Cognitive Science

http://www.cogsci.jhu.edu/

Cognitive science is the study of the human mind and brain, focusing on how the mind represents and manipulates knowledge and how mental representations and processes are realized in the brain. Conceiving of the mind as an abstract computing device instantiated in the brain, cognitive scientists endeavor to understand the mental computations underlying cognitive functioning and how these computations are implemented by neural tissue. Cognitive science has emerged at the interface of several disciplines. Central among these are cognitive psychology, linguistics, and portions of computer science and artificial intelligence; other important components derive from work in the neurosciences, philosophy, and anthropology. This diverse ancestry has brought into cognitive science several different perspectives and methodologies. Cognitive scientists endeavor to unite such varieties of perspectives around the central goal of characterizing the structure of human intellectual functioning. It is this common object of inquiry that integrates traditionally separate disciplines into the unified field of cognitive science.

Programs in cognitive science at Johns Hopkins University reflect the interdisciplinary nature of the subject, requiring the student to approach the study of the mind/brain from several different investigative perspectives. Programs in cognitive science draw on courses offered by several other departments as well.

Facilities

The department is located in Krieger Hall. Laboratory and office space is provided for graduate students. The department’s research facilities are provided by the following laboratories:

• Language and Cognition Lab (Landau)
• Language Acquisition Lab (Legendre)
• Cognitive Neuroscience Lab (McCloskey)
• Language Processing and Development Lab (Omaki)
• Visual Cognitive Neuroscience Lab (Park)
• CogNeuro Lab (Rapp)
• Semantics Lab (Rawlins)
• Computational Linguistics Lab (Smolensky)
• Phonetics/Phonology Lab (Wilson)
• Integrated Experimental/Theoretical Grammar Research (IGERT) Lab and Library

Department members also conduct research in the F.M. Kirby Center for Functional Brain Imaging at the Kennedy Krieger Institute and in other laboratories at Johns Hopkins School of Medicine.

The required courses are divided into five general areas, as described below. The program is structured so as to ensure some exposure to each of the five areas. In addition, it provides in-depth training in two focal areas chosen by the student. Majors in cognitive science thus acquire a broad perspective which will enable them to situate particular research disciplines within the overall study of the mind/brain.

Requirements for the B.A. Degree

(See also General Requirements for Departmental Majors (http://ecatalog.jhu.edu/archive/2013-14/undergrad-students/academic-policies/requirements-for-a-bachelors-degree).)

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<tr>
<th>Course</th>
<th>Title</th>
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<tr>
<td>AS.050.101</td>
<td>Cognition</td>
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<tr>
<td>AS.110.106</td>
<td>Calculus I</td>
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<td>or AS.110.108</td>
<td>Calculus I</td>
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<tr>
<td>AS.110.107</td>
<td>Calculus II (For Biological and Social Science)</td>
<td>3</td>
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<tr>
<td>or AS.110.109</td>
<td>Calculus II (For Physical Sciences and Engineering)</td>
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<td>AS.110.201</td>
<td>Linear Algebra</td>
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<tr>
<td>or EN.550.291</td>
<td>Lin Alg &amp; Diff Equations</td>
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<tr>
<td>AS.150.118</td>
<td>Introduction to Formal Logic</td>
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<tr>
<td>AS.050.370</td>
<td>Formal Methods in Cognitive Science: Language</td>
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<td>AS.050.372</td>
<td>Formal Methods in Cognitive Science: Neural Networks</td>
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<tr>
<td>EN.550.171</td>
<td>Discrete Mathematics</td>
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B. Statistics Sequence *

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<tr>
<td>EN.550.111</td>
<td>Statistical Analysis I</td>
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<tr>
<td>or EN.550.113</td>
<td>Statistics Through Case Study</td>
<td>3</td>
</tr>
<tr>
<td>EN.550.112</td>
<td>Statistical Analysis II</td>
<td>3</td>
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<tr>
<td>AS.200.207</td>
<td>Research Methods in Experimental Psychology</td>
<td>3</td>
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One modern foreign language at the intermediate level, or two modern foreign languages at the elementary level.

Total Credits 12

* Students may use three credits of research to satisfy one of these course requirements. All three courses are required for completion of the statistics sequence. If Cognitive Psychology and Neuropsychology is a focal area, the statistics sequence is required, and should be completed by the end of the sophomore year if possible.

All courses taken to fulfill major requirements must be passed with a grade of C or better.

Up to 12 credits taken for departmental requirements may be used to fulfill university distribution requirements. See the Undergraduate Academic Manual.

Areas of Concentration

1. Cognitive Psychology/Neuropsychology
2. Linguistics
3. Computational Approaches to Cognition
4. Philosophy of Mind
5. Neuroscience

Courses offered by the Cognitive Science Department, and also courses offered by other departments (e.g., Psychological and Brain Sciences, Philosophy, Computer Science), may be used to satisfy the requirements for these areas of concentration. A list of the specific courses that satisfy the requirements for each area is maintained on the Cognitive Science Department website. However, please note that courses change over time, and some courses are not offered every year. The Director of Undergraduate Studies can answer questions about which courses qualify for each area of concentration.

Minor in Linguistics

A minor in linguistics is available to undergraduates majoring in any department, except for cognitive science majors who choose linguistics as one of their focal areas. Students intending to minor in linguistics should declare their intention, preferably by the beginning of junior year.

