Dean.pdf: Letter of Support from College

  (Letter from the College to OAA. Owner: Haddad,Deborah Moore)

- Cognitive and Brain Sciences GIS--Q&A.pdf: Q&A -- ASC Graduate Curriculum Committee

  (Other Supporting Documentation. Owner: Vankeerbergen,Bernadette Chantal)

- Cognitive and Brain Sciences_Single PDF.pdf: Single PDF of Proposal

  (Program Proposal. Owner: Soave,Melissa A)

- GIS Cogn Brain Sci.pdf: Graduate School Letter

  (Other Supporting Documentation. Owner: Herness,M Scott)

- GIS Cogn Brain Sci2.pdf: Graduate School Letter

  (Other Supporting Documentation. Owner: Herness,M Scott)

- cogsci GIS proposal 031114.pdf: Revised Proposal

  (Program Proposal. Owner: Haddad,Deborah Moore)

Comments

- Revision requested by the Graduate School. Letters attached. *(by Herness,M Scott on 03/07/2014 10:01 AM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Haddad,Deborah Moore	08/29/2013 12:36 PM	Submitted for Approval
Approved	Vankeerbergen,Bernadette Chantal	08/29/2013 12:39 PM	Unit Approval
Approved	Heysel,Garett Robert	09/09/2013 10:26 PM	College Approval
Approved	Herness,M Scott	09/10/2013 01:31 PM	GradSchool Approval
Approved	Vankeerbergen,Bernadette Chantal	10/21/2013 09:43 AM	Ad-Hoc Approval
Revision Requested	Herness,M Scott	12/19/2013 05:26 PM	Ad-Hoc Approval
Submitted	Haddad,Deborah Moore	01/16/2014 11:06 AM	Submitted for Approval
Approved	Selfe,Richard Jerome	01/16/2014 03:37 PM	Unit Approval
Approved	Heysel,Garett Robert	01/16/2014 03:49 PM	College Approval
Revision Requested	Herness,M Scott	03/07/2014 10:01 AM	GradSchool Approval
Submitted	Haddad,Deborah Moore	03/11/2014 12:43 PM	Submitted for Approval
Approved	Vankeerbergen,Bernadette Chantal	03/11/2014 12:45 PM	Unit Approval
Approved	Heysel,Garett Robert	03/11/2014 02:17 PM	College Approval
Approved	Herness,M Scott	04/04/2014 03:41 PM	GradSchool Approval
Pending Approval	Newhouse,Melissa Ann	04/04/2014 03:41 PM	CAA Approval

From: Clopper, Cynthia
To: Vankeerbergen, Bernadette
Cc: Fink, Steven; Haddad, Deborah
Subject: Re: Cognitive and Brain Sciences GIS
Date: Thursday, October 17, 2013 12:19:08 PM

Dear Bernadette,

I would be happy to clarify these points for you.

1. Some of the elective courses have prerequisites, but in almost all cases, those prerequisites are other courses on the elective list and/or graduate standing and/or permission of the instructor. It will therefore be possible for any student, regardless of discipline, to complete the GIS without taking more than the minimum number of required courses. A student who wishes to obtain more advanced knowledge or training in a particular area may choose to take an additional course, but that could involve either a prerequisite or a more advanced course on the topic, and would never be required to complete the GIS. To make the course selection process more transparent, we will include the prequisites for each course on the elective course list on the GIS website to make sure that students take prerequisites into account in planning their coursework.

2. As described in the Administration section of the proposal, the Graduate Studies Chair for the GIS will formally approve the proposed curriculum for each student pursuing the GIS. The Graduate School specifies the procedure for this approval process, including a form for students to complete indicating their proposd coursework. This form must be signed by the student, the student's home department advisor, and the GIS GSC Chair (http://www.gradsch.ohio-state.edu/Depo/PDF/InterdisciplinarySpecializationForm.pdf). Our guideline that students select their electives in consultation with their advisor is simply a further specification of the process for our GIS.

I do not have access to curriculum.osu.edu (Deborah Haddad submitted the proposal for me), so I would greatly appreciate it if you could forward the current version of the proposal to the Graduate School with the ASC endorsement. Please let me know if you think we should proceed differently.

Thank you!
Cynthia

On Oct 16, 2013, at 10:58 AM, Vankeerbergen, Bernadette wrote:

> Dear Cynthia,
>
> As you know, the ASC Graduate Curriculum Committee reviewed the proposed GIS in Cognitive and Brain Sciences and approved it unanimously.
>
> That said, a couple of questions/requests for clarification came up:
> 1) In the long list of elective courses, from which students must choose 2, are there any "hidden" prerequisites that would, in practice, require students from some disciplines to take additional credit hours? If so, this should be addressed and made

transparent to students looking into this GIS.
2) The guidelines state that "elective courses should be selected in consultation with the student's advisor," presumably meaning the advisor from that student's home department. So are we correct in inferring that approval is more or less informal and that there is no formal mechanism or approval process by the Graduate Studies Chair or the Graduate Studies Committee charged with administering the GIS itself?

If you would prefer to address those points in your proposal before we move it on to the Graduate School, please let us know. In that case, we will return the proposal via curriculum.osu.edu.

Should you have any questions about this feedback, please feel free to contact Steven Fink (Chair of the ASC Graduate Curriculum Committee), or me.

