### Cognitive Science

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**Website:** http://cogsci.cas2.lehigh.edu/  
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**Williams Hall, 31 Williams Drive**

### Core Faculty

- Kate Arrington, Ph.D. (Department of Psychology); Mark Bickhard, Ph.D. (Departments of Philosophy and Psychology); Amanda Brandone, Ph.D. (Department of Psychology); John Gatewood, Ph.D. (Department of Sociology and Anthropology); Jeffrey D. Hefflin, Ph.D. (Department of Computer Science and Engineering); Almut Hupbach, Ph.D. (Department of Psychology); Kiri Lee, Ph.D. (Department of Modern Languages and Literatures); Barbara Malt, Ph.D. (Department of Psychology); Jessecah Marsh, Ph.D. (Department of Psychology); Hector Munoz-Avila, Ph.D. (Department of Computer Science and Engineering); Padraig O'Seaghdha, Ph.D. (Department of Psychology); Dominic Packer, Ph.D. (Department of Psychology); and Aladdin Yaqub, Ph.D. (Department of Philosophy)

The mission of the Cognitive Science Program is to advance the interdisciplinary study of mind, in all its aspects, through research and teaching. The interdisciplinary study of cognition in the fields of psychology, linguistics, computer science, philosophy, anthropology, and neuroscience provides excellent preparation for life in the age of information. The program aims to instill in students a solid grasp of the intellectual problems, frameworks, and methodologies currently available; to provide experience exploring these through guided research; and to foster the desire to create, develop, and disseminate new knowledge. With this foundation, students are well prepared for a wide variety of careers or for further graduate or professional studies in Cognitive Science or any of the contributing disciplines.

We offer an undergraduate major in Cognitive Science, an undergraduate minor, a graduate minor, and a graduate certificate. A Cognitive Science major is easy to combine with a second major in the humanities, natural sciences, social sciences, or computer science.

### B.A. IN COGNITIVE SCIENCE

The B.A. with a major in Cognitive Science requires a minimum of 13 courses. All majors take COGS 007, an introduction to cognitive science. Core courses in cognitive psychology, philosophy, artificial intelligence, and cognitive neuroscience, and collaterals in computer science and math. In a second tier, majors complete at least five electives selected from three thematic tracks. A capstone integration occurs in the required two-semester senior thesis (COGS 301 and COGS 399), in which students focus on a topic of their choice spanning at least two cognitive science sub-disciplines.

### Collateral Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSE 001</td>
<td>Breadth of Computing</td>
<td>2</td>
</tr>
<tr>
<td>CSE 002</td>
<td>Fundamentals of Programming</td>
<td>2</td>
</tr>
<tr>
<td>MATH 021</td>
<td>Calculus I (preferred)</td>
<td>4</td>
</tr>
<tr>
<td>or MATH 051</td>
<td>Survey of Calculus I</td>
<td></td>
</tr>
</tbody>
</table>

### Introductory Course

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>COGS 007</td>
<td>Introduction to Cognitive Science</td>
<td>4</td>
</tr>
</tbody>
</table>

### Disciplinary Core Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>COGS/PSYC 117</td>
<td>Cognitive Psychology</td>
<td>4</td>
</tr>
<tr>
<td>COGS/PSYC 176</td>
<td>Cognitive Neuroscience</td>
<td>4</td>
</tr>
<tr>
<td>COGS/PHIL 250</td>
<td>Philosophy of Mind</td>
<td>4</td>
</tr>
<tr>
<td>COGS/CSE 327</td>
<td>Artificial Intelligence Theory and Practice</td>
<td>3</td>
</tr>
</tbody>
</table>

### Major Electives

Select a minimum of five of the following, with at least one course from each of the three tracks:

<table>
<thead>
<tr>
<th>Track</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artificial Intelligence and Formal Models</td>
<td>COSE 017 Programming and Data Structures, CSE 042 Game Design, CSE/MATH 261 Discrete Structures, CSE 262 Programming Languages, CSE 318 Introduction to the Theory of Computation, CSE 326 Pattern Recognition, CSE 335 Topics on Intelligent Decision Support Systems</td>
</tr>
<tr>
<td>Cognition and Neuroscience</td>
<td>COGS/ANTH/MLL Introduction to Linguistics, ANTH 145 Human Evolution, BIOS 121 Biology Core III: Integrative &amp; Comparative Biology, BIOS 276 Central Nervous System and Behavior, BIOS 277 Experimental Neuroscience Laboratory, BIOS 365 Neurobiology of Sensory Systems, BIOS 366 Diseases of the Nervous System, BIOS 382 Endocrinology of Behavior, BIOS 385 Synapses, Plasticity and Learning, PSYC 358 Inside the Infant Mind, PSYC 347 Cognitive Neuroscience of Memory, PSYC 369 Memory Under Construction, PSYC 377 Attention and Attentional Failures</td>
</tr>
</tbody>
</table>