The requirements for the minor are:

- One foreign language through the intermediate level or two foreign languages through the elementary level.
- Six courses in linguistics from those listed under Area B. Of these, four must be at the 300-level or above, excluding research and reading courses.

Requirements for Admission

A program of study leading to the Ph.D. degree is open to students with a bachelor’s or master’s degree in cognitive science or one of the several areas that contribute to it. Prospective graduate students would be well advised to take courses in cognitive psychology, linguistics, and computer science. Some preparation in the foundations of contemporary neuroscience is also an asset, as is training in the philosophical issues surrounding the study of mind and consciousness. However, there are no fixed prerequisites (in the form of specific required courses) for admission to graduate studies. The Department of Cognitive Science invites inquiries from students who are prepared in any of the related fields and who are interested in extending their work to the broader study of the mind/brain.

Requirements for the Ph.D. Degree

Doctoral candidates will be expected to meet the following specific requirements:

- A dissertation proposal detailing a significant research project and the methods to be used:
- A Ph.D. dissertation presenting an original contribution to some area(s) of cognitive science, in a format approaching publication standards
- A dissertation defense

(For a precise and up-to-date statement of the requirements, see information on the Ph.D. program at [http://www.cog.jhu.edu/](http://www.cog.jhu.edu/) )

Financial Aid for Graduate Students

The department provides competitive levels of funding covering tuition and living expenses. Research expenses, including some support for travel to present papers at scholarly meetings, are also provided.

For current faculty and contact information go to [http://cogsci.jhu.edu/people/](http://cogsci.jhu.edu/people/)

Faculty

Chair
Brenda Rapp
Professor: cognitive neuropsychology, spelling, spoken language production, spatial frames of reference, reading and neural bases of recovery of function.

Professors
Barbara Landau
Dick and Lydia Todd Faculty Development Professor: language acquisition, cognitive development, spatial representation, and acquisition of the lexicon.

Géraldine Legendre
syntax, optimality theory, Romance and Balkan morphology and syntax, acquisition of syntax.

Michael McCloskey
cognitive neuropsychology, vision, spatial and lexical representation, foundations of cognitive science.

Paul Smolensky

Associate Professor

Colin Wilson
theoretical phonology (constraint interaction, targeted constraints, learnability), experimental phonology (artificial grammar learning, substantive bias), computational cognitive science (finite state, maximum entropy, and Bayesian methods).

Assistant Professors

Akira Omaki
psycholinguistics, first language acquisition, second language acquisition, syntax.

Soojin Park
cognitive neuroscience, vision, scene perception and memory, spatial navigation, functional neuroimaging.

Kyle Rawlins
formal semantics, pragmatics, syntax and interfaces, lexical representation, mathematical linguistics, computational models of meaning and communication.

Professor Emeritus
Luigi Burzio
theoretical phonology, morphology, and syntax, Romance linguistics.

Joint/Adjunct Appointments
Dana Boatman
Associate Professor (Neurology and Otolaryngology, School of Medicine): speech perception, auditory processing disorders, auditory neurophysiology.

John Desmond
Associate Professor (Neurology, School of Medicine): neuroimaging, transcranial magnetic stimulation methods to investigate neural correlates of behavior.

Howard Egeth
Professor (Psychological and Brain Sciences): perception, attention, cognition, psychology, law.

Jason Eisner
Associate Professor (Computer Science): computational linguistics (syntax and phonology), natural language processing, statistical machine learning, programming language design.

Lisa Feigenson
Associate Professor (Psychological and Brain Sciences): cognitive development, numerical cognition.

Barry Gordon
Therapeutic Cognitive Neuroscience Professor (Neurology, School of Medicine): cognitive neurology, cognitive neuroscience, language, aphasia, memory, amnesia and memory disorders, autism, computational models of cognition, and cognitive disorders.

Steven Gross
Associate Professor (Department of Philosophy): philosophy of language, philosophy of mind, metaphysics.

Justin Halberda
Associate Professor (Psychological and Brain Sciences): cognitive development, reasoning, language acquisition.

Argye Hillis-Trupe
Professor (Neurology, School of Medicine): language impairments in acute stroke, hemi-spatial neglect after stroke, relationship between cognitive impairments and regions of hypoperfused brain.

Guy McKhann
Professor (Neurology, School of Medicine): neurological and cognitive changes after cardiac surgery.

Maureen Stone
Adjunct Professor (Director, Vocal Tract Visualization Lab, Department of Neural and Pain Sciences, University of Maryland School of Dentistry): speech science, phonetics, vocal tract and tongue kinesiology, measurement and modeling.

Steven Yantis
Professor (Psychological and Brain Sciences): visual perception, attention, long-term memory, aging, dementia.

