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 at the interfaces of technology, minds, brains, and behavior, and for graduate study in Cognitive Science or any of the contributing disciplines.

We offer undergraduate B.A. and B.S. degrees in Cognitive Science, an undergraduate 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.

Professors. Catherine M. Arrington, PhD (Michigan State University); Barbara C. Malt, PhD (Stanford University); Hector Munoz-Avila, PhD (Technische Universitat Kaiserslautern); Padraig O'Seaghdha, PhD (University of Toronto); Dominic J. Packer, PhD (University of Toronto)

Associate Professors. Amanda C. Brandone, PhD (University of Michigan); Jeffrey D. Hefflin, PhD (University of Maryland, College Park); Almut Hubbach, PhD (Universitat Trier)

Assistant Professor. Nancy B. Carlisle, PhD (Vanderbilt University, Peabody College)

B.A. IN COGNITIVE SCIENCE

The B.A. in Cognitive Science requires a minimum of 14 courses. All majors take COGS 007, an introduction to cognitive science, plus core courses in cognitive psychology, philosophy, artificial intelligence, and cognitive neuroscience, and collaborates in computer science. They also complete a course in research methods or tools. Students then pursue their individual interests by completing at least five electives from across 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 major 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

| CSE 007 | Introduction to Programming |
| CSE 003 | Introduction to Programming, Part A |
| CSE 004 | Introduction to Programming, Part B |
| CSE 140 | Foundations of Discrete Structures and Algorithms |
| PSYC 001 | Introduction to Psychology |
| PSYC 201 | Research Methods and Data Analysis I |
| PSYC 202 | Research Methods and Data Analysis II |
| PSYC 045 | Statistical Methods |
| SOAN 111 | Research Methods and Data Analysis; CSE 160 Introduction to Data Science |
| BIOS 130 | Biostatistics |

Introductory Course: 1

COGS 007 Introduction to Cognitive Science 15

| COGS/PSYC 117 | Cognitive Psychology |
| COGS/CSE 127 or COGS/CSE 327 | Survey of Artificial Intelligence |
| COGS/PSYC 176 | Cognitive Neuroscience |
| COGS/PHIL 250 | Philosophy of Mind |

Senior Project: 6-8

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

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

Senior Project: 6-8

Honors Thesis in Cognitive Science: Proposal and Honors Thesis in Cognitive Science: Project Execution and Thesis Credit may be split between two advisers but must total 3 per semester.

| COGS 007 | Introduction to Cognitive Science |
| COGS/PSYC 117 | Cognitive Psychology |
| COGS/CSE 127 or COGS/CSE 327 | Survey of Artificial Intelligence |
| COGS/PSYC 176 | Cognitive Neuroscience |
| COGS/PHIL 250 | Philosophy of Mind |

Major Electives: 15-20

B.S. IN COGNITIVE SCIENCE

The B.S.in Cognitive Science entails additional courses beyond those in the B.A. to provide both additional breadth and depth. It requires a minimum of 20 courses. All majors take COGS 007, an introduction to cognitive science, plus core courses in cognitive psychology, philosophy, artificial intelligence, and cognitive neuroscience, and collaborates in computer science, math, and social science. They also complete two courses in research methods or tools and at least one semester of supervised research. Students then pursue their individual interests by choosing a concentration area from among three tracks and completing at least six electives with a minimum of four in the concentration area. 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 major 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: 1

| CSE 001 | Breadth of Computing |
| CSE 012 | Survey of Computer Science |
| CSE 002 | Calculus I |
| MATH 051 | Survey of Calculus I |
| MATH 075 | Calculus I, Part A |
| MATH 076 | Calculus I, Part B |
| CSE 140 | Foundations of Discrete Structures and Algorithms |
| PSYC 001 | Introduction to Psychology |
| PSYC 201 | Research Methods and Data Analysis I |
| PSYC 202 | Research Methods and Data Analysis II |
| PSYC 045 | Statistical Methods |
| SOAN 111 | Research Methods and Data Analysis |
| BIOS 130 | Biostatistics |

Two courses in research methods and tools.

