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.

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)
- Visual Cognitive Neuroscience Lab (Park)
- CogNeuro Lab (Rapp)
- Semantics Lab (Rawlins)
- Computational Linguistics Lab (Smolensky)
- Phonetics/Phonology Lab (Wilson)
- Computational Vision Lab (Yuille)
- 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.

Undergraduate Program

Our cognitive science undergraduate program reflects the interdisciplinary nature of the field, allowing students to approach the study of the mind and brain from multiple perspectives. Students gain broad knowledge of the field as a whole, plus a greater depth of the understanding in two of the sub-disciplines within the field. Training emphasizes not only learning about the principal theories and evidence, but also development of the conceptual and practical skills needed for understanding and conducting theoretical and empirical work in the field.

Our department offers a B.A. in Cognitive Science as well as a Linguistics Minor (p. 3).

B.A. in Cognitive Science

Also see Requirements for a Bachelor’s Degree (http://e-catalog.jhu.edu/undergrad-students/academic-policies/requirements-for-a-bachelors-degree).

Cognitive Science Major Requirements

The required courses for cognitive science majors 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 of the areas, deemed 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.

Areas of Focus: Students must take courses in all five focal areas; however, two focal areas must be chosen in which a greater selection of courses is required. Courses offered by our department and other affiliated departments (e.g., Departments of Psychological and Brain Sciences, Philosophy, Computer Science, Neuroscience, etc.) may be used to satisfy the requirements for these areas of concentration. Examples of courses that satisfy the requirements for each area can be found on our website. (http://cogsci.jhu.edu/undergraduate/focal-areas.html) However, please note that courses change over time, and some courses are not offered every year. The Director of Undergraduate Studies (http://www.advising.jhu.edu/directors.php) can answer questions about which courses qualify for each focal area.

- Cognitive Psychology/Neuropsychology
- Linguistics
- Computational Approaches to Cognition
- Neuroscience
- Philosophy of Mind

B.A. Coursework

Introductory Course

AS.050.101 Cognition

Two Focal Areas, see areas above

Three courses in each of the two selected focal areas. At least one course in each area must be at the 300 - 600 level, not including research, readings, or practica.

Three Non-Focal Areas

One course at any level from each of the three non-focal areas.

Additional Upper-Level Courses

Nine credits at the 300 - 600 level, chosen from any focal areas or other cognitive science offerings.

Math Requirement (Option A or B)

Math Option A Any two of the following courses:

- AS.110.106 Calculus I (Biology and Social Sciences)
- or AS.110.11C Calculus I

- AS.110.107 Calculus II (For Biological and Social Science)
- or AS.110.10B Calculus II (For Physical Sciences and Engineering)
- or AS.110.11 Honors Single Variable Calculus

- AS.110.201 Linear Algebra
- or EN.550.25 Linear Algebra and Differential Equations
- or AS.110.21 Honors Linear Algebra

Math Option B

- AS.110.106 Calculus I (Biology and Social Sciences)
- or AS.110.11C Calculus I

- AS.110.107 Calculus II (For Biological and Social Science)
- or AS.110.10B Calculus II (For Physical Sciences and Engineering)
- or AS.110.11 Honors Single Variable Calculus

- AS.110.201 Linear Algebra
- or EN.550.25 Linear Algebra and Differential Equations
- or AS.110.21 Honors Linear Algebra
AS.150.118  Introduction to Formal Logic  
AS.150.201  Mathematical Logic I  
AS.150.420  Mathematical Logic II  
AS.050.370  Mathematical Models of Language  
AS.050.371  Bayesian Inference  
AS.050.372  Foundations of Neural Network Theory  
EN.550.171  Discrete Mathematics  
Math Option B  Statistics Sequence, all three of the following courses  
**  
EN.550.111  Statistical Analysis I  
& EN.550.112  & AS.200.207  and Research Methods in Experimental Psychology**  

Foreign Language Requirement  
One foreign language through the intermediate level OR two foreign languages at the elementary level.  
* Up to three credits of research may apply to this requirement.  
** If cognitive psychology/neuropsychology is a focal area, the statistics sequence is required and should be completed by the end of the sophomore year, if possible.  