Courses
AS.050.101. Cognition. 3 Credits.
Introductory course exploring the study of human mental processes within the field of cognitive science. Drawing upon cognitive psychology, cognitive neuropsychology, cognitive neuroscience, linguistics, and artificial intelligence, the course examines theory, methods, and major findings in work on vision, reasoning, and language. Instructor(s): C. Wilson
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.102. Language and Mind. 3 Credits.
Introductory course dealing with theory, methods, and current research topics in the study of language as a component of the mind. What it is to “know” a language: components of linguistic knowledge (phonetics, phonology, morphology, syntax, semantics) and the course of language acquisition. How linguistic knowledge is put to use: language and the brain and linguistic processing in various domains. This course is restricted to freshmen and sophomores. Juniors and seniors must seek instructor approval to enroll. Cross-listed with Neuroscience and Psychology.
Instructor(s): A. Omaki
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.105. Intro To Cognitive Neuropsychology. 3 Credits.
When the brain is damaged or fails to develop normally, even the most basic cognitive abilities (such as the ability to understand words, or perceive objects) may be disrupted, often in remarkable ways. This course explores a wide range of cognitive deficits, focusing on what these deficits can tell us about how the normal brain works. Topics include brain anatomy and causes of brain damage, reading and spelling deficits, unilateral spatial neglect, hemispheric disconnection, cortical plasticity, and visual perception of location and orientation. Students read primary sources: journal articles that report deficits and discuss their implications. Cross-listed with Neuroscience.
Instructor(s): M. McCloskey
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.107. Language and Advertising. 3 Credits.
Advertising pervades our culture; interactions with advertising are an unavoidable fact of modern life. This class uses tools from linguistics and cognitive science to analyze these interactions, and understand the impact of advertising on its viewers. A central theme is to treat ads as communicative acts, and explore the consequences -- what can theories of communication (from linguistics, psychology, and philosophy) tell us about ads? How do ads use central features of human cognition to accomplish their aims? Do ads manipulate, and if so, how successfully? The theories of communication we explore include Greelan pragmatics, theories of speech acts, linguistic theories of presuppositions, and more. Students will collect, analyze, and discuss advertisements in all mediums.
Instructor(s): K. Rawlins
Area: Natural Sciences, Social and Behavioral Sciences.

For current course information and registration go to https://isis.jhu.edu/classes/
AS.050.109. Minds, Brains and Computers. 3 Credits.
Mental processes such as language comprehension and visual perception involve complex computations carried out by the brain. But how do brains compute? What exactly does it mean to "compute" anyway? How do the brain and mind relate? Topics include cognition viewed as abstract computation, the brain viewed as a physical computer, and "neural network" computers viewed as models of how both the mind and the brain compute.
Instructor(s): J. Chen-Main
Area: Natural Sciences, Social and Behavioral Sciences.

Using both seminal and contemporary readings as a foundation, this seminar explores how genetics and experience interact to influence thinking, understanding the underlying cognitive processes (both human and otherwise). In so doing, we will discuss how innate determination of various components of cognition ultimately influence human nature. Open to freshmen only.
Area: Natural Sciences, Social and Behavioral Sciences
Writing Intensive.

AS.050.203. Cognitive Neuroscience: Exploring the Living Brain. 3 Credits.
This course surveys theory and research concerning how mental processes are carried out by the human brain. Currently a wide range of methods of probing the functioning brain are yielding insights into the nature of the relation between mental and neural events. Emphasis will be placed on developing an understanding of both the physiological bases of the techniques and the issues involved in relating measures of brain activity to cognitive functioning. Methods surveyed include electrophysiological recording techniques such as EEG, VEP, ERP, single/multiple unit recording and MEG; functional imaging techniques such as PET and fMRI; and methods that involve lesioning or disrupting neural activity such as WADA, cortical stimulation, animal lesion studies, and the study of brain-damaged individuals. (Co-listed as AS.080.203 in Neuroscience.)
Instructor(s): B. Rapp; S. Park
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.204. Visual Cognition. 3 Credits.
Vision is central to our daily interactions with the world: we can effortlessly navigate through a city, comprehend fast movie trailers, and find a friend in a crowd. While we take the visual experience for granted, visual perception involves a series of complicated cognitive processes beyond just opening our eyes. The goal of this course is to provide an introduction to visual cognition, including existing theoretical frameworks and recent research findings. We will explore questions such as: How do we see the stable world when our eyes are constantly moving? What is the relationship between seeing and knowing? Do infants see the world the same way as adults do? What are the neural mechanisms underlying visual perception?
Instructor(s): S. Park
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.205. Structure Of English. 3 Credits.
Area: Humanities, Natural Sciences.

