Cognitive Science

Program Director: Barbara Malt, Ph.D. (Stanford) (https://psychology.cas2.lehigh.edu/content/bcm0)
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Website: http://cogsci.cas2.lehigh.edu/
Supported by the Office of Interdisciplinary Programs 610-758-3996; incasip@lehigh.edu
Williams Hall, 31 Williams Drive

Core Faculty
Kate Arrington, Ph.D. (Psychology); Mark Bickhard, Ph.D. (Philosophy and Psychology); Amanda Brandone, Ph.D. (Psychology); Nancy Carlisle, Ph.D. (Psychology); Jeffrey Heflin, Ph.D. (Computer Science and Engineering); Almut Hupbach, Ph.D. (Psychology); Kiri Lee, Ph.D. (Modern Languages and Literatures); Barbara Malt, Ph.D. (Psychology); Jessere Marsh, Ph.D. (Psychology); Hector Munoz-Avila, Ph.D. (Computer Science and Engineering); Padraig O’Seaghhdha, Ph.D. (Psychology); Dominic Packer, Ph.D. (Psychology); and Aladdin Yaqub, Ph.D. (Philosophy)

The mission of the Cognitive Science Program is to advance the study of minds and brains, real or artificial, in all their aspects, through research and teaching. This interdisciplinary field, encompassing 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 and disseminate new knowledge. With this foundation, students are well prepared for a wide variety of careers in technology, human thought and behavior, or their interaction, and for graduate 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.

Professor. Hector Munoz-Avila, PHD (Technische Universität Kaiserslautern)
Associate Professors. Jeffrey D. Heflin, PHD (University of Maryland College Park); Padraig G O’Seaghhdha, PHD (University of Toronto)

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. They also complete a course in research methods or tools. Students then pursue their individual interests by completing at least five electives from three tracks. A capstone integration occurs in the required two-semester senior project (COGS 301 and COGS 302, or, for Honors, COGS 391 and COGS 392), in which students focus on a topic of their choice spanning at least two cognitive science sub-disciplines.

Additional coursework in affiliated disciplines is recommended, to be selected in consultation with the major advisor and dependent upon anticipated career path. These courses may fulfill college distribution requirements. Note: A number of courses have pre-requisites. Students considering this major should check pre-requisites and plan accordingly. A preliminary meeting with the program director may be useful.

Collateral Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>CSE 001</td>
<td>Breadth of Computing</td>
</tr>
<tr>
<td>or CSE 012</td>
<td>Survey of Computer Science</td>
</tr>
<tr>
<td>CSE 002</td>
<td>Fundamentals of Programming</td>
</tr>
<tr>
<td>MATH 021</td>
<td>Calculus I</td>
</tr>
</tbody>
</table>

Major Electives

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

Senior Project

Select one course in research methods and tools from the following: PSYC 110 Statistical Analysis of Behavioral Data; PSYC 210 Experimental Research Methods and Laboratory (pre-requisite PSYC 110); ECO 045 Statistical Methods; SOAN 111 Research Methods and Data Analysis; CSE 160 Introduction to Data Science; BIOS 130 Biostatistics

Introdutory Course

COGS 007 Introduction to Cognitive Science

Discipliary Courses

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

Artificial Intelligence and Formal Models

<table>
<thead>
<tr>
<th>Course</th>
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</thead>
<tbody>
<tr>
<td>CSE 017</td>
<td>Programming and Data Structures</td>
</tr>
<tr>
<td>CSE 042</td>
<td>Game Design</td>
</tr>
<tr>
<td>CSE 140</td>
<td>Foundations of Discrete Structures and Algorithms</td>
</tr>
<tr>
<td>CSE 262</td>
<td>Programming Languages</td>
</tr>
<tr>
<td>CSE 318</td>
<td>Introduction to the Theory of Computation</td>
</tr>
<tr>
<td>CSE 326</td>
<td>Fundamentals of Machine Learning</td>
</tr>
<tr>
<td>CSE 331</td>
<td>User Interface Systems and Techniques</td>
</tr>
<tr>
<td>CSE 335</td>
<td>Topics on Intelligent Decision Support Systems</td>
</tr>
<tr>
<td>CSE 337</td>
<td>Reinforcement Learning</td>
</tr>
<tr>
<td>CSE 347</td>
<td>Data Mining</td>
</tr>
<tr>
<td>CSE 348</td>
<td>AI Game Programming</td>
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<tr>
<td>CSE 360</td>
<td>Introduction to Mobile Robotics</td>
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<tr>
<td>CSE 428</td>
<td>Semantic Web Topics</td>
</tr>
<tr>
<td>CSE 431</td>
<td>Intelligent Agents</td>
</tr>
<tr>
<td>PHIL/MATH 114</td>
<td>Symbolic Logic</td>
</tr>
<tr>
<td>PHIL/MATH 214</td>
<td>Topics in Philosophical Logic</td>
</tr>
<tr>
<td>PHIL 265</td>
<td>Philosophy of Mathematics</td>
</tr>
<tr>
<td>PHIL/MATH 303</td>
<td>Mathematical Logic</td>
</tr>
<tr>
<td>MATH 304</td>
<td>Axiomatic Set Theory</td>
</tr>
<tr>
<td>MATH 329</td>
<td>Computability Theory</td>
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Cognition, Culture, and Meaning