For Artificial Intelligence and Formal Models Concentration:
CSE 160 & MATH 231 & or ECO 045

Introduction to Data Science and Probability and Statistics
or Statistical Methods

For all other concentrations:

PSYC 201 & PSYC 202

Research Methods and Data Analysis I
and Research Methods and Data Analysis II

Introductory Course

COGS 007

Introduction to Cognitive Science

Disciplinary Core Course

COGS/PSYC 117

COGS/PSYC 176

COGS/PHIL 250

COGS/CSE 327

COGS 183 or COGS 184

COGS/CSE 327

COGS/CSE 327

COGS/PHIL 250

COGS/CSE 327

COGS 183

Artificial Intelligence and Formal Models

CSE 017

Introduction to Programming and Data Structures

Cognition, Culture, and Meaning

COGS 140

Introduction to Linguistics

Cognitive Neuroscience

BIOS 121

Biology Core III: Integrative & Comparative Biology 1

Research Experience

COGS 161

Supervised Research 4

Senior Project

COGS 301 & COGS 302

Senior Project in Cognitive Science: Proposal and Senior Project in Cognitive Science: Execution

or COGS 391 & COGS 392


Total Credits

46-56

1 Collateral courses may count toward CAS distribution requirements where applicable.

2 BIOS 121 Biology Core III: Integrative & Comparative Biology pre-reqs: any CHM course that fulfills the pre-requisite for BIOS 041, plus BIOS 041 Biology Core I: Cellular and Molecular and BIOS 042 Biology Core I: Cellular and Molecular Lab. These are not part of the major but can count toward CAS Natural Science distribution.

3 Students are encouraged to take the required research credits beginning in the second year or even earlier. At least two semesters of relevant research experience (minimum 4 credits) are required for B.S. students prior to enrolling in COGS 391 Honors Thesis in Cognitive Science: Proposal and COGS 392 Honors Thesis in Cognitive Science: Project Execution and Thesis for their senior project.

4 May be repeated for credit.

MAJOR ELECTIVES

Artificial Intelligence and Formal Models

CSE 017

Programming and Data Structures

CSE 042

Game Design

CSE 140

Foundations of Discrete Structures and Algorithms

CSE 262

Programming Languages

CSE 318

Introduction to the Theory of Computation

CSE 326

Fundamentals of Machine Learning

CSE 331

User Interface Systems and Techniques

CSE 335

Topics on Intelligent Decision Support Systems

CSE 337

Reinforcement Learning

CSE 347

Data Mining

CSE 348

AI Game Programming

CSE 360

Introduction to Mobile Robotics

CSE 428

Semantic Web Topics

CSE 431

Intelligent Agents

PHIL/MATH 114

Symbolic Logic

PHIL/MATH 214

Topics in Philosophical Logic

PHIL 265

Philosophy of Mathematics

PHIL/MATH 303

Mathematical Logic

MATH 261

Discrete Structures

MATH 304

Axiomatic Set Theory

MATH 329

Computability Theory

Cognition, Culture, and Meaning

ANTH 376

Culture and the Individual

COGS/ANTH/MLL 140

Introduction to Linguistics

COMM 385

Seminar in Communication Issues

CSE 252

Computers, the Internet, and Society

PHIL 128

Philosophy Of Science

PHIL 135

Modern Philosophy

PHIL 139

Contemporary Philosophy

PHIL 220

Epistemology

PHIL 288

Topics in the Philosophy of Science

PHIL 260

Making Sense of Words

PSYC 307

Higher Order Cognition

PSYC 313

Person Perception

PSYC 314

Social Cognition

PSYC 320

Psychology of Language

PSYC/HMS 344

Health Care Reasoning and Decision Making

PSYC 351

Children's Thinking

PSYC/ES 357

Psychology of Environmental Issues

PSYC 358

Inside the Infant Mind

PSYC 362

Cognition in Practice & Policy

PSYC/GS 365

Human Development in Cross-Cultural Perspective

PSYC 384

Self and Identity

SOC/JOUR 135

Human Communication

Cognitive Neuroscience

ANTH 012

Human Evolution and Prehistory

ANTH 145

Human Evolution

BIOS 121

Biology Core III: Integrative & 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

BIOS 386

Genes and the Brain

PSYC 012

Introduction to Human Neuroscience

PSYC 316

The Talking World: Psychology and Neuroscience of Speaking

PSYC 347

Cognitive Neuroscience of Memory

PSYC 355

Seminar in Cognitive Neuroscience
PSYC 369  Memory Under Construction
PSYC 377  Attention and Attentional Failures
PSYC 433  Cognitive Neuroscience Techniques

MINOR IN COGNITIVE SCIENCE
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 with enrollment in COGS 391 Honors Thesis in Cognitive Science: Project Execution and Thesis. Theses submitted for honors will be evaluated by a committee of at least three cognitive science faculty.