AS.050.206. Bilingualism. 3 Credits.
Do children get confused when they grow up exposed to more than one language? Is it possible to forget one's native language? Are the first and second language processed in different areas of the brain? How does brain damage impact the different languages of a polyglot? Does knowing a second language affect non-linguistic cognitive processing? This course will address questions such as these through an exploration of mental and neural processes underlying bilingual and multilingual language processing.
Instructor(s): J. Yarmolinskaya
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.231. Lab-based Survey of Cognitive Science. 3 Credits.
How can we study human behavior to understand how the mind works? In this class we will examine several classic human cognitive science experimental paradigms such as the Stroop, lexical decision, and n-back tasks. We will discuss the reasoning and motivation underlying each experimental approach and learn how they provide us with an understanding of the major domains of cognitive science, such as executive function, language, and working memory. This is a computer lab based course during which students will carry out cognitive science experiments during class.
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.240. World of Language. 3 Credits.
This hands-on course exposes students to the fascinating variety – and uniformity – to be found among the world’s 6000 languages through group lectures on a variety of topics as well as actual linguistic fieldwork conducted in small groups with a native speaker of a language unknown to the participants. Among the fundamental questions examined in lectures and tested against realistic linguistic data are the following. Is knowledge of language encoded in the genes? Is it unique to mankind? How do new languages emerge from the contact of two very different languages? How did English change over time? Are all languages related? Where does language come from?
Instructor(s): G. Legendre
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.301. Stress and the Brain. 3 Credits.
The purpose of this course is to explore the phenomenon of stress by investigating the neural, endocrine and molecular mechanisms involved. By reviewing both animal and human research, this course will consider disorders of the stress control system and the adverse impact of stress on human physical and mental health. Topics in this class will include, but are not limited to I) disorders such as PTSD, anxiety, major depression; II) interactions between stress and neurodegenerative disorders; III) stress-immune-inflammatory interactions; IV) the role of stress in obesity, hypertension, and other metabolic syndromes; V) stress effects on reproduction. Students will finish this course with a greater understanding for the fundamental neuroendocrine responses to stress and its consequent and/or associated adverse effects on human health.
Area: Natural Sciences.
**AS.050.303. Mind, Brain and Beauty. 3 Credits.**
What underlies our aesthetic response to art, music, and other facets of human experience? Do identifiable properties of objects and events evoke consistent aesthetic responses, or is beauty mostly in the eye of the beholder? Examining such questions from cognitive science, neuroscience, and philosophical perspectives, this course explores relevant research and theory in the visual, auditory, and tactile domains. Several researchers will discuss their ongoing studies with the class, and students will also have the opportunity to participate in demonstration experiments that illustrate phenomena under discussion. (Same as AS.050.603) Recommended Course Background: One or more courses in one of these: Cognitive Science, Neuroscience, Philosophy, or Psychology or permission of instructor.
Instructor(s): M. McCloskey
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.311. The Literate Mind and Brain. 3 Credits.**
This course surveys both the historical development of written language as well as current cognitive theories that account for the manner in which the written language is represented and processed by “readers/writers” of a language. Issues regarding the relationship between the written and spoken language, the acquisition of written language skills, as well as developmental and acquired disorders of reading and writing will be examined.
Prerequisites: AS.050.101 or AS.050.102 or AS.050.105 or Instructor's Permission
Instructor(s): B. Rapp
Area: Natural Sciences, Social and Behavioral Sciences
Writing Intensive.

**AS.050.312. Cognitive Neuroimaging Methods in High-Level Vision. 3 Credits.**
This course is an advanced seminar and research practicum course. It will provide the opportunity to learn about fMRI methods used in the field of vision science and for students to have hands-on experience to develop, design and analyze a research study on topics in the cognitive neuroscience field of high-level vision. In the first part of the course students will read recent fMRI journal papers and learn about common fMRI designs and analysis methods; in the second part of the course students will conduct a research study as a group to address a research question developed from readings. Students are expected to write a paper in a journal article format at the end of the course and to present their results in front of the class. Research topics will vary but with special focus on topics in object, scene and space recognition. Cross-listed with Neuroscience and Psychology. instructor’s permission required.
Prerequisites: AS.050.204 OR AS.050.319 OR AS.050.315 OR AS.200.312 OR AS.050.203 OR AS.080.203 or equivalent; instructor's permission required.
Instructor(s): S. Park
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.314. Classic Papers in Language Learning. 3 Credits.**
Classic and current issues in language acquisition focusing on enduring questions and issues – how different scientific disciplines and theorists and experimentalists have addressed these issues.
Area: Humanities, Social and Behavioral Sciences.