Additional Cognitive Science Major Information  
• Departmental requirements may not be taken Satisfactory/Unsatisfactory, with the exception of research.  
• A grade of C- or better must be earned in all major requirements.  

Sample Program  
The below sample program that demonstrates how a student with the focal areas (p. 1) of Cognitive Psychology/Neuropsychology and Linguistics might complete the Cognitive Science major requirements in four years. In this scenario, the student has not placed out of any foreign language requirements. Each student’s path through the program will have variation depending on the two focal areas they choose to pursue within the major.  

Freshman  
Fall  
AS.050.101  Cognition  3  AS.050.203  Cognitive Neuroscience: Exploring the Living Brain  
Electives to fulfill degree requirements  12  Electives to fulfill degree requirements  12  
15  15  

Sophomore  
Fall  
AS.050.105  Introduction to Cognitive Neuropsychology  3  AS.050.320  Syntax I  
AS.050.240  World of Language  3  AS.050.339  Cognitive Development  
EN.550.111 or 113  Statistical Analysis I  4-4  EN.550.112  Statistical Analysis II  
Electives to fulfill degree requirements  9  Electives to fulfill degree requirements  6  
19-19.5  16  

Junior  
Fall  
AS.050.319  Visual Cognition  3  AS.150.245  Introduction to Philosophy of Mind  
AS.050.513  Research in Cognitive Science/Juniors  1-3  AS.250.205  Introduction to Computing  
Foreign language course  4  Foreign language course  4  
14-16  14-16  

Senior  
Fall  
AS.050.625  Phonology I  3  AS.050.312  Cognitive Neuromaging Methods in High-Level Vision  
AS.050.517  Research in Cognitive Science/Seniors  1-3  Foreign language course  4  
Foreign language course  4  Electives to fulfill degree requirements  6  
15-17  16  

Total Credits: 124-130.5  

Practicum in Language Disorders  
In addition to having numerous research opportunities year-round, our department also offers AS.050.318 Practicum in Language Disorders-Community Based Learning (also listed as AS.080.400 Research Practicum: Language Disorders-Community Based Learning in the Department of Neuroscience) to its majors. Each fall and spring semester two qualified upperclassmen may enroll in this practicum and have the unique opportunity to learn about adult aphasias, be trained in supportive communication techniques, and work as a communication partner with an individual with aphasia throughout the semester at SCALE (http://www.scalebaltimore.org), a local aphasia support non-profit organization.  

Departmental Honors  
To receive Honors in Cognitive Science, graduating seniors must have a major GPA of 3.5 or higher and complete an Honors Clearance
Responsible Conduct of Research). See the coursework requirements below. As the capstone event for a student’s completion of the program, he/she must produce a portfolio of accomplishments from the program (e.g., course assignments, seminar papers) overseen by the faculty adviser, prepare a reading list and set of discussion questions, and present what has been learned from the year of study at an Oral Presentation supervised by two faculty members.

**MA Course Track Coursework**

- Courses: seven courses, 600 or above *
- Lab or Research Seminars: two courses, 800-level
- Directed Reading or Research: three total courses, one during Intersession
- AS.360.625 Responsible Conduct of Research
- Capstone: Portfolio and Oral Exam

* Up to three courses may be substituted by 300/400-level courses with a mentor’s written permission.

**Research Track:** Students in this track must complete 12 courses. Students must work on full-time research overseen by their faculty adviser and must complete maintain a B- or better in all coursework. Additionally, MA students are expected to take a research ethics course (AS.360.625 Responsible Conduct of Research). See the course requirements below. At the end of the program, a student in the research track must produce and defend research paper that is approved by the faculty adviser.

**MA Research Track Coursework**

- Lab or Research Seminar: two courses, 800-level
- Directed Research: six courses, one during Intersession
- AS.360.625 Responsible Conduct of Research
- Capstone: Research Paper and Oral Defense

**Financial Support**

No regular funding is provided to students in the M.A. Research and Course Tracks, though a 50% reduction in tuition is offered to students with JHU undergraduate degrees. Students will be encouraged to seek funding from both internal and external sources.