Best regards,
Bernadette

Bernadette Vankeerbergen, Ph.D.
Program Manager, Curriculum and Assessment
Arts and Sciences
The Ohio State University
154D Denney Hall
164 W 17th Ave.
Columbus, OH 43210
Phone: 614-688-5679
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http://asccas.osu.edu

Cynthia G. Clopper
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THE OHIO STATE UNIVERSITY

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artsandsciences.osu.edu

August 27, 2013

Council on Academic Affairs
c/o Office of Academic Affairs
203 Bricker Hall
190 North Oval Mall
CAMPUS

Dear Council on Academic Affairs Members,

I am pleased to submit for your consideration a proposal for a Graduate Interdisciplinary Specialization (GIS) in Cognitive and Brain Sciences. The distinctive quality of this program is a result of faculty research collaboration across nine departments in three colleges in the areas of cognitive science and cognitive neuroscience. The involved faculty members are all affiliated with the Center for Cognitive and Brain Sciences.

The program is rigorous, yet its interdisciplinarity and flexibility will appeal to many graduate students across the university as an important complement to their primary programs. Given the strong and growing communities of faculty researchers in cognitive science and cognitive neuroscience, I strongly support the GIS in Cognitive and Brain Sciences, and I encourage its approval.

Sincerely,

David Manderscheid

David C. Manderscheid
Executive Dean and Vice Provost

Status: PENDING

PROGRAM REQUEST
Cognitive and Brain Sciences

Last Updated: Vankeerbergen,Bernadette Chantal
10/21/2013

Fiscal Unit/Academic Org	ASC Administration - D4350
Administering College/Academic Group	Arts and Sciences
Co-administering College/Academic Group	
Semester Conversion Designation	New Program/Plan
Proposed Program/Plan Name	Cognitive and Brain Sciences
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Is this a degree program (undergraduate, graduate, or professional) or major proposal? No

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Pre-Major

Does this Program have a Pre-Major? No

Status: PENDING

PROGRAM REQUEST
Cognitive and Brain Sciences

Last Updated: Vankeerbergen,Bernadette Chantal
10/21/2013

Attachments

- Cog Brain GIS Proposal Submission.pdf: Proposal and Concurrences

  (Program Proposal. Owner: Haddad,Deborah Moore)

- Cog Brain Letter from Dean.pdf: Letter of Support from College

  (Letter from the College to OAA. Owner: Haddad,Deborah Moore)

- Cognitive and Brain Sciences GIS--Q&A.pdf: Q&A -- ASC Graduate Curriculum Committee

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Comments

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Approved	Vankeerbergen,Bernadette Chantal	10/21/2013 09:43 AM	Ad-Hoc Approval
Pending Approval	Soave,Melissa A	10/21/2013 09:43 AM	CAA Approval

Graduate Interdisciplinary Specialization Proposal
Cognitive and Brain Sciences
August 23, 2013

Contact

Cynthia G. Clopper
Associate Director, Center for Cognitive and Brain Sciences
clopper.1@osu.edu
614-292-8235

Rationale

The purpose of the proposed Graduate Interdisciplinary Specialization in Cognitive and Brain Sciences is to provide graduate students with interdisciplinary training in Cognitive Science and Cognitive Neuroscience. The strong interdisciplinary cognitive science and cognitive neuroscience communities at Ohio State coupled with the recent integration of the Center for Cognitive Science with the new neuroimaging center (Center for Cognitive and Behavioral Brain Imaging) provide a unique opportunity for developing a highly synergistic program of graduate training. The proposed GIS will facilitate this interdisciplinary training program by providing students with the opportunity to interact with faculty and graduate students across a range of disciplines. It will also expand the recruitment pool of potential graduate students who are explicitly seeking interdisciplinary training in Cognitive Science and Cognitive Neuroscience and expand the career opportunities for graduates of the GIS by broadening the range of academic and industry positions that they can compete for.

Proposed curriculum

A Graduate Interdisciplinary Specialization (GIS) involves two or more disciplines outside of the student's home discipline. At least nine hours must be from outside the home graduate program, but may include cross-listed courses. Cross-listed courses that comprise the nine hours minimum must be offered from outside the home department. The proposed curriculum for the GIS in Cognitive and Brain Sciences includes a total of at least 11 credit hours earned through at least four different courses:

1. **Required introductory course (3 credits).** Either Introduction to Cognitive Science or Cognitive Neuroscience can be taken to fulfill the introductory course requirement. Students will be strongly encouraged to take the introductory course that they have less background in, and students with sufficient background in both areas may petition to replace the introductory course with a more advanced course.
2. **Required proseminar (2 credits).** The Proseminar in Cognitive Science must be taken to fulfill this requirement. It may be repeated for credit once to fulfill the disciplinary breadth requirement of the GIS.
3. **Two elective courses (6 credits).** The elective courses should be selected in consultation with the student's advisor and must be courses that are not cross-listed in the home department to ensure intellectual breadth. Elective courses may count towards both the primary degree and the GIS. The electives may either represent breadth (two courses from different disciplines) or depth (two courses from the same discipline) in Cognitive Science or Cognitive Neuroscience. (Note that if the two elective courses are from the same

discipline, at least one of the other GIS requirements must be met through completion of a course offered a different discipline that is not the student's home discipline.)

A master list of required and suggested elective courses is provided in Appendix A, although other relevant courses may be approved for an individual student's curriculum by the Graduate Studies Chair for the GIS.