**AS.050.315. Cognitive Neuropsychology of Visual Perception: The Malfunctioning Visual Brain. 3 Credits.**
When we think about our ability to see, we tend to think about our eyes, but in fact vision happens mostly in the brain. This course explores the remarkable perceptual deficits that occur when the visual regions of the brain are damaged or fail to develop normally, focusing on what these perceptual malfunctions tell us about normal visual perception. Topics include visual system anatomy and physiology; functional specialization in the lower visual system as revealed by cerebral achromatopsia (color blindness resulting from brain damage) and akinetopsia (impaired motion perception); cortical plasticity in the visual system; spatial deficits in perception and action; and the implications of high-level visual deficits, including prosopagnosia (impaired face recognition), Charles Bonnet syndrome (complex visual hallucinations in blind areas of the visual field), blindsight (accurate responding to visual stimuli despite apparent inability to see them), and Anton’s syndrome (denial of blindness).
Instructor(s): M. McCloskey
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.316. Morpho - Phonology. 3 Credits.**
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.317. Semantics I. 3 Credits.**
This is an introduction to the study of meaning in natural language. We address the conceptual and empirical issues in semantic theory and introduce some formal machinery that has been developed to deal with such problems. After discussing foundational questions, we turn to formal semantics and pragmatics, as well as their interfaces with syntax and the lexicon. Specific topics include presupposition, type-driven composition, quantification, lexical aspect, argument structure, and lexical representations of meaning.
Instructor(s): E. Zarokian; M. Oliver
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.318. Practicum in Language Disorders-Community Based Learning. 2 Credits.**
This course provides the opportunity to learn about adult aphasias, language disorders which are one of the most common consequences of stroke. You will receive training in supportive communication techniques and work as a communication partner with an individual with aphasia for two hours per week. Three class meetings for orientation and reading assignments will be held on campus; training and practicum will be conducted at a local aphasia support center. Transportation required. Junior or Senior status. Co-listed with Neuroscience (AS.080.400). Please see additional instructions on the Neuroscience Department website at: http://krieger.jhu.edu/neuroscience/courses/index.html>the Neuroscience Department Website</a>
Prerequisites: AS.080.203(C) OR AS.050.203(C) OR AS.050.105(C) OR AS.050.105(C)
Instructor(s): B. Rapp
Area: Natural Sciences, Social and Behavioral Sciences.
AS.050.319. Visual Cognition. 3 Credits.
Vision is central to our daily interactions with the world: we can effortlessly navigate through a city, comprehend fast movie trailers, and find a friend in a crowd. While we take the visual experience for granted, visual perception involves a series of complicated cognitive processes beyond just opening our eyes. The goal of this course is to introduce students to the field of visual cognition, including existing theoretical frameworks and recent research findings. We will explore questions such as: How do we see the visual world? Do we see and remember correctly what’s in the physical world? How many items can we keep track of and remember at a time? How is the visual system structured and what are the neural mechanisms underlying visual perception? Meets with AS.050.619.
Prerequisites: AS.200.101 OR AS.050.101 OR AS.080.203 OR AS.050.203
Instructor(s): S. Park
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.320. Syntax I. 3 Credits.
Introduces the basic methods and means of analysis used in contemporary syntax investigations, practicing with data from different languages. Also offered as AS.050.620.
Prerequisites: Prereqs: AS.050.102 OR AS.050.240
Instructor(s): G. Legendre
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.321. Syntax II. 3 Credits.
Building on AS.050.320, this course addresses and compares conceptions of syntactic theory that have emerged in the 1980s and 1990s. Discussion focuses on both the substantive and formal properties of the fundamental principles of syntactic theory, as well as the cross-linguistic evidence that has motivated them. When possible, connections will be made to other areas of linguistic inquiry such as processing, acquisition, and computation. The particular choice of topics and conceptions will vary from year to year but may include (1) the contrast between the Principles and Parameters view where syntactic theory is composed of a set of inviolable principles whose form admits a certain amount of cross-linguistic variation, and the Optimality Theory view where the principles are invariant though violable, and cross-linguistic variation is determined by the relative importance of satisfying the various principles; (2) the role of structure building operations in grammar, and the differences between characterizations of well-formedness in terms of sequences of derivational steps and representational well-formedness requirements. Meets with AS.050.621
Prerequisites: AS.050.320[C] or instructor's permission.
Instructor(s): G. Legendre
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.322. Semantics II. 3 Credits.
This course extends the material in AS.050.317 to cover advanced but central topics in semantic and pragmatic theory, focusing on intensional semantics (especially possible world semantics and situation semantics). Empirical domains of interest in this class include modality, tense, grammatical aspect, conditionals, attitude and speech reports, questions, and free choice phenomena. Three core theoretical issues addressed in this class are the nature of a compositional account of the above intensional phenomena, the representations of possibilities involved, and the role of the syntax/semantics/pragmatics interface in such an account. Meets with AS.050.622
Prerequisites: AS.050.317[C] or instructor's permission.
Instructor(s): K. Rawlins
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.325. Phonology I. 3 Credits.
An introduction to the basic principles underlying the mental representation and manipulation of language sounds and their relation to human perception and vocal articulation: how units of sound are both decomposable into elementary features and combined to form larger structures like syllables and words. The role of rules and constraints in a formal theory of phonological competence and in accounting for the range of variation among the world’s languages. (Same as AS.050.625) Previous experience with one other language-related course is desirable but not obligatory.
Instructor(s): C. Kirov
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.326. Foundations In Cognitive Science. 3 Credits.
This course explores general issues and methodologies in cognitive science through the reading of classic works (from Plato and Kant through Skinner and Turing) and recent research articles to begin construction of a coherent picture of many seemingly divergent perspectives on the mind/brain. Recent brain-based computational models serve to focus discussion. Recommended Course Background: at least one course at the 300-level or higher in cognitive science, computer science, neuroscience, philosophy, or psychology. Co-listed with AS.050.626.
Instructor(s): P. Smolensky
Area: Natural Sciences, Social and Behavioral Sciences Writing Intensive.

AS.050.327. Phonology II. 3 Credits.
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.332. Development Cog Neurosci. 3 Credits.
Prerequisites: AS.050.101 (Cognition) or AS.050.339/639 (Intro to Cog. Development) or AS.200.132 (Introductory Developmental Psychology) or instructors permission required. In-depth examination of the current literature on cognitive development in the context of development cognitive neuroscience. Same as 050.632.
Instructor(s): B. Landau
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.333. Psycholinguistics. 3 Credits.
This course provides a broad survey of current research on language processing in adult native speakers and language learners. Topics include speech perception, word recognition, and sentence production and comprehension. We will discuss the nature of representations that are being constructed in real-time language use, as well as how the mental procedures for constructing linguistic representations could be studied by various behavioral and physiological measures. Meets with AS.050.633
Prerequisites: AS.050.102 or AS.050.240 or instructor's permission.
Instructor(s): A. Omaki
Area: Natural Sciences, Social and Behavioral Sciences Writing Intensive.
**AS.050.335. Introduction to Connectionist Modeling of Cognition. 3 Credits.**
This course explores general issues and methodologies in cognitive science through the reading of classic works (from Plato and Kant through Skinner and Turing) and recent research articles to begin construction of a coherent picture of many seemingly divergent perspectives on the mind/brain. Recent brain-based computational models serve to focus discussion. (Same as AS.050.626) Recommended Course Background: at least one course at the 300-level or higher in cognitive science, computer science, neuroscience, philosophy, or psychology.
Instructor(s): C. Wilson
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.372. Formal Methods in Cognitive Science: Neural Networks. 4 Credits.**
Introduction to continuous mathematics for cognitive science, with applications to biological and cognitive network models: real and complex numbers, differential and integral multi-variable calculus, linear algebra, dynamical systems, numerical optimization. Meets with AS.050.672
Prerequisites: Calculus I AS.110.106 OR AS.110.108
Instructor(s): P. Smolensky
Area: Natural Sciences, Quantitative and Mathematical Sciences.