GRADUATE CERTIFICATE IN COGNITIVE SCIENCE
 The graduate certificate provides the opportunity to develop an interdisciplinary perspective on human and machine intelligence. It is available to both enrolled and external students.

Students in Lehigh University graduate degree programs such as computer science, psychology, and instructional technology are encouraged to participate with the approval of an adviser in their major program. Non-degree, post-baccalaureate individuals with sufficient background to complete the coursework are also welcome to undertake the certificate. The certificate may be especially relevant to those working in technology-related fields. Interested individuals should contact the Director of the Cognitive Science Program. External candidates will also need to apply to the College of Arts and Sciences for non-degree graduate status.

The certificate will appear on the student’s transcript after submission of a signed completion form by the program director.

The Graduate Certificate requires four courses from the list below. At least two of the courses must be at the 400-level, and the four courses must be spread over at least two departments. For Lehigh degree candidates, at least three of the four courses must be outside the home department. The certificate will entail 12-16 credits.

ELECTIVES

Computer Science

CSE 327  Artificial Intelligence Theory and Practice
CSE 331  User Interface Systems and Techniques
CSE 332  Topics on Intelligent Decision Support Systems
CSE 335  Artificial Intelligence Theory and Practice
CSE 348  AI Game Programming
CSE 409  Theory of Computation
CSE 426  Fundamentals of Machine Learning
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 316  The Talking World: Psychology and Neuroscience of Speaking
PSYC 320  Psychology of Language
PSYC/HMS 344  Health Care Reasoning and Decision Making
PSYC 347  Cognitive Neuroscience of Memory
PSYC 351  Children's Thinking
PSYC 355  Seminar in Cognitive Neuroscience
PSYC 358  Inside the Infant Mind
PSYC 362  Cognition in Practice & Policy
PSYC 377  Attention and Attentional Failures
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

Philosophy

PHIL/COGS 250  Philosophy of Mind
PHIL 260  Making Sense of Words

Sociology and Anthropology

ANTH 376  Culture and the Individual

Total Credits  0

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 098  1-4 Credits
Repeat Status: Course may be repeated.

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 127 (CSE 127)  Survey of Artificial Intelligence  3 Credits
An introduction to artificial intelligence (AI) intended for non-majors. AI concepts, systems, and history. Credit will not be given for both CSE/COGS 127 and CSE/COGS 327.
Prerequisites: CSE 002 or CSE 004 or CSE 007

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 183 (PSYC 183) Cognitive Psychology Recitation 1 Credit
Research, discussion, and analysis of topics in cognitive psychology.
Prerequisites: PSYC 117 or COGS 117
Can be taken Concurrently: PSYC 117, COGS 117

COGS 184 (PSYC 184) Cognitive Neuroscience Recitation 1 Credit
Research, discussion, and analysis of topics in cognitive neuroscience.
Prerequisites: PSYC 176 or COGS 176
Can be taken Concurrently: PSYC 176, COGS 176

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.
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. Students must enroll for a total of three credits which may be split between the sections of a primary and secondary 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 presentation will be given at the end of the semester. Students must enroll for a total of three credits which may be split between the sections of a primary and secondary adviser. Consent of program director and project adviser required.
Repeat Status: Course may be repeated.
Prerequisites: COGS 301

COGS 327 (CSE 327) Artificial Intelligence Theory and Practice 3 Credits
Detailed analysis of a broad range of artificial intelligence (AI) algorithms and systems. Problem solving, knowledge representation, reasoning, planning, uncertainty and machine learning. Applications of AI to areas such as natural language processing, vision, and robotics. Credit will not be given for both CSE/COGS 127 and CSE/COGS 327.
Prerequisites: CSE 017 and CSE 140

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