Cognitive Science

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Core Faculty
Kate Arrington, Ph.D. (Psychology); Mark Bickhard, Ph.D. (Philosophy and Psychology); Amanda Brandone, Ph.D. (Psychology); Nancy Carlisle, Ph.D. (Psychology); John Gatewood, Ph.D. (Sociology and Anthropology); Jeffrey Heflin, Ph.D. (Computer Science and Engineering); Almut Hubbach, Ph.D. (Psychology); Kiri Lee, Ph.D. (Modern Languages and Literatures); Barbara Malt, Ph.D. (Psychology); Jessicac Marsh, Ph.D. (Psychology); Hector Munoz-Avila, Ph.D. (Computer Science and Engineering); Padraig O'Seaghdha, 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, or 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.

Associate Professor.  Padraig O'Seaghdha, 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 adviser 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. Click here for Cognitive Science Major Declaration Form. (http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/cognitivescience/COGS_Major_Plan_2017-18.pdf)

Collateral Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<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>
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MATH 021  Calculus I
or MATH 051  Survey of Calculus I

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

Introductory Course

COGS 007  Introduction to Cognitive Science

Disciplinary Core Courses

COGS/PSYC 117  Cognitive Psychology
COGS/PSYC 176  Cognitive Neuroscience
COGS/PHIL 250  Philosophy of Mind
COGS/CSE 327  Artificial Intelligence Theory and Practice

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

Senior Project

COGS 301 & COGS 302  Senior Project in Cognitive Science: Proposal and Senior Project in Cognitive Science: Execution

or


MAJOR ELECTIVES

Artificial Intelligence and Formal Models

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<tr>
<th>Course</th>
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<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/MATH 261</td>
<td>Discrete Structures</td>
</tr>
<tr>
<td>CSE 262</td>
<td>Programming Languages</td>
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<tr>
<td>CSE 318</td>
<td>Introduction to the Theory of Computation</td>
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<tr>
<td>CSE 326</td>
<td>Fundamentals of Machine Learning</td>
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<tr>
<td>CSE 331</td>
<td>User Interface Systems and Techniques</td>
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<tr>
<td>CSE 335</td>
<td>Topics on Intelligent Decision Support Systems</td>
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<tr>
<td>CSE 337</td>
<td>Reinforcement Learning</td>
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<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>
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<tr>
<td>PHIL/MATH 114</td>
<td>Symbolic Logic</td>
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<tr>
<td>PHIL/MATH 214</td>
<td>Topics in Philosophical Logic</td>
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<tr>
<td>PHIL 265</td>
<td>Philosophy of Mathematics</td>
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<tr>
<td>PHIL/MATH 303</td>
<td>Mathematical Logic</td>
</tr>
<tr>
<td>MATH 304</td>
<td>Axiomatic Set Theory</td>
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<tr>
<td>MATH 329</td>
<td>Computability Theory</td>
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Cognition, Culture, and Meaning

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<tr>
<td>ANTH 376</td>
<td>Culture and the Individual</td>
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<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>
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<tr>
<td>PHIL 135</td>
<td>Modern Philosophy</td>
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educational technology, an opportunity to develop expertise at the
degree programs, such as computer science, psychology, and

The minor gives students enrolled in Lehigh University graduate

Graduate Minor in Cognitive Science

FOR GRADUATE STUDENTS

Theses submitted for honors will be
have a 3.30 GPA in the major, a 3.30 GPA overall, and complete
Majors seeking to graduate with honors in cognitive science must

PROGRAM HONORS

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. The certificate is
intended for non-degree students.

Graduate Minor in Cognitive Science

The minor gives students enrolled in Lehigh University graduate
degree programs, such as computer science, psychology, and
educational technology, an opportunity to develop expertise at the
intersection of information processing by humans and intelligent
machines. Graduate students 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 she or he has met the requirements of
the minor.

The Graduate Minor requires five graduate level courses.

Required
COGS/PSYC 423  Foundations of Cognitive Science  3

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

CSE 331  User Interface Systems and Techniques
CSE 348  AI Game Programming
CSE 409  Theory of Computation
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
PSYC 402  Developmental Psychology
PSYC 403  Cognitive Psychology
PSYC 406  Social Cognition
PSYC 433  Cognitive Neuroscience Techniques
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

Total Credits  15-19

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. It provides non-degree post-baccalaureate
students with an interdisciplinary perspective on human and machine
intelligence.

The Graduate Certificate requires four graduate level courses: the
core course COGS/PSYC 423 and three electives. At least two of the
tree electives must be at the 400-level, and the three electives must
be spread over at least two departments.

COGS 423  Foundations of Cognitive Science  3
Three electives from the list below.  9-12

Computer Science
CSE 327  Artificial Intelligence Theory and Practice
CSE 331  User Interface Systems and Techniques
CSE 332  Multimedia Design and Development
CSE 335  Topics on Intelligent Decision Support Systems
CSE 348  AI Game Programming
CSE 426  Pattern Recognition
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 141 (ANTH 141, MLL 141) Introduction to Anthropology 4 Credits

The cultural contexts of the human mind; the question of what is the mind. May not be taken pass/fail.
Attribute/Distribution: SS

COGS 194 Special Topics in Cognitive Science 2-4 Credits

Course may be repeated.

COGS 200 Seminar in Cognitive Science 1-4 Credits

A faculty advisor is required. Consent of project advisor and program director required.

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 261 Cognitive Science 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 300 Apprentice Teaching 1-4 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 301 Senior Project in Cognitive Science: Proposal 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.
Prerequisites: COGS 301 and consent of the program director.

COGS 302 Senior Project in Cognitive Science: Execution 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. Consent of faculty sponsor is required.
Prerequisites: COGS 301
Attribute/Distribution: COGS 301

COGS 307 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 309 (PHIL 309) History of Philosophy 3 Credits

A historical survey of the main issues in the philosophy of mind.
Attribute/Distribution: PHIL

COGS 313 Person Perception 3 Credits

The building blocks of social perception and decision: the nature of people, their actions, and the roles they play in our lives.
Attribute/Distribution: PSYC

COGS 314 Social Cognition 3 Credits

The social mind and 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 317 Psychology of Emotion 3 Credits

The study of emotional experience and its biological bases. May not be taken pass/fail.
Prerequisites: PSYC 313 or PSYC 314
Attribute/Distribution: PSYC

COGS 320 Psychology of Language 3 Credits

An 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 321 Language Development 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 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 376 Culture and the Individual 3 Credits

An introduction to the study of culture and the mind. May not be taken pass/fail.
Attribute/Distribution: ANTH

COGS 391 Honors Thesis in Cognitive Science: Proposal 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.

Total Credits 12-15

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.
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, 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 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

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 301 Senior Project in Cognitive Science: Proposal 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. Consent of program director and project adviser required.
Prerequisites: COGS 301 and consent of the program director.

COGS 302 Senior Project in Cognitive Science: Execution 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. Consent of program director and project adviser required.
Prerequisites: COGS 301
Attribute/Distribution: COGS 301

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 391 Honors Thesis in Cognitive Science: Proposal 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 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.