**AS.050.446. Integrative Research Methods in Cognitive Science. 3 Credits.**
Through a series of case studies, we will examine contemporary approaches to integrating the perspectives and research methods of multiple sub-disciplines of cognitive science. Also offered as AS.050.646.
Prerequisites: AS.050.326, or instructor’s permission required.
Instructor(s): P. Smolensky
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.480. Learning Theory. 3 Credits.**
Recently, statistical learning has played a leading role in informing the empiricist/nativist and connectionist/symbolic debates. But just what is “statistical learning” and what’s new about it? This course presents theories of statistical learning, such as Bayesian models, causal networks, information-theoretic models (e.g., Minimum Description Length and Maximum Entropy formalisms). These methods have caused revolutions in machine vision and natural language processing. During the course, these methods will be compared with other numerical learning methods such as connectionist networks, and with non-numerical learning theories such as Gold’s classic learnability theory and its probabilistic extension to PAC (probably approximately correct) learning theory. This recent work has fundamental implications for the ancient problem of induction. Prerequisites: With instructor permission, this course is open to upperclass undergraduates concentrating in computation. This course is open to upperclass undergraduates concentrating in computation.
Instructor(s): P. Smolensky
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.501. Readings in Cognitive Science/Freshmen. 3 Credits.**
Research current topics in cognitive science.
Instructor(s): Staff.

**AS.050.502. Readings in Cognitive Science-Freshmen. 0 - 3 Credit.**
Permission Required.
Instructor(s): Staff.

**AS.050.503. Research in Cognitive Science/Freshmen. 3 Credits.**
Research current topics in cognitive science.
Instructor(s): Staff.

**AS.050.504. Research Cognitive Science-Freshmen. 0 - 3 Credit.**
Permission Required.
Instructor(s): Staff.

**AS.050.505. Readings in Cognitive Science/Sophomores. 3 Credits.**
Research current topics in cognitive science.
Instructor(s): Staff.

**AS.050.506. Readings Cognitive Science-Sophomores. 0 - 3 Credit.**
Permission Required.
Instructor(s): Staff.
AS.050.507. Research in Cognitive Science/Sophomores. 3 Credits.
Research current topics in cognitive science.
Instructor(s): Staff.

AS.050.508. Research Cognitive Science - Sophomores. 0 - 3 Credit.
Permission Required.
Instructor(s): Staff.

Research current topics in cognitive science.
Instructor(s): Staff.

AS.050.510. Cognitive Science Internship. 0 - 3 Credit.
Permission Required.
Instructor(s): Staff.

AS.050.511. Readings in Cognitive Science/Juniors. 3 Credits.
Research current topics in cognitive science.
Instructor(s): Staff.

AS.050.512. Readings Cognitive Science-Juniors. 0 - 3 Credit.
Permission Required.
Instructor(s): Staff.

AS.050.513. Research in Cognitive Science/Juniors. 3 Credits.
Research current topics in cognitive science.
Instructor(s): Staff.

Permission Required.
Instructor(s): Staff.

AS.050.515. Readings in Cognitive Science/Seniors. 3 Credits.
Research current topics in cognitive science.
Instructor(s): Staff.

AS.050.516. Readings Cognitive Science - Senior. 0 - 3 Credit.
Permission Required.
Instructor(s): Staff.

AS.050.517. Research in Cognitive Science/Seniors. 3 Credits.
Research current topics in cognitive science.
Instructor(s): Staff.

AS.050.518. Research Cognitive Science - Seniors. 0 - 3 Credit.
Permission Required.
Instructor(s): Staff.

AS.050.599. Research-Cognitive Science. 3 Credits.
Instructor(s): B. Landau; B. Rapp; C. Wilson; K. Rawlins; M. McCloskey.

AS.050.603. Mind, Brain and Beauty.
Instructor(s): M. McCloskey
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.617. Semantics I.
This course is an introduction to the study of meaning in natural language. We address both the conceptual and empirical issues that a semantic theory must grapple with, as well as some of the formal machinery that has been developed to deal with such problems. After discussing foundational questions, we turn to formal semantics and pragmatics, as well as their interfaces with syntax and the lexicon. Specific topics covered include conversational implicature; presupposition, type-driven composition, quantification and scope, lexical aspect, argument structure, and the nature of lexical representations of meaning.
Instructor(s): K. Rawlins
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.610. Syntactic Interactions.
Vision is central to our daily interactions with the world: we can effortlessly navigate through a city, comprehend fast movie trailers, and find a friend in a crowd. While we take the visual experience for granted, visual perception involves a series of complicated cognitive processes beyond just opening our eyes. The goal of this course is to introduce students to the field of visual cognition, including existing theoretical frameworks and recent research findings. We will explore questions such as: How do we see the visual world? Do we see and remember correctly what’s in the physical world? How many items can we keep track of and remember at a time? How is the visual system structured and what are the neural mechanisms underlying visual perception? Meets with AS.050.319. Recommended Course Background: AS.200.101, AS.050.101, or AS.080.203/AS.050.203
Instructor(s): S. Park.