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<tbody>
<tr>
<td>ANTH 376</td>
<td>Culture and the Individual</td>
</tr>
<tr>
<td>COGS/ANTH/MLL 140</td>
<td>Introduction to Linguistics</td>
</tr>
<tr>
<td>CSE 252</td>
<td>Computers, the Internet, and Society</td>
</tr>
<tr>
<td>PHIL 128</td>
<td>Philosophy Of Science</td>
</tr>
<tr>
<td>PHIL 135</td>
<td>Modern Philosophy</td>
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or MATH 051 Survey of Calculus I
degree programs, such as computer science, psychology, and

The minor gives students enrolled in Lehigh University graduate
courses. Theses submitted

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<th>COGS/PSYC 423</th>
<th>Foundations of Cognitive Science</th>
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<td>Electives</td>
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</table>

**Total Credits**

| Total Credits | 15-19 |

**FOR GRADUATE STUDENTS**

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**Graduate Minor in Cognitive Science**

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The Graduate Minor requires five graduate level courses.

**MINOR IN COGNITIVE SCIENCE**

The undergraduate minor in Cognitive Science requires five courses:

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<th>COGS 007</th>
<th>Introduction to Cognitive Science</th>
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Four additional courses selected from among the major's core courses and major electives, with at least two of these being Disciplinary Core Courses.

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CSE 426  Pattern Recognition  
CSE 428  Semantic Web Topics  
CSE 431  Intelligent Agents  
CSE 435  Topics on Intelligent Decision Support Systems  
CSE 437  Reinforcement Learning and Markov Decision Processes  
CSE 447  Data Mining  
CSE 460  Mobile Robotics  

Psychology  
PSYC 307  Higher Order Cognition  
PSYC 313  Person Perception  
PSYC 314  Social Cognition  
PSYC 317  Psychology of Emotion  
PSYC 320  Psychology of Language  
PSYC 321  Language Development  
PSYC 347  Cognitive Neuroscience of Memory  
PSYC 351  Children’s Thinking  
PSYC 358  Inside the Infant Mind  
PSYC 362  Cognition in Practice & Policy  
PSYC 365  Human Development in Cross-Cultural Perspective  
PSYC 369  Memory Under Construction  
PSYC 377  Attention and Attentional Failures  
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  
PHIL/COGS 250  Philosophy of Mind  
PHIL 260  Making Sense of Words  

Sociology and Anthropology  
ANTH 376  Culture and the Individual  

Total Credits  12-15

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

Courses

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.

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 1-3 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 194 Special Topics in Cognitive Science 2-4 Credits
Topics vary from semester to semester. Topics are addressed at an intermediate level. Previous course work in cognitive science and consent of faculty sponsor is required.
Repeat Status: Course may be repeated.

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-designated course in Philosophy at 100-level or higher.
Attribute/Distribution: HU

COGS 300 Apprentice Teaching 1-4 Credits

COGS 301 Senior Project in Cognitive Science: Proposal 1-3 Credits
For students not intending to apply for program Honors. Background reading and preparation of a short written proposal are conducted in the first semester in consultation with a faculty adviser. Consent of program director and project adviser required.

COGS 302 Senior Project in Cognitive Science: Execution 1-3 Credits
For students not intending to apply for program Honors. Execution of the project is conducted in the second semester in consultation with a faculty adviser. A poster presentation will be given at the end of the semester. Consent of program director and project adviser required.
Prerequisite: COGS 301 and consent of the program director.

COGS 307 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. May not be taken pass/fail. 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 391 Honors Thesis in Cognitive Science: Proposal 1-4 Credits
For students with 3.3 or higher GPA overall and in major by the spring of the junior year, who want to undertake a research project with the potential to result in program Honors. Literature review and preparation of a written proposal are conducted in the first semester in consultation with a faculty adviser. An oral presentation will be given at end of the semester. Consent of program director and project adviser required.
COGS 392 Honors Thesis in Cognitive Science: Project Execution and Thesis 1-4 Credits
For students with 3.3 or higher GPA overall and in major by the spring of the junior year, who want to undertake a research project with the potential to result in program Honors. Project execution and preparation of the written report is conducted in the second semester in consultation with a faculty adviser. An oral presentation will be given at the end of the semester. Theses will be evaluated for Honors by three cognitive science faculty.
Prerequisites: COGS 391

COGS 394 Special Topics in Cognitive Science 3-4 Credits
Topics vary from semester to semester. Topics are presented at an advanced level.
Repeat Status: Course may be repeated.

COGS 399 Senior Project in Cognitive Science: Thesis 1-3 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. Students must enroll for a total of three credits which may be split between the sections of a primary and secondary adviser. Theses submitted for honors will be evaluated by a committee of at least three cognitive science faculty.
Prerequisite: COGS 301 and consent of the program director.
Repeat Status: Course may be repeated.
Prerequisites: COGS 301

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.