### Senior Thesis

<table>
<thead>
<tr>
<th>Thesis</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>COGS/ANTH/MLL Introduction to Linguistics</td>
<td>16-20</td>
</tr>
</tbody>
</table>
COGS 301 Senior Project in Cognitive Science: Proposal
COGS 399 Senior Project in Cognitive Science: Thesis

Total Credits 43-47

1. Additional coursework in mathematics is strongly recommended (particularly CSE 261/MATH 261). Also recommended are the non-major courses ANTH 011, ANTH 012, COGS 140 and PSYC 001 which provide valuable background. These courses may fulfill Social Science Distribution requirements. A lower level Philosophy course is a prerequisite for COGS/PHIL 250.

2. Students intending to take behavioral neuroscience BIOS courses in the Cognition and Neuroscience track need to take the prerequisite sequence CHM 030 or CHM 040, and BIOS 041 with their associated laboratory courses, by the end of the sophomore year.

3. After completing the introductory and the core courses, students pursue their individual interests in their selections of major electives. The required senior thesis provides a capstone integration through an individual research project spanning at least two cognitive science sub-disciplines.

RECOMMENDED TIMING OF COURSES

<table>
<thead>
<tr>
<th>First Year</th>
<th>CR</th>
<th>1st Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>COGS 007 (Spring)</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>CSE 001</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>CSE 002</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>MATH 021 or 051</td>
<td>4</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>11-12</td>
</tr>
<tr>
<td>Second Year</td>
<td>CR</td>
<td></td>
</tr>
<tr>
<td>COGS 117</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>COGS 176</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>1 major elective¹</td>
<td>3-4</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>13-15</td>
</tr>
<tr>
<td>Third Year</td>
<td>CR</td>
<td></td>
</tr>
<tr>
<td>COGS 250</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>COGS 327</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2 major electives¹</td>
<td>6-8</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>12-14</td>
</tr>
<tr>
<td>Fourth Year</td>
<td>CR</td>
<td></td>
</tr>
<tr>
<td>COGS 301 &amp; COGS 399 (thesis)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>2 major electives¹</td>
<td>6-8</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td>Total Credits: 48-53</td>
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</tbody>
</table>

¹ Students must complete a minimum of five major electives totaling at least 16 credits with at least one course from each of the three tracks.

MINOR IN COGNITIVE SCIENCE

Minor Declaration Form (http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/cognitivescience/2015-2016Cognitive_Science_Minor_Declaration_Form.pdf)

The undergraduate minor in Cognitive Science requires five courses:

COGS 007 Introduction to Cognitive Science 4

Four additional courses selected from among the major’s core courses and major electives, with at least two of these being Disciplinary Core Courses 12-16

Total Credits 16-20

PROGRAM HONORS

Majors seeking to graduate with honors in cognitive science must have a 3.30 GPA in the major, a 3.30 GPA overall, and complete a high quality senior thesis. Theses submitted for honors will be evaluated by a committee of at least three cognitive science faculty.

FOR GRADUATE STUDENTS

There are two concentrations in Cognitive Science available for post-baccalaureate students: a Graduate Minor and a Graduate Certificate. The minor is intended for students currently enrolled in a degree-granting graduate program at Lehigh University. By contrast, the certificate is intended for non-degree students.

Graduate Minor in Cognitive Science

The minor gives graduate students who are enrolled in Lehigh University degree programs, such as computer science or psychology, an opportunity to develop expertise at the intersection of information processing by humans and intelligent machines. Graduate students investigating mental processes or applications such as artificial intelligence or educational technology are encouraged to participate, with the approval of an advisor in their major program, by contacting the Director of the Cognitive Science Program. On completion of the program, the Director of the Cognitive Science Program will issue a letter to the student certifying that he or she has met the requirements of the minor.

The Graduate Minor requires five graduate level courses.

COGS/PSYC 423 Foundations of Cognitive Science 3

Four electives from the list below (or approved substitutions). ¹ 12-16

Computer Science

CSE 348 AI Game Programming
CSE 426 Pattern Recognition
CSE 428 Semantic Web Topics
CSE 431 Intelligent Agents
CSE 435 Topics on Intelligent Decision Support Systems
CSE 447 Data Mining
CSE 460 Mobile Robotics

Psychology

PSYC 402 Developmental Psychology
PSYC 403 Cognitive Psychology
PSYC 406 Social Cognition
PSYC 443 Seminar In Language Acquisition
PSYC 448 Seminar in Psychology of Language
PSYC 464 Naive Realism in Social Judgement
PSYC 476 Seminar In Cognition
PSYC/COGS 478 Ontological Psychology
PSYC 480 Seminar in Cognitive Development

Philosophy ²

PHIL/COGS 250 Philosophy of Mind
PHIL 260 Philosophy Of Language

Sociology and Anthropology

ANTH 376 Culture and the Individual

Total Credits 15-19

¹ At least two of the four electives must be taken outside the student’s home department. Special topics courses with a cognitive science emphasis may also count toward the minor, with the approval of the Cognitive Science Program Director. Courses taken toward the minor may also fulfill requirements of the student’s major program, with the approval of the major department.