AS.050.620. Syntax I.
Also offered as AS.050.320.
Instructor(s): G. Legendre
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.621. Syntax II.
Co-taught with AS.050.321. See description.
Instructor(s): G. Legendre
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.622. Semantics II.
Co-taught with AS.050.322. See description.
Instructor(s): K. Rawlins
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.625. Phonology I.
An introduction to the basic principles underlying the mental representation and manipulation of language sounds and their relation to human perception and vocal articulation: how units of sound are both decomposable into elementary features and combined to form larger structures like syllables and words. The role of rules and constraints in a formal theory of phonological competence and in accounting for the range of variation among the world’s languages. (Same as AS.050.325) Previous experience with one other language-related course is desirable but not obligatory.
Instructor(s): C. Kirov
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.626. Phonology II.
Classic and current issues in language acquisition focusing on enduring questions and issues – how different scientific disciplines and theorists and experimentalists have addressed these issues.
Area: Humanities, Social and Behavioral Sciences.

Classic and current issues in language acquisition focusing on enduring questions and issues – how different scientific disciplines and theorists and experimentalists have addressed these issues.
Area: Humanities, Social and Behavioral Sciences.

AS.050.616. Morpho - Phonology.
Area: Natural Sciences, Social and Behavioral Sciences.
**AS.050.626. Foundations In Cog Sci.**
This course explores general issues and methodologies in cognitive science through the reading of classic works (from Plato and Kant through Skinner and Turing) and recent research articles to begin construction of a coherent picture of many seemingly divergent perspectives on the mind/brain. Recent brain-based computational models serve to focus discussion. (Same as AS.050.326) Recommended Course Background: at least one course at the 300-level or higher in cognitive science, computer science, neuroscience, philosophy, or psychology.
Instructor(s): P. Smolensky
Writing Intensive.

**AS.050.627. Phonology II.**

**AS.050.632. Development Cog Neurosci.**
Recommended Course Background: AS.050.101, AS.050.339/AS.050.639, AS.200.132, or instructor’s permission required.
Instructor(s): B. Landau.

**AS.050.633. Psycholinguistics.**
Co-taught with AS.050.333. See description.
Instructor(s): A. Omaki
Writing Intensive.

**AS.050.635. Introduction to Connectionist Modeling of Cognition.**
Connectionism is an approach to studying cognition in which cognitive processes are modeled by the behavior of interconnected networks of simple processing units. Connectionist models have shown the ability to provide a precise match to experimental data with human subjects, and have provided examples of how complex processes such as position-invariant face recognition could conceivably be implemented by networks of simple processing units. This course provides a hands-on introduction to connectionist modeling. In addition to readings, students will construct and run computer simulations of connectionist networks and study their properties, utilizing a public-domain neural network simulation package. We’ll study classic network architectures, as well as more recent developments. (Same as AS.050.335) Programming experience is helpful, but not required. Recommended Course Background: 100-level course in Cognitive Science or permission of instructor.
Instructor(s): D. Mathis.

**AS.050.639. Cognitive Development.**
Also offered as AS.050.339. Instructor approval required.
Instructor(s): J. Yarmolinskaya
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.646. Integrative Research Methods in Cognitive Science.**
It is recommended to have taken AS.050.626, but not required. Also offered as AS.050.446.
Instructor(s): P. Smolensky
Area: Natural Sciences, Social and Behavioral Sciences.

Also offered as AS.050.370.
Instructor(s): K. Rawlins
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.671. Formal Methods in Cognitive Science: Inference.**
Also offered as AS.050.371.
Instructor(s): C. Wilson
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.672. Formal Methods in Cognitive Science: Neural Networks.**
Introduction to continuous mathematics for cognitive science, with applications to biological and cognitive network models: real and complex numbers, differential and integral multi-variable calculus, linear algebra, dynamical systems, numerical optimization. Meets with AS.050.372
Instructor(s): P. Smolensky
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.680. Learning Theory.**
Permission from instructor. Recently, statistical learning has played a leading role in informing the empiricist/nativist and connectionist/symbolic debates. But just what is “statistical learning” and what’s new about it? This course presents theories of statistical learning, such as Bayesian models, causal networks, information-theoretic models (e.g., Minimum Description Length and Maximum Entropy formalisms). These methods have caused revolutions in machine vision and natural language processing. During the course, these methods will be compared with other numerical learning methods such as connectionist networks, and with non-numerical learning theories such as Gold’s classic learnability theory and its probabilistic extension to PAC (probably approximately correct) learning theory. This recent work has fundamental implications for the ancient problem of induction. Same as AS.050.480
Instructor(s): P. Smolensky
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.800. Directed Readings.**
Guided independent readings in special fields of cognitive science. Sec. 01 Staff Sec. 02 Badecker Sec. 03 Burzio Sec. 04 Frank Sec. 05 Landau Sec. 06 Legendre Sec. 09 Smolensky
Instructor(s): Staff.