**PhD 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 doctoral 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 the doctoral program. 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.
Goals:
Research papers. The requirements are designed to meet the following course goals:

- **Depth**: Students become expert in their primary area of research interest and also are prepared so that they will be competitive for academic positions in one of the traditional disciplines. Students take 8 - 10 advanced courses that the student, in conjunction with his/her advisory committee, determines to be important for achieving expertise in a chosen research area and marketplace competitiveness in one of the traditional areas: cognitive psychology/neuropsychology, computer science or linguistics.

- **Breadth**: Students develop the ability to understand, appreciate and critically evaluate work in the various sub-disciplines of cognitive science by taking a selection of courses, two each in the areas of cognitive psychology/neuropsychology, computation and linguistics and one each in philosophy and cognitive neuroscience. Students may place out of breadth courses based on undergraduate coursework and (for certain courses) based on examination. It is not uncommon for a student to place out of two breadth requirements.

- **Integration**: Students learn to integrate theory and method across sub-disciplines through specially-designed integrative courses and regular seminars involving the entire department.

**Breadth**

<table>
<thead>
<tr>
<th>Cognitive Neuroscience</th>
<th>One course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philosophy</td>
<td>One course in philosophy of mind/language/science</td>
</tr>
<tr>
<td>Cognitive Psychology/Neuropsychology</td>
<td>Two each in the areas of cognitive psychology/neuropsychology, computation and linguistics and one each in philosophy and cognitive neuroscience.</td>
</tr>
<tr>
<td>Computation</td>
<td>Two each in philosophy of mind/language/science</td>
</tr>
<tr>
<td>Language</td>
<td>Two each in philosophy of mind/language/science</td>
</tr>
<tr>
<td>Integration</td>
<td>Two each in philosophy of mind/language/science</td>
</tr>
<tr>
<td>Depth: Area of Focus</td>
<td>Two each in philosophy of mind/language/science</td>
</tr>
</tbody>
</table>

**Research Papers & Dissertation:** Emphasis is placed on producing two research papers prior to writing a dissertation. These two research papers are typically presented at conferences and often lead to separate journal publications. Students are encouraged to incorporate the two research papers into their dissertation.

- Nov. 1 (2nd year) First Research Paper*, completion of which marks achievement of an M.A. within the Ph.D. program
- May 1 (3rd year) Second Research Paper*, completion of which signals readiness to discuss a career path with an adviser
- May 1 (4th year) Dissertation Proposal detailing a significant research project and the methods to be used
- Aug. 1 (5th year) Graduate Board Oral Exam defending a Ph.D. Dissertation that presents an original contribution to some area(s) of cognitive science in a format approaching publication standards

* The two research papers must each employ a different research methodology within cognitive science, e.g., theoretical linguistics and psychology, supervised by two appropriate faculty members.

**Financial Support**

The department provides competitive levels of funding for Ph.D. students covering tuition and living expenses. Research expenses, including some support for travel to present papers at scholarly meetings, are also provided. If a student maintains an academic good standing, funding is extended up to five years of total support. Students are encouraged to apply for external graduate fellowship opportunities (NSF, NIH, DoD, etc.). As funded entities, our graduate students are expected to engage in full-time research during the summer months and the January intersession in addition to their regular coursework, TA responsibilities, and participation in academic departmental talks and events.

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

**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, acquisition of the lexicon.

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

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

Paul Smolensky
Krieger-Eisenhower Professor of Cognitive Science: grammatical theory, neural networks, optimality theory.

Alan Yuille
Bloomberg Distinguished Professor of Cognitive Science and Computer Science: computational models of vision, mathematical models of cognition, and artificial intelligence and neural networks

Associate Professor
Colin Wilson
Associate Professor: theoretical phonology, experimental phonology, computational cognitive science.

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

Secondary Appointments
Marina Bedny
Assistant Professor (Psychological and Brain Sciences): brain development and plasticity, cognitive neuroscience, concepts.

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

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

Jonathan Flombaum
Assistant Professor (Psychological and Brain Sciences): Visual perception, attention, cognition.

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

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

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

Mark Chevillet

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

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

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

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 Emeritus (Neurology, School of Medicine; Founder, Mind/Brain Institute): neurological and cognitive changes after cardiac surgery.

Nazbanou "Bonnie" Nozari
Assistant Professor (Neurology, School of Medicine): monitoring and metacognitive processes over language, selective attention in language production, computational models of language production, aphasia.