² Note: These particular 200-level courses may be taken by graduate students.

Graduate Certificate in Cognitive Science

This concentration is intended for people working in technology-related businesses and other qualified individuals with an interest in cognitive science. The purpose of the certificate program is to provide non-degree post-baccalaureate students an interdisciplinary perspective on human and machine intelligence.

The Graduate Certificate requires four graduate level courses.

COGS 423 Foundations of Cognitive Science 3

Three electives from the list below. ¹ 9-12

Computer Science
COGS 007 Introduction to Cognitive Science 4 Credits
What is a mind? How is the mind related to the brain? Could we make an artificial mind? Issues concerning knowledge representation and intelligence in minds and computers as investigated by psychologists, philosophers, linguists, neuroscientists, and researchers in artificial intelligence.
Attribute/Distribution: SS

COGS 117 (PSYC 117) Cognitive Psychology 4 Credits
The architecture and dynamics of the human mind: How we acquire knowledge through perception, represent and activate it in memory, and use it to communicate, make decisions, solve problems, and reason creatively. May not be taken pass/fail.
Prerequisites: PSYC 001 or COGS 007
Attribute/Distribution: SS

COGS 140 (ANTH 140, MLL 140) Introduction to Linguistics 4 Credits
Relationship between language and mind; formal properties of language; language and society; how languages change over time. May not be taken pass/fail.
Attribute/Distribution: SS

COGS 161 Supervised Research 2-4 Credits
Research under the direct supervision of a faculty member in the cognitive science program. Students must arrange the particular project with a faculty member before enrolling. Consent of program director required.
Repeat Status: Course may be repeated.
Attribute/Distribution: ND

COGS 176 (PSYC 176) Cognitive Neuroscience 4 Credits
Perception and cognitive neuroscience as the link between mental processes and their biological bases. Visual and auditory perception; the control of action; neuropsychological syndromes of perception, language, memory, and thought; neural network (connectionist) models of mental processes. May not be taken pass/fail.
Prerequisites: PSYC 001 or COGS 007
Attribute/Distribution: NS

COGS 250 (PHIL 250) Philosophy of Mind 4 Credits
An exploration of the mind-body problem. Are the body and mind distinct substances (dualism); or is there only body (materialism); or only mind (idealism)? Other views to be considered include behaviorism (the view that behavior can be explained without recourse to mental states), and the view that the mind is a complex computer. Must have completed one HU course in Philosophy.
Attribute/Distribution: HU

COGS 301 Senior Project in Cognitive Science: Proposal 3 Credits
Senior year integration of the material from cognitive science begins with the proposal of a substantial review or research project spanning at least two cognitive science disciplines under the direction of a Cognitive Science faculty member. Consent of program director required.
Attribute/Distribution: ND

COGS 327 (CSE 327) Artificial Intelligence Theory and Practice 3 Credits
Introduction to the field of artificial intelligence: Problem solving, knowledge representation, reasoning, planning and machine learning. Use of AI systems or languages. Advanced topics such as natural language processing, vision, robotics, and uncertainty. CSE 261 is recommended.
Prerequisites: (CSE 001 and CSE 002) or CSE 017
COGS 361 Independent Research 2-4 Credits
Independent research in cognitive science with a faculty advisor. Students must arrange the particular project with a faculty advisor before enrolling. Consent of program director required.
Repeat Status: Course may be repeated.
Attribute/Distribution: ND

COGS 399 Senior Project in Cognitive Science: Thesis 3 Credits
Research during senior year culminating in senior thesis advised by a member of the Cognitive Science faculty. Execution and written report of project proposed and approved in COGS 301. Theses submitted for honors will be evaluated by a committee of at least three cognitive science faculty. Consent of program director required.
Prerequisites: COGS 301
Attribute/Distribution: ND
COGS 405 Individual Study in Cognitive Science 1-6 Credits
Study of a topic not covered in regular course offerings. By arrangement with a consulting faculty member. Consent of program director required.
Repeat Status: Course may be repeated.

COGS 423 (PSYC 423) Foundations of Cognitive Science 3 Credits
Survey of fundamental theory and methodologies from artificial intelligence, linguistics, cognitive psychology, philosophy, and neuroscience, as well as salient research problems such as knowledge acquisition and representation, natural language processing, skill acquisition, perception and action, and the philosophical question of intentionality.

COGS 478 (PSYC 478) Ontological Psychology 3 Credits
Principles and constraints for modeling psychological phenomena. Representation; perception; memory; knowing; learning; emotions; consciousness; language; rationality.