Administration

The GIS in Cognitive and Brain Sciences will be administered by the College of Arts and Sciences (ASC). The ASC Dean of the Social and Behavioral Sciences (SBS), or the Dean's designee, will chair the oversight committee for this ASC GIS. The Oversight Committee will be composed of the chair of the steering committee (described below) and faculty from units offering courses in the GIS who will be appointed by the Dean. An Associate Director of the Center for Cognitive and Brain Sciences will serve as the Graduate Studies Chair for the GIS and will be responsible for convening a Graduate Studies Committee (GSC) to regularly review the structure and curriculum of the GIS. The Graduate Studies Committee will be the steering committee for the GIS and the Graduate Studies Chair will chair the steering committee. The Steering Committee will consist of at least four faculty members from different departments, including both faculty with expertise in cognitive science and faculty with expertise in neuroscience. The GSC Chair will report to the oversight committee. The GSC Chair also will be responsible for approving the proposed curricula for all students who wish to pursue the GIS in Cognitive and Brain Sciences, in consultation with the steering committee and the student's advisor. A website describing the GIS will be developed and maintained on the Center for Cognitive and Brain Sciences website.

Enrollment

We expect graduate students from a range of disciplines, including Biophysics, Computer Science and Engineering, Education, Electrical and Computer Engineering, Linguistics, Philosophy, Psychology, Speech and Hearing Sciences, and the foreign language departments, to participate in the GIS in Cognitive and Brain Sciences. Given this large potential pool of students, we expect to enroll 15-20 students per year in the GIS, with a total enrollment of approximately 100 students in the program at any given time. Given that all of the required courses are taught annually and that the number of potential elective courses is quite large, we do not anticipate the program outgrowing our capacity to offer a sufficient number of courses, and therefore have no plans to impose a maximum on the number of enrolled students in the program.

Letters of support

Letters of support have been provided by the Chair of each of the affiliated departments, including Computer Science & Engineering (Xiaodong Zhang), Electrical and Computer Engineering (Robert Lee), Integrated Systems Engineering (Philip Smith), Linguistics (Shari Speer), Music (Richard Blatti), Neuroscience (Randy Nelson), Philosophy (Donald Hubin), Psychology (Richard Petty), and Speech and Hearing Science (Robert Fox). Letters of support have also been provided by the Deans of the Colleges of Engineering (Edward McCaul) and Medicine (Charles Lockwood). The letters of support are included in Appendix B.

APPENDIX A
COGNITIVE AND BRAIN SCIENCES
GRADUATE INTERDISCIPLINARY SPECIALIZATION PROPOSAL
CENTER FOR COGNITIVE AND BRAIN SCIENCES
REQUIRED AND ELECTIVE COURSE DESCRIPTIONS

	COURSE	DESCRIPTION	CREDIT HOURS
INTRODUCTORY COURSE CHOOSE 1 COURSE	**CSE 5531 or LING 5612 or PHILOS 5830 or PSYCH 5612:** *Introduction to Cognitive Science*	Cognitive science is an interdisciplinary study of the nature of human thought; psychological, philosophical, linguistic, and artificial intelligence approaches to knowledge representation.	3
	PSYCH 5614: *Cognitive Neuroscience*	Neuronal mechanisms of information processing.	3

	COURSE	DESCRIPTION	CREDIT HOURS
PROSEMINAR REQUIRED	**CSE 5891 or LING 5891 or PHILOS 5891 or PSYCH 5891 or SPHHRNG 5891:** *Proseminar in Cognitive Science*	Provides an in-depth examination of cognitive science from an interdisciplinary perspective.	3

ELECTIVES	COURSE	DESCRIPTION	CREDIT HOURS
ELECTIVE COURSES CHOOSE 2 COURSES	**CSE 4521:** *Survey of Artificial Intelligence for Non-Majors*	Survey of the basic concepts and techniques in artificial intelligence, including problem solving, knowledge representation, and machine learning.	3
	CSE 5521: *Survey of Artificial Intelligence I: Basic Techniques*	Survey of the basic concepts and techniques in artificial intelligence, including problem solving, knowledge representation, and machine learning.	2
	CSE 5522: *Survey of Artificial Intelligence II: Advanced Techniques*	Survey of advanced concepts, techniques, and applications of artificial intelligence, including knowledge representation, learning, natural language understanding, and vision.	3
	CSE 5523: *Machine Learning and Statistical Pattern Recognition*	Introduction to basic concepts of machine learning and statistical pattern recognition; techniques for classification, clustering and data representation and their theoretical analysis.	3

ELECTIVES	COURSE	DESCRIPTION	CREDIT HOURS
ELECTIVE COURSES CONTINUED CHOOSE 2 COURSES	**CSE 5524:** *Computer Vision for Human-Computer Interaction*	Computer vision algorithms for use in human-computer interactive systems; image formation, image features, segmentation, shape analysis, object tracking, motion calculation, and applications.	3
	CSE 5525: *Foundations of Speech and Language Processing*	Fundamentals of natural language processing, automatic speech recognition and speech synthesis; lab projects concentrating on building systems to process written and/or spoken language.	3
	CSE 5526: *Introduction to Neural Networks*	Survey of fundamental methods and techniques of neural networks; single- and multi-layer perceptrons; radial-basis function networks; support vector machines; recurrent networks; supervised and unsupervised learning.	3
	CSE 5539: *Intermediate Studies in Artificial Intelligence*	Intermediate-level topics in artificial intelligence.	2
	ECE 5200: *Introduction to Digital Signal Processing*	Sampling and reconstruction; discrete-time rate conversion; processing of discrete-time signals; design of discrete-time filters, selected topics in adaptive and/or multidimensional signal processing.	3
	ECE 5206: *Medical Imaging and Processing*	Introduction to medical imaging techniques (CT, MRI, PET, ultrasound), including data collection, image reconstruction, physics of tissue interactions, and digital processing of medical images.	3
	ECE 5460: *Image Processing*	Fundamentals and research directions in image processing: cameras, geometry, calibration, 2D and 3D image reconstruction, stereo, structure from motion, Radiometry, filtering, motion estimation, and applications.	3
	ECE 5759: *Optimization for Static and Dynamic Systems*	Numerical optimization techniques as applied to selected electrical engineering application areas.	3
	ECE 6001: *Probability and Random Variables*	Probability, random variables, and random vectors for analysis and research in electrical engineering. Distribution functions, characteristic functions, functions of random variables and vectors, Markov chains.	3