Benjamin Van Durme
Assistant Research Professor (Computer Science, Whiting School of Engineering, Senior Research Scientist, Human Language Technology Center of Excellence): natural language processing, specifically semantics; streaming/randomized algorithms.

For current course information and registration go to https://sis.jhu.edu/classes/

Courses

**AS.050.101. Cognition. 3.00 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; S. Park
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.102. Language and Mind. 3.00 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. Cross-listed with Neuroscience and Psychology.
Instructor(s): J. Yarmolinskaya
Area: Natural Sciences, Social and Behavioral Sciences.
**AS.050.105. Introduction to Cognitive Neuropsychology. 3.00 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.
Instructor(s): M. McCloskey
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.106. Cognitive Neuroscience: Exploring the Living Brain. 3.00 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, 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 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.050.107. Language and Advertising. 3.00 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? Theories of communication we explore include Gricean 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.

**AS.050.108. Theory of Mind and the Development of Language. 1.00 Credit.**
The course offers an overview of recent research on language and social cognition. It focuses on Theory of Mind (ToM) and the development of language. Theory of Mind is the ability to attribute mental states to oneself and others and to understand that others have beliefs, desires, and intentions that are different from one's own. The development of human language is closely related to the development of ToM.
Instructor(s): A. Tamm
Area: Natural Sciences, Social and Behavioral Sciences.

**AS.050.124. Freshmen Seminar: Born to Talk: Language in the Human Mind. 3.00 Credits.**
Human infants learn their native language in less than 5 years with no direct teaching from adults. This mysterious fact is the basis of the modern study of language as a cognitive and computational system. In this seminar we will review major findings about how children learn the sound system, words, and grammar of their first language, focusing on how the evidence reveals the role of biological structures and environmental influences on language development. Weekly readings will include summary texts, original research articles, and coverage of language science in the popular media. Although language development is a topic of real importance to parents, educators, and policy-makers, it is often difficult to disseminate findings in a way that the public can understand. In weekly writing assignments, students will practice “translating” scientific reasoning for a general audience. Freshman Seminar
Instructor(s): S. Lewis
Area: Natural Sciences, Social and Behavioral Sciences.
AS.050.312. Cognitive Neuroimaging Methods in High-Level Vision. 3.00 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. 
Instructor(s): S. Park
Area: Natural Sciences, Social and Behavioral Sciences.

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).
Prerequisites: AS.050.105 OR AS.050.203 OR AS.080.203 OR AS.050.101 OR AS.200.110 OR AS.200.211 OR instructor’s permission
Instructor(s): M. McCloskey
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.317. Semantics I. 3.00 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.
Prerequisites: AS.050.101 OR AS.050.107 OR AS.050.102 OR AS.050.128
Instructor(s): K. Rawlins
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.318. Practicum in Language Disorders-Community Based Learning. 2.00 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. Independent mode of transportation required. Co-listed as AS.080.400 in Neuroscience. Additional information can be found on the Department of Neuroscience’s website: http://krieger.jhu.edu/neuroscience/academics/practicums/practicum-in-language-disorders. Interested students should contact the instructor. Find out more about the practicum site at http://www.scalebaltimore.org. 
Prerequisites: AS.050.105 OR AS.050.203 OR AS.080.203 OR AS.050.311 OR instructor’s permission.
Instructor(s): B. Rapp
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.319. Visual Cognition. 3.00 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. 3.00 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: AS.050.102 OR AS.050.240
Instructor(s): G. Legendre
Area: Natural Sciences, Social and Behavioral Sciences.
AS.050.321. Syntax II. 3.00 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. 3.00 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. 3.00 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. Also offered as AS.050.625.
Instructor(s): C. Wilson
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.326. Foundations of Cognitive Science. 3.00 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.050.332. Developmental Cognitive Neurosciences. 3.00 Credits.
In-depth examination of the current literature on cognitive development in the context of developmental cognitive neuroscience. Please see course prerequisites. Meets with AS.050.632.
Prerequisites: AS.050.101 OR AS.050.339 OR AS.200.132 OR AS.050.105 OR Instructor’s Permission.
Instructor(s): B. Landau
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.333. Psycholinguistics. 3.00 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. Also offered as AS.050.633.
Prerequisites: AS.050.102 OR AS.050.128 OR AS.050.240 OR AS.050.317 OR AS.050.320 OR AS.050.325
Instructor(s): E. Atkinson
Area: Natural Sciences, Social and Behavioral Sciences
Writing Intensive.