**AS.050.801. Research Seminar in Cognitive Neuropsychology.**
Participants in this graduate seminar will read and discuss current research articles in cognitive neuropsychology of vision or language, and present their own research.
Instructor(s): M. McCloskey.

**AS.050.802. Research Seminar in Cognitive Processes.**
Permission required. Current issues and ongoing research on human cognition are discussed.
Instructor(s): B. Rapp.

**AS.050.811. Research Seminar in Language & Cognition.**
A specialized research seminar for individuals researching language acquisition, cognitive development and the interface between language and cognition. Students must actively carry out empirical or theoretical research in these areas. Permission required.
Instructor(s): B. Landau.

**AS.050.817. Research Seminar in Semantics.**
Instructor(s): K. Rawlins.

**AS.050.818. Research Seminar: AcqLab Meeting.**
Participants in this graduate seminar will read and discuss current research articles in language development and present their own research. Permission required.
Instructor(s): G. Legendre.
AS.050.821. Research Seminar: Sentence++. Topics in phonological, morphological, syntactic, and/or semantic theory. Discussion of the current literature and specifically of the relevance of linguistic results for the study of the mind. Permission required. Instructor(s): A. Omaki; G. Legendre.


AS.050.826. Research Seminar in Formal Approaches to Cognitive Science. Readings and research presentations on varying topics in mathematics, computation, and formal linguistics with bearing on cognitive science. Instructor(s): P. Smolensky.

AS.050.827. Research Seminar in Language Acquisition. Focus is on current research in acquisition of syntax. Instructor(s): A. Omaki; G. Legendre.

AS.050.828. Research Seminar in Cognitive Neuroscience of Vision. This seminar will read on-going and recent papers on the cognitive neuroscience research of vision. Permission required. Instructor(s): S. Park.


AS.050.839. Research in Cognitive Science. Current topics in any area of cognitive science, including language and vision, with discussion of recent developments in theory, experimental study, and computational modeling. Instructor(s): Staff.


AS.050.850. Department Seminar. Instructor(s): P. Smolensky.

AS.050.860. Professional Seminar in Cognitive Science. Instructor permission required. Addresses professional issues such as research ethics, success on the job market and in an academic career, teaching and mentoring and differing professional standards in the sub-disciplines of cognitive science. Instructor(s): P. Smolensky.

AS.050.870. Dissertation Research. Independent study. Intended for graduate students who have completed all degree requirements except for their dissertation but must remain or return to residency status in order to fulfill other obligations. Advisor or department approval required. Instructor(s): Staff.

Cross Listed Courses

Neuroscience

AS.080.203. Cognitive Neuroscience. 3 Credits. This course surveys theory and research concerning how the human brain carries out mental processes. Co-listed as AS.050.203 in Cognitive Science. Instructor(s): B. Rapp; S. Park Area: Natural Sciences, Social and Behavioral Sciences.

AS.080.320. The Auditory System. 3 Credits. This course will cover the neuroanatomy and neurophysiology of the human auditory system from the ear to the brain. Behavioral, electrophysiological, and neuroimaging methods for assessing peripheral and central auditory function will be discussed. Acquired and developmental disorders of auditory function will be reviewed using clinical case studies. Prerequisites: Prereqs: AS.080.305 OR AS.020.312 AND AS.020.306 OR AS.200.141 Instructor(s): D. Boatman Area: Natural Sciences.

Psychological Brain Sciences


Music

AS.376.371. Topics in Music Cognition I. 3 Credits. What underlies our aesthetic response to music? How and why are we able to identify certain sounds as music? To what extent are music and natural language similar? What is it about music that evokes such powerful emotions such as happiness and sadness? What is unique to musical creativity? Examining such questions from cognitive science, neuroscience, psychology, and philosophical perspectives, this course explores relevant research and theory in the emerging domain of music perception and cognition. Students will complete a final research paper on the topic of their choice that integrates the course material. Instructor(s): M. Lopez-Gonzalez Area: Natural Sciences, Social and Behavioral Sciences.

AS.376.372. Introduction to Music Cognition II. 3 Credits. Continuing from Topics in Music Cognition I, this course explores further the similarities and differences between music and language, the effects of musical training on cognitive development, and the expressive power of music, with an introduction to music and its role in film. We will read relevant research and theory on these topics from cognitive science, neuroscience, psychology, musicology, and philosophical perspectives. Instructor(s): M. Lopez-Gonzalez Area: Natural Sciences, Social and Behavioral Sciences.
Computer Science

EN.600.625. Events Semantics in Theory and Practice.
This course explores selected topics in the nature of event representations from the perspective of cognitive science, computer science, linguistics, and philosophy. These fields have developed a rich array of scientific theories about the representation of events, and how humans make inferences about them -- we investigate how (and if) such theories could be applied to current research topics and tasks in computational semantics such as inference from text, automated summarization, veridicality assessment, and so on. In addition to classic articles dealing with formal semantic theories, the course considers available machine-readable corpora, ontologies, and related resources that bear on event structure, such as WordNet, PropBank, FrameNet, etc.. The course is aimed to marry theory with practice: students with either a computational or linguistic background are encouraged to participate. [Applications]
Instructor(s): B. Van Durme; K. Rawlins.