ELECTIVES	COURSE	DESCRIPTION	CREDIT HOURS
ELECTIVE COURSES CONTINUED CHOOSE 2 COURSES	**ECE 7866**: *Computer Vision*	Computer vision systems, image models, feature extraction, shape representation and recognition, object modeling and recognition, matching, probabilistic and statistical modeling, semantic knowledge, and face perception.	3
	ECE 7868: *Pattern Recognition and Machine Learning*	Fundamentals of pattern recognition techniques and their application to computer and electrical engineering problems, medicine, cognitive science, and bioinformatics.	3
	ISE 5700: *Introduction to Cognitive Systems Engineering*	Human-centered design of consumer products, web sites and complex sociotechnical systems. Topics include human-computer interaction and the design of decision support and distributed work systems.	3
	ISE 5705: *Cognitive Engineering Systems: Distributed and Cooperative Work*	Provides key concepts for the design and assessment of computer supported collaborative and distributed work systems.	3
	ISE 5710: *Behind Human Error: Safety and Complex Systems*	Covers how complex systems fail and the human contribution to success and failure by studying actual disasters in diverse fields.	3
	ISE 5720: *Human Systems Integration*	Concepts and methods for considering the human as part of the design and operation of any system, especially large scale systems and enterprises.	3
	ISE 5730: *Information Analysis and Synthesis*	Professional information analysis in engineering, intelligence/security, business, and health care that identifies the factors that make the analytical process shallow or rigorous.	3
	ISE 5740: *Cognitive Engineering Systems: Human-Centered Automation*	Provides key concepts to make autonomous systems, robots, and artificially intelligent systems team players with responsible people.	3
	ISE 5760: *Cognitive Engineering Systems: Visualization and Human-Computer Interfaces*	Visualization and interface design principles and techniques to overcome data overload and aid sense making and other aspects of cognitive work.	3
	ISE 5770: *Cognitive Engineering Systems: Design and Evaluation*	Evaluation of product and system design to assess usefulness and usability; advanced design concepts for consumer products, web sites, educational tools and information retrieval systems.	3
	ISE 7700: *Cognitive Systems Engineering: Advanced Topics*	Seminar on emerging themes about human-machine systems and how these relate to current societal issues.	3

ELECTIVES	COURSE	DESCRIPTION	CREDIT HOURS
ELECTIVE COURSES CONTINUED CHOOSE 2 COURSES	**LING 5001:** *Formal Foundations of Linguistics*	Applying tools from set theory, symbolic logic, model theory, algebra and formal grammar in the foundations of formal linguistic theories and in linguistic analysis.	3
	LING 5002: *Algebraic Linguistics*	Formal properties of grammar and automata; relations between linear, context-free and context-sensitive grammars and finite, pushdown-storage and linear-bounded automata; properties of transformational grammars.	3
	LING 5051: *Quantitative Methods in Linguistics*	Quantitative methods in the sub-disciplines of Linguistics, including data analysis, interpretation and display of data, inferential statistics, and statistical modeling.	3
	LING 5101: *Phonetics: Phonetic Theory*	Principles of articulatory phonetics, with some discussion of acoustic phonetics; practice in the production, recognition, and transcription of sounds in various languages of the world.	3
	LING 5102: *Laboratory Phonology*	Introduction to laboratory methods and quantitative models of speech for linguistics.	3
	LING 5201: *Syntactic Theory I*	Theories of syntax; principles of syntactic description.	3
	LING 5202: *Syntactic Theory II*	Theories of syntax; principles of syntactic description.	3
	LING 5203: *Syntactic Theory III*	Theories of syntax; principles of syntactic description.	3
	LING 5301: *Phonological Theory I*	Introduction to phonological analysis and the principles governing the structure, acquisition, and change of phonological systems; survey of major phonological theories.	3
	LING 5302: *Topics in Advanced Phonology*	Introduction to phonological analysis and the principles governing the structure, acquisition, and change of phonological systems; survey of major phonological theories.	3
	LING 5351: *Morphological Theory*	Introduction to and comparison of current theories of morphology with application to linguistic data and problems.	3
	LING 5401: *Semantic Theory I*	Problems and methods in linguistic semantics, using logic and semantic model theory as analytic tools; reference, compositionality, presupposition, conversational implicature, speech acts, deixis.	3

ELECTIVES	COURSE	DESCRIPTION	CREDIT HOURS
ELECTIVE COURSES CONTINUED CHOOSE 2 COURSES	**LING 5402:** *Semantic Theory II*	Montague semantics and more recent semantic theories; analysis of important problems, such as generalized quantifiers, lattice-based accounts of plurals and events, discourse representation theory.	3
	LING 5451: *Formal Pragmatics*	Introduction to contemporary theories of pragmatic phenomena which build on theories of dynamic interpretation in formal semantics.	3
	LING 5701: *Psycholinguistics I*	An introduction to high-level language processing, word recognition, sentence understanding, and discourse processing.	3
	LING 5702: *Psycholinguistics II*	Models of human language processing and language parsing and interpretation; probabilistic models, issues in experimentation, and model implementation.	3
	LING 5801: *Computational Linguistics I*	Symbolic and probabilistic computation applied to the structure of words and sentences, models of syntax, parsing algorithms.	3
	LING 5802: *Computational Linguistics II*	Computational models of language acquisition and application of machine learning techniques to language processing.	3
	LING 5803: *Computational Semantics*	Methods for construction semantic representations for fragments of natural language and performing inference with such representations.	3
	LING 8100: *Seminar in Phonetics*	Study of specific problems in articulatory and acoustic phonetics at an advanced level.	3
	LING 8200: *Seminar in Syntax*	Advanced topics in syntactic analysis.	3
	LING 8300: *Seminar in Phonology*	Advanced topics in phonological analysis.	3
	LING 8350: *Seminar in Morphology*	Advanced topics in morphological analysis.	1-3
	LING 8400: *Seminar in Semantics*	Accounts of semantic judgments in languages, especially within the theory of generative grammar; relationships between syntax, semantics, and language use.	3
	LING 8450: *Seminar in Pragmatics*	An intensive examination of one or more major problems in pragmatics, such as speech acts, implicature, or presupposition.	3
	LING 8700: *Seminar in Psycholinguistics*	Advanced topics in psycholinguistics.	1-3
	LING 8800: *Seminar in Computational Linguistics*	Advanced topics in computational linguistics.	1-3