AS.050.339. Cognitive Development. 3.00 Credits.
This is a survey course in developmental psychology, designed for individuals with some basic background in psychology or cognitive science, but little or none in development. The course is strongly theoretically oriented, with emphasis on issues of nature, nurture, and development. We will consider theoretical issues in developmental psychology as well as relevant empirical evidence. The principle focus will be early development, i.e., from conception through middle childhood. The course is organized topically, covering biological and prenatal development, perceptual and cognitive development, the nature and development of intelligence, and language learning. Also listed as AS.050.639. Cross-listed with Neuroscience. Instructor’s approval required.
Instructor(s): J. Yarmolinskaya
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.345. Cognitive and Neural Basis of Executive Control. 3.00 Credits.
This course discusses the concept of executive control, a general class of functions that support more specialized cognitive operations such as language and problem solving, and their neural underpinning. Discussion will include classification of executive functions, relationship to working memory, domain-generality or specificity of executive control functions, and experimental, neural, and computational approaches to exploring components of executive control, with a special emphasis on the role of cognitive control in the processing of language. The goal of this course is two-fold: to teach students the basic knowledge regarding cognitive and neural mechanisms of executive control, and more importantly to encourage them to put that knowledge to use by asking them to think critically about the readings, to participate in interactive discussions with questions they bring in each week based on the readings assigned for that week, and finally to propose one well thought-out question at the end of the semester and to write a short proposal on how to explore that question. As such, the course puts little emphasis on memorization and a strong emphasis on analytical abilities and integration.
Prerequisites: AS.200.207[C] OR AS.050.333[C] OR EN.550.111[C]
Instructor(s): N. Nozari
Area: Natural Sciences, Social and Behavioral Sciences.
AS.050.370. Mathematical Models of Language. 3.00 Credits.
This course will be devoted to the study of formal systems that have proven useful in the cognitive science of language. We will discuss a wide range of mathematical structures and techniques and demonstrate their applications in theories of grammatical competence and performance. A major goal of this course is bringing students to a point where they can evaluate the strengths and weaknesses of existing formal theories of cognitive capacities, as well as profitably engage in such formalization, constructing precise and coherent definitions and rigorous proofs. Also offered as AS.050.670.
Prerequisites: AS.050.101[C] OR AS.050.102[C] OR AS.050.128[C]
Instructor(s): K. Rawlins
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.371. Bayesian Inference. 3.00 Credits.
This course introduces techniques for computational modeling of aspects of human cognition, including perception, categorization, and induction. Possible topics include maximum likelihood and Bayesian inference, structured statistical models (including hierarchical and graphical models), nonparametric models. The course emphasizes the close connections among data analysis, theory development, and modeling, with examples drawn from language and vision.
Instructor(s): C. Wilson
Area: Natural Sciences, Social and Behavioral Sciences.

AS.050.372. Foundations of Neural Network Theory. 4.00 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: AS.110.106 OR AS.110.108
Instructor(s): P. Smolensky
Area: Natural Sciences, Quantitative and Mathematical Sciences.

AS.050.373. Neural-Network Modeling of Learning, Language and Cognition. 3.00 Credits.
Connectionism is an approach to Artificial Intelligence computation inspired by how the brain, a network of neurons, works. A connectionist model (or artificial neural network) is a collection of simple processing units that are massively interconnected with each other, and that represents knowledge in its connection pattern. Each processing unit has highly limited computational power but the collection of units as a whole has great computational power (as strong as the Turing machine). Connectionist models have been used to study diverse aspects of human cognition: attention, pattern recognition, memory, categorization, language processing, learning, and decision making. In this seminar, students will learn important concepts, principles, algorithms, and practical skills in connectionist modeling by actually doing connectionist modeling. Students will first play with toy problems to learn various types of connectionist modeling techniques, and will then carry out a team research project. In addition to practical skills, students will learn to be explicit about their assumptions and reasoning when making their (conceptual or implemented) models and to make new observable predictions that can be tested in experiments.Recommended Course Background: Experience with some programming language. Exceptions can be made by seeking instructor's permission.
Instructor(s): P. Cho
Area: Natural Sciences, Quantitative and Mathematical Sciences.