ELECTIVES	COURSE	DESCRIPTION	CREDIT HOURS
ELECTIVE COURSES CONTINUED CHOOSE 2 COURSES	**MUSIC 7785:** *Cognitive Ethnomusicology*	Topics and issues in historical musicology and ethnomusicology.	3
	MUSIC 8824.01: *Computational Musicology I*	The use of computers in music research and instruction; music data structures and programming routines for music research and instruction.	3
	MUSIC 8824.02: *Computational Musicology II*	The use of computers in music research and instruction; music data structures and programming routines for music research and instruction.	3
	MUSIC 8838.01: *Topics in Music Cognition*	Critical survey of perceptual, cognitive, affective or neuroscience research related to music.	3
	MUSIC 8838.03: *Music and Emotion*	Examination of modern ideas related to music and affect.	3
	MUSIC 8838.04: *Topics in Recent Literature of Music Cognition*	Critical readings and discussion of current research publications in music cognition.	3
	MUSIC 8839.01: *Music Cognition Research Laboratory*	Practical experiences in laboratory studies of music.	3
	NEUROSC 7001: *Foundations of Neuroscience 1*	Discusses basic principles of the cellular, molecular and neurophysiological, and neuropharmacological organization of the nervous system.	6
	NEUROSC 7002: *Foundations of Neuroscience 2*	Discusses the organization of select systems in the nervous system including motor, sensory, autonomic, and higher cognitive centers. Course will cover anatomical, functional and behavioral concepts.	6
	NEUROSC 7050: *Neurobiology of Disease*	Neurobiology of Disease will explore the basis of major diseases affecting the nervous system.	3
	PHILOS 5510: *Nonclassical Logic*	Study of selected systems of nonclassical logic, such as entailment systems, modal, many-valued, epistemic deontic, imperative, erotetic, tense and free logics.	3
	PHILOS 5520: *Inductive Logic and Probability Theory*	An analysis of selected systems of inductive inference; the probability calculus and its interpretations; confirmation theory.	3
	PHILOS 5530: *Philosophy of Logic and Mathematics*	Analysis of basic concepts used in logic and in philosophical claims about logic and mathematics, such as proposition, logical truth, mathematical objects, and necessity.	3
	PHILOS 5540: *Theory of Rational Choice*	Introduction to the principles and methods of the theory of rational choice with applications in the theory of knowledge, ethics, and social and political philosophy.	3

ELECTIVES	COURSE	DESCRIPTION	CREDIT HOURS
ELECTIVE COURSES CONTINUED CHOOSE 2 COURSES	**PHILOS 5550:** *Advanced Logical Theory*	Topics include formal arithmetic, recursive functions, Turing machines, Godel's incompleteness theorems, Church's thesis, arithmetical truth, logical paradoxes, and higher-order logic.	3
	PHILOS 5600: *Advanced Philosophy of Language*	Basic problems and results in the philosophy of language, concentrating on theories of reference, theories of meaning, and theories of language-use (including speech-acts, implicature).	3
	PHILOS 5800: *Advanced Philosophy of Mind*	Classical and contemporary approaches to the nature of mind, mind-body, other minds, intentionality, and other problems.	3
	PHILOS 5840: *Advanced Philosophy of Cognitive Science*	In-depth examination of the influence of results in cognitive science upon the way in which philosophers approach fundamental issues about the nature of the mind.	3
	PHILOS 8500: *Seminar in Logic*	Seminar in Logic.	1-4
	PHILOS 8600: *Seminar in Philosophy of Language*	Seminar in Philosophy of Language.	1-4
	PHILOS 8650: *Seminar in Philosophy of Science*	Seminar in Philosophy of Science.	1-4
	PSYCH 5600: *Psychobiology of Learning & Memory*	Integrate coverage of animal learning and human memory, focusing on three key components of the field: behavioral processes, brain systems, and clinical perspectives.	3
	PSYCH 5606: *High-Level Vision*	Examines the perceptual processes by which humans and other animals are able to obtain knowledge about the three-dimensional environment.	3
	PSYCH 5608: *Introduction to Mathematical Psychology*	Survey of mathematical and computational modeling in psychology. Topics include psychophysical scaling, information processing, probabilistic choice, signal detection theory, model comparison, and Bayesian graphical modeling.	3
	PSYCH 5609: *Introduction to Mathematical Models In Experimental Psychology*	An introduction to cognition with a focus on the application of mathematical models. Topic areas include memory, decision making, categorization, word recognition, priming, and reaction time.	3

ELECTIVES	COURSE	DESCRIPTION	CREDIT HOURS
ELECTIVE COURSES CONTINUED CHOOSE 2 COURSES	**PSYCH 5613:** *Biological Psychiatry*	Provides a contemporary overview of the biological bases of several significant psychopathologies, including mood disorders, schizophrenia, and PTSD/dissociative identity disorders.	3
	PSYCH 5615: *Psychology of Language*	An introduction to high-level language processing, including word recognition, sentence understanding, and discourse processing.	3
	PSYCH 5616: *Models of Language*	Critically examines psychological models of language. Phenomena examined include word recognition, lexical semantics, sentence processing, discourse processing, and general verbal cognition.	3
	PSYCH 5617: *Models of Memory*	Examines models of memory and their construction and critically evaluate their claims. Coverage includes abstract and neural models of episodic memory attempting to capture a wide range of behaviors in recognition and recall.	3
	PSYCH 5618: *Introduction to Computational Cognitive Neuroscience*	Introductory survey of neural-network models, emphasizing their neural foundations and applications to perceptions, memory, and language. Hands-on explorations with simulation software.	3
	PSYCH 5621: *Introduction to Event-Related-Potentials*	Training to become an independent event-related-potential researcher. Develop skills in experimental programming, application of electrode nets, artifact detection, filtering and component analysis, and localization.	3
	PSYCH 5898: *Seminar in Behavioral Neuroscience*	Team-taught seminar on selected topics from contemporary research areas in the field of behavioral neuroscience.	3
	PSYCH 6619: *Natural Scene Perception*	Concerns how humans perceive their natural environment. Explores philosophical, psychological, and computational aspects of the perception of natural scenes in readings and discussions.	3
	PSYCH 6806: *Behavioral Neuroscience I*	The first in a two semester sequence surveying behavioral neuroscience with an emphasis on neurophysiology, the integration of neuronal signaling, and the emergence of high functions.	3

ELECTIVES	COURSE	DESCRIPTION	CREDIT HOURS
ELECTIVE COURSES CONTINUED CHOOSE 2 COURSES	**PSYCH 6807:** *Behavioral Neuroscience II*	The second in a two semester sequence surveying behavioral neuroscience with an emphasis on the age-related changes in the brain, consequences of brain damage and the dementias.	3
	PSYCH 6861: *Design & Methods in Clinical Psychology*	Introduction to the theory and use of clinical methods in psychology, designed for first-year graduate students in clinical psychology.	3
	PSYCH 7708: *Psychology of Judgment & Decision Making*	Introductory graduate course in the psychology of judgment and decision making, including applications to health, law, economics, environmental issues, and social, cognitive, and clinical psychology.	3
	PSYCH 7820: *Fundamentals of Factor Analysis*	Basic Common Factor Model and its application in psychology; model, communality estimation, factor extraction, orthogonal and oblique rotation, factor scores, confirmatory factor analysis, use of computer programs.	3
	PSYCH 7821: *Covariance Structure Models*	Theory and methods of testing models of covariance structures; general mathematical model, identification, parameter estimation, goodness of fit, model modification, and the use of computer programs such as LISREL.	3
	PSYCH 7822: *Fundamentals of Item Response Theory*	Basic concepts underlying item response theory; overview of more advanced topics.	3
	PSYCH 7823: *Analysis of Repeated Measures and Longitudinal Data*	Review statistical methods for the analysis of repeated measures experiments and longitudinal studies, and investigate the way that participants change over time.	3
	PSYCH 7824: *Non-Parametric Statistics*	Considers nonparametric and distribution free statistical methods, with emphasis on applications to psychological data.	3
	PSYCH 7845: *Cognitive Development*	Intensive survey of theory and research in cognitive development, including development of perception, language, memory, concepts, reasoning, academic skills, and social cognition.	3
	PSYCH 7847: *Language Development*	Survey of language acquisition, including phonemes, words, morphology, syntax.	3
	PSYCH 7895: *Current Issues in Cognitive Development*	Current topics in cognitive development.	3

ELECTIVES	COURSE	DESCRIPTION	CREDIT HOURS
ELECTIVE COURSES CONTINUED CHOOSE 2 COURSES	**SPHHRNG 6150:** *The Role of the SLP in Autism Spectrum Disorders and Alternative/ Augmentative Communication*	Provides students with knowledge in autism spectrum disorders and augmentative and alternative communication by integrating research with clinical practice in assessment, treatment, and intervention.	3
	SPHHRNG 6761: *Adult Neurogenic Language Disorders I: Language and Cognition*	Impairments in communication due to neurologically related changes in language and/or cognition. Pertinent topics include aphasia, traumatic brain injury, dementia and impairments right hemisphere damage.	4
	SPHHRNG 6725: *Language Acquisition and Early Intervention in Language Delay*	Development of language in children with an emphasis on the interaction between the development of language and cognition with implications for delay. The emphasis in on children aged zero to five years.	4
	SPHHRNG 6775: *Anatomy and Physiology of the Auditory System*	The structure, function, and stimulus processing capacities of the ear and central auditory pathways as they relate to performance on tests of auditory function in normal and impaired listeners.	4
	SPHHRNG 7820: *Acoustic Phonetics*	An introduction to the acoustic characteristics of human speech sounds, the acoustic theory of speech production, and spectrographic analysis.	3
	SPHHRNG 8950: *Seminar in Speech and Hearing Science*	Advanced seminars in speech and hearing science and disorders.	2

APPENDIX B
COGNITIVE AND BRAIN SCIENCES
GRADUATE INTERDISCIPLINARY SPECIALIZATION PROPOSAL
CENTER FOR COGNITIVE AND BRAIN SCIENCES
LETTERS OF SUPPORT