AS.050.375. Probabilistic Models of the Visual Cortex. 3.00 Credits.
The course gives an introduction to computational models of the mammalian visual cortex. It covers topics in low-, mid-, and high-level vision. It briefly discusses the relevant evidence from anatomy, electrophysiology, imaging (e.g., fMRI), and psychophysics. It concentrates on mathematical modeling of these phenomena taking into account recent progress in probabilistic models of computer vision and developments in machine learning, such as deep networks. Co-listed with Computer Science as EN.600.485.
Prerequisites: Pre-reqs: AS.110.106 OR AS.110.108
Instructor(s): A. Yuille
Area: Quantitative and Mathematical Sciences.

AS.050.446. Integrative Research Methods in Cognitive Science. 3.00 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.050.501. Readings in Cognitive Science/Freshmen. 3.00 Credits.
Research current topics in cognitive science.
Instructor(s): Staff.

AS.050.502. Readings in Cognitive Science-Freshmen. 3.00 Credits.
Permission Required.
Instructor(s): Staff.

AS.050.503. Research in Cognitive Science/Freshmen. 3.00 Credits.
Research current topics in cognitive science.
Instructor(s): Staff.

AS.050.504. Research Cognitive Science-Freshmen. 0.00 - 3.00 Credits.
Permission Required.
Instructor(s): Staff.

AS.050.505. Readings in Cognitive Science/Sophomores. 1.00 - 3.00 Credits.
Research current topics in cognitive science.
Instructor(s): Staff.

AS.050.506. Readings in Cognitive Science-Sophomores. 0.00 - 3.00 Credits.
Permission Required.
Instructor(s): Staff.

AS.050.507. Research in Cognitive Science/Sophomores. 3.00 Credits.
Research current topics in cognitive science.
Instructor(s): Staff.

AS.050.508. Research Cognitive Science-Sophomores. 0.00 - 3.00 Credits.
Permission Required.
Instructor(s): Staff.

AS.050.509. Cognitive Science Internship. 1.00 Credit.
Research current topics in cognitive science.
Instructor(s): Staff.

AS.050.510. Cognitive Science Internship. 0.00 - 3.00 Credits.
Permission Required.
Instructor(s): Staff.

AS.050.511. Readings in Cognitive Science/Juniors. 3.00 Credits.
Research current topics in cognitive science.
Instructor(s): Staff.
Visual Cognition

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: 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.

Developmental Cognitive Neuroscience

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.

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.

Probability Models of the Visual Cortex

The course gives an introduction to computational models of the mammalian visual cortex. It covers topics in low-, mid-, and high-level vision. It briefly discusses the relevant evidence from anatomy, electrophysiology, imaging (e.g., fMRI), and psychophysics. It concentrates on mathematical modelling of these phenomena taking into account recent progress in probabilistic models of computer vision and developments in machine learning, such as deep networks. Also offered as AS.050.375. Co-listed with Computer Science as EN.600.485

Instructor(s): A. Yuille.
AS.050.690. Directed Readings in Cognitive Science. 3.00 Credits.
Directed readings on current topics in cognitive science. Instructor approval required.
Instructor(s): Staff.

AS.050.800. Directed Readings. 3.00 Credits.
Guided independent readings in special fields of cognitive science.
Instructor(s): P. Smolensky.

AS.050.801. Research Seminar in Cognitive Neuropsychology. 3.00 Credits.
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. 3.00 Credits.
Permission required. Current issues and ongoing research on human cognition are discussed.
Instructor(s): B. Landau.

AS.050.811. Research Seminar in Language & Cognition. 3.00 Credits.
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): A. Yuille.

AS.050.814. Research Seminar in Computer Vision. 3.00 Credits.
This course covers advanced topics in computational vision. It discusses and reviews recent progress and technical advances in visual topics such as object recognition, scene understanding, and image parsing.
Instructor(s): A. Omaki; G. Legendre; K. Rawlins.