1. AFFILIATED DEPARTMENT CHAIRS

Computer Science and Engineering (Xiaodong Zhang)
Electrical and Computer Engineering (Robert Lee)
Integrated Systems Engineering (Philip Smith)
Linguistics (Shari Speer)
Music (Richard Blatti)
Neuroscience (Randy Nelson)
Philosophy (Donald Hubin)
Psychology (Richard Petty)
Speech and Hearing Science (Robert Fox)

2. PARTICIPATING COLLEGE DEANS

College of Engineering (Edward McCaul)
College of Medicine (Charles Lockwood)

Department of Computer Science and Engineering

395 Dreese Labs
2015 Neil Avenue
Columbus, OH 43210-1277

Phone (614) 292-5813
Fax (614) 292-2911
www.cse.ohio-state.edu

March 13, 2013

Graduate School
The Ohio State University

Dear Colleagues,

I strongly support the proposal of Graduate Interdisciplinary Specialization submitted from the Center of Cognitive and Brain Sciences. This proposed program will provide graduate students with unique opportunities on multidisciplinary studies and research focusing on cognitive science and cognitive neuroscience. This is an important area to improve our life and the society, which demands a lot research efforts and human talents. Some graduate students from the computer science and engineering department will benefit from this program for their multidisciplinary research.

I give my strongest support to this proposal on behalf of the computer science and engineering faculty.

Sincerely yours,

Xiaodong Zhang
Robert M. Critchfield Professor in Engineering
Chairperson, Department of Computer Science and Engineering
The Ohio State University

THE OHIO STATE UNIVERSITY

Department of Electrical & Computer Engineering

205 Dreese Laboratory
2015 Neil Avenue
Columbus, OH 43210-1272

Phone (614) 292-2572
Fax (614) 292-7596

4/3/2013

Dear Cynthia Clopper,

With the approval of ECE Graduate Studies Committee, both the ECE Graduate Studies Chair and ECE Department Chair support the proposal for a Graduate Interdisciplinary Specialization in Cognitive and Brain Sciences. The committee recommends that the ECE classes below be added to the list of courses:

ECE 5200 - Introduction to Digital Signal Processing
ECE 5206 - Medical Imaging and Processing
ECE 5759 -Optimization for Static and Dynamic Systems

We feel such a specialization will be of great interest to our graduate students in the future given the growth of research opportunities in brain research.

Sincerely,

Fusun Ozguner
Professor and Graduate Studies Chair

Robert Lee
Professor and Chair

THE OHIO STATE UNIVERSITY

Department of Integrated Systems Engineering

210 Baker Systems Bldg.
1970 Neil Ave.
Columbus, OH 43210-1271

Phone (614) 292-6239
Fax (614) 292-7852
Web http://ise.osu.edu/index.cfm

To: Zhong-Lin Lu, Director of the Center for Cognitive and Brain Sciences
From: Philip J. Smith, Chair, ISE Department
Date: March 11, 2013

I am writing this letter to very strongly support the proposal for a Graduate Interdisciplinary Specialization (GIS) in Cognitive and Brain Sciences. This is a well structured proposal that will make possible a very useful interdisciplinary specialization in this important area of study.

Let me know if there is any additional information required from the Department of Integrated Systems Engineering.

Department of Linguistics

222 Oxley Hall
1712 Neil Avenue
Columbus, OH 43210-1298

Phone (614) 292-4052
Fax (614) 292-8833
E-mail lingadm@ling.osu.edu
http://linguistics.osu.edu

1 April 2013

Dr. Cynthia Clopper
COG Associate Director, Center for Cognitive and Brain Sciences
Associate Professor, Linguistics

Dear Cynthia,

This letter expresses the Department of Linguistics' support for the proposed Graduate Interdisciplinary Specialization in Cognitive and Brain Sciences, to be administered by the Center for Cognitive and Brain Sciences. The proposed program constitutes an excellent opportunity for our graduate students to take advantage of OSU's newly integrated resources in Cognitive Science and neuroimaging.

Best regards,

Shari R. Speer
Professor and Chair, Linguistics

THE OHIO STATE UNIVERSITY

Director's Office
School of Music
110 Weigel Hall
1866 College Road
Columbus, OH 43210-1170

614-292-7664 Phone
614-292-1102 Fax

music.osu.edu

June 15, 2013

Cynthia G. Clopper
Associate Professor
Department of Linguistics
CAMPUS

Dear Dr. Clopper,

Your proposal for a graduate interdisciplinary specialization in cognitive and brain sciences has the support of the OSU School of Music. Although not everyone in Music who might be involved with such a program has had the opportunity to weigh in, our chief expert in this field is David Huron, Professor of Music Theory and Director of the Music Cognition Program. His comments follow:

> I am fully in support of the graduate interdisciplinary specialization in cognitive and brain sciences. A handful of our own students are likely to enroll over time, and I expect there will be a reciprocal attraction for a handful of students from other departments to attend our graduate cognition course offerings. Apart from music cognition however, this GIS will benefit a much wider number of students across the university. I am happy to support it.

We have reviewed the proposed curriculum, projected enrollments, and plans for the administration of the program and feel that these factors resonate well with our curriculum and graduate resources. The four School of Music courses listed in the proposed GIS curriculum, MUS 6645: Music's Meanings,_MUS 8838.01: Topics in Music Cognition,_MUS 8838.03: Music and Emotion, and_MUS 8838.04: Topics in Recent Literature of Music Cognition should be able to sustain modest enrollment increases and our faculty are eager to interact with students from other disciplines. Although our Music Theory faculty who cover graduate course offerings are currently stretched to the limit, we look to make at least one hire in the near future to ease the situation. In the meantime, joining David Huron are Professors Johanna Devaney, David Clampitt, and Ethnomusicologist Udo Will, who all share interest in this field and have done considerable research of their own.