AS.050.817. Research Seminar in Semantics. 3.00 Credits.
A critical analysis of current issues and debates in natural language semantics. Discussion of on-going research.
Instructor(s): K. Rawlins.

AS.050.818. Research Seminar: AcqLab Meeting. 3.00 Credits.
Participants in this graduate seminar will read and discuss current research articles in language development and present their own research.
Instructor(s): G. Legendre.

AS.050.821. Research Seminar: Sentence++. 3.00 Credits.
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; K. Rawlins.

AS.050.822. Research Seminar Syntax. 3.00 Credits.
A critical analysis of current issues and debates in theoretical syntax. Discussion of on-going research.
Instructor(s): G. Legendre.

AS.050.823. Research Seminar in Phonology. 3.00 Credits.
Permission required.
Instructor(s): C. Wilson.

AS.050.825. Research Seminar in Optimality Theory. 3.00 Credits.
A specialized research seminar on constraint based theories of human language, including Optimality Theory, Harmonic Grammar, and Maximum Entropy models.
Instructor(s): G. Legendre.

AS.050.826. Research Seminar in Formal Approaches to Cognitive Science. 3.00 Credits.
Readings and research presentations on varying topics in mathematics, computation, and formal linguistics with bearing on cognitive science.
Instructor(s): C. Wilson.

AS.050.827. Research Seminar in Language Acquisition. 3.00 Credits.
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. 3.00 Credits.
This seminar will read on-going and recent papers on the cognitive neuroscience research of vision. Permission required.
Instructor(s): S. Park.

AS.050.829. Research Seminar on Formal Theory in Cognitive Science. 3.00 Credits.
Topics range from mathematical analysis of neural networks to computational studies of linguistic structure. Focus is ongoing research and current literature.
Instructor(s): P. Smolensky.

AS.050.832. Research Seminar in Language Processes. 3.00 Credits.
Current Topics in Human Language Processing, with discussion of recent developments in theory and experimental study. Permission required.
Instructor(s): A. Omaki.

AS.050.839. Research in Cognitive Science. 3.00 Credits.
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.050.849. Teaching Practicum. 3.00 Credits.
Permission required. Essential for Teaching Assistants.
Instructor(s): Staff.

AS.050.860. Professional Seminar in Cognitive Science. 3.00 Credits.
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.050.880. Dissertation Research. 3.00 Credits.
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. 3.00 Credits.
This course surveys theory and research concerning how the human brain carries out mental processes. The sections of this course correspond with the sections listed for AS.020.203. All sections will meet together on exams day and guest lecture days. 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. 3.00 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.
Prequisites: AS.080.305 OR AS.080.203 OR AS.050.203 OR AS.200.141 OR AS.020.312 or permission of the instructor.
Instructor(s): D. Boatman
Area: Natural Sciences.

Psychological Brain Sciences
AS.200.336. Foundations of Mind. 4.00 Credits.
An interdisciplinary investigation into the innateness of concepts: perception, number, language, and morality, physics discussed. Evidence from animals, infants, patients, brains. Students collect data in sections investigating claims from the readings. Cross-listed with Cognitive Science and Philosophy.
Instructor(s): J. Halberda; L. Feigenson
Area: Social and Behavioral Sciences.

AS.200.367. Episodic Memory in Human and Nonhuman Animals. 3.00 Credits.
Episodic memory, or autobiographical memory, has been said to be a capacity that is uniquely human. Consisting of the what, when, and where components of our experiences, episodic memory is what makes each of us who we are. This course will explore each of these components individually—the psychology and neural underpinnings of each component—before discussing them in combination as episodic memory. Finally, we will visit one of the greatest ongoing debates in the memory literature: whether or not this ability is truly uniquely human or if our nonhuman animal counterparts also have this capacity. Throughout the course, we will draw on evidence from empirical articles based on studies in a variety of species including rodents, primates, and birds.
Prerequisites: AS.200.101 OR AS.200.141 OR AS.080.105 OR (AS.080.305 AND AS.080.306) OR Permission required.
Instructor(s): J. Asem
Area: Natural Sciences, Social and Behavioral Sciences.

Music
AS.376.371. Introduction to Music Cognition. 3.00 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. Topics in Music Cognition. 3.00 Credits.
This course explores 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. 3.00 Credits.
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.