In summary, the School of Music stands behind this proposal and we look forward to however we may assist in establishing this exciting new graduate interdisciplinary specialization.

Respectfully,

Richard L Blatti

Richard L. Blatti
Professor and Director

Department of Neuroscience

Wexner Medical Center

Randy J. Nelson, Ph.D.
Dr. John D. and E. Olive Brumbaugh Chair in Brain Research and Teaching
Department Of Neuroscience
Professor and Chair
4084 Graves Hall
333 West 10th Avenue
Columbus, OH 43210
Phone: 614-688-8327
Fax: 614-688-8742
Email: Randy.nelson@osumc.edu

12 May 2013

Dr. Cynthia Clopper,
COG Associate Director,
Center for Cognitive and Brain Sciences

Dear Cynthia,

I am writing to express our support of the Graduate Interdisciplinary Specialization in Cognitive and Brain Sciences to be administered by the Center for Cognitive and Brain Sciences. The proposed program represents an additional opportunity for students at Ohio State to explore a much needed level of neuroscience. Given the importance of neuroanatomy in imaging studies, I hope that you strongly recommend our neuroanatomy course in the Neuroscience Graduate Studies Program. Another opportunity for your students to expand their translational education would be to encourage your students to take the Neurobiology of Disease course (NS8050) as an elective.

In order to continue to consolidate Neuroscience at OSU, I hope that you include a representative from the Department of Neuroscience for the GIS administration. We want to avoid unnecessary duplication of efforts in training in Neuroscience. I look forward to strengthening our future collaborations future.

Cordially,

Randy J. Nelson, Brumbaugh Chair in Brain Research and Teaching
Professor and Chair, Department of Neuroscience
Distinguished Professor, Wexner College of Medicine

Department of Philosophy
350 University Hall
230 North Oval Mall
Columbus, OH 43210-1356
Phone (614) 292-2510
Fax (614) 292-7502

April 12, 2013

Cynthia G. Clopper
Associate Professor
Department of Linguistics
Ohio State University
CAMPUS

Dear Cynthia,

Thank you for sending me the proposal for a Graduate Interdisciplinary Specialization in Cognitive and Brain Sciences. (I should thank you twice—and apologize—since my delay in responding forced you to resend the materials and, even then, I missed your requested deadline.)

The Philosophy Department strongly and enthusiastically supports the establishment of the GIS in Cognitive and Brain Sciences. The program is well designed and extremely well timed. I believe that many in our Philosophy Ph.D. program will pursue this specialization and, in doing so, they will enhance their education, and that of the students from other Ph.D. programs with whom they interact in the program.

Please let me know if there is anything else that the Philosophy Department can do to help to advance this project.

Sincerely,

Donald C. Hubin, Professor & Chair
Department of Philosophy
email: hubin.1@osu.edu

THE OHIO STATE UNIVERSITY

Department of Psychology

225 Psychology Building
1835 Neil Avenue
Columbus, OH 43210

Phone 614- 292-8185:
psy.ohio-state.edu

June 20, 2013

Cynthia G. Clopper
COG Associate Director,
Center for Cognitive and Brain Sciences
Associate Professor
Department of Linguistics
CAMPUS

Dear Dr. Clopper,

This letter expresses the Department of Psychology's support for the proposed Graduate Interdisciplinary Specialization in Cognitive and Brain Sciences. The proposed program creates a valuable opportunity for our Psychology graduate students to take advantage of the newly integrated resources in Cognitive Science and Neuroimaging. Thus, we endorse this proposal and look forward to be of assistance in any way possible.

Sincerely,

Richard E. Petty
Distinguished University Professor and Chair
Department of Psychology

THE OHIO STATE UNIVERSITY

College of Engineering

122 Hitchcock Hall
2070 Neil Avenue
Columbus, OH 43210

(614) 292-2851 Phone
(614) 292-9379 Fax

engineering.osu.edu

2 August 2013

Dr. Cynthia Clopper
COG Associate Director, Center for Cognitive and Brain Sciences
Associate Professor, Linguistics

Dear Dr. Clopper,

This letter expresses the College of Engineering's support for the proposed Graduate Interdisciplinary Specialization in Cognitive and Brain Sciences that will be administered by the Center for Cognitive and Brain Sciences. The proposed program should be of interest to a number of our graduate students in a wide range of disciplines.

Sincerely,

Edward B. McCaul, Jr., PhD, PE
Assistant Dean for Curriculum and Assessment
College of Engineering

THE OHIO STATE UNIVERSITY
WEXNER MEDICAL CENTER

Charles J. Lockwood, MD, MHCM
Dean, College of Medicine
Vice President for Health Sciences
Professor, Obstetrics and Gynecology
Leslie H. and Abigail S. Wexner Dean's Chair in Medicine

254 Meiling Hall
370 West 9th Avenue
Columbus, OH 43210
Phone: 614.292.2600/ Fax 614.292.4284

August 5, 2013

Dr. Cynthia Clopper
Associate Director, Center for Cognitive and Brain Sciences
Associate Professor, Department of Linguistics

Dear Dr. Clopper:

I am writing to express the support of the College of Medicine for the proposed Graduate Interdisciplinary Specialization in Cognitive and Brain Sciences. We look forward to contributing to interdisciplinary graduate education in cognitive and neuroscience and building stronger connections across Colleges in neuroscience research.

Sincerely,

Charles J. Lockwood, M.D.
Dean, College of Medicine
Vice President for Health Sciences
Professor, Obstetrics and Gynecology
Leslie H. and Abigail S. Wexner Dean's Chair in Medicine