COGNITIVE SCIENCE

https://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 (https://cogsci.jhu.edu/research-areas/labs/):

- Cognitive and Brain Sciences Lab (Rapp)
- Cognitive Neuroscience Lab (McCloskey)
- Cognitive Neuroscience and Machine Learning Lab (Bonner)
- Computational Cognitive Neuroscience Lab (Isik)
- Computational Cognition, Vision, & Learning (CCVL) Research Group (Yuille)
- Computational Psycholinguistics Lab (Hu)
- Language Creation & Learning Lab (Kocab)
- Language Acquisition Lab (Legendre)
- Language and Cognition Lab (Landau)
- Phonetics/Phonology Lab (Wilson)
- Semantics Lab (Rawlins)
- Sociophonetics Lab (Renwick)

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.

Programs

- Cognitive Science, Bachelor of Arts (https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/cognitive-science/cognitive-science-bachelor-arts/)
- Cognitive Science, Master of Arts (https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/cognitive-science/cognitive-science-master-art/)
- Cognitive Science, PhD (https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/cognitive-science/cognitive-science-phd/)
- Linguistics, Minor (https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/cognitive-science/linguistics-minor/)

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

Courses

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.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Science and Data (FA2), Ethics and Foundations (FA5)

AS.050.105. Introduction 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.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Writing and Communication (FA1), Science and Data (FA2), Projects and Methods (FA6)
Writing Intensive

AS.050.116. Visual Cognition. 3 Credits.
How do humans make sense of the visual world around them? This course will provide an introductory survey of current research, methods, and theories in visual cognition. We will draw upon topics in cognitive psychology, cognitive neuroscience, cognitive neuropsychology, and artificial intelligence.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

AS.050.135. Speech & Voice. 3 Credits.
Course on human speech production and perception, covering topics including anatomy and physiology of the vocal tract, phonetic analysis, language acquisition and impairments, and speech technologies.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

AS.050.202. Introduction to Computational Cognitive Science. 3 Credits.
How does the mind work? Cognitive science addresses this question from a multidiscliplinary perspective, drawing upon methods and ideas from psychology, neurophysiology, neuroscience, philosophy, linguistics, and computer science. Within this framework, computational cognitive science has two related goals. The first is to create computational models of human cognition, computer programs that simulate certain aspects of the mind. The second is to understand how to produce intelligent behavior in machines, taking cues from humans. The computational frameworks we will discuss include symbolic structured representations, probabilistic inference and artificial neural networks, as applied to concept learning, language and vision. While this class does not have formal prerequisites, some programming experience (e.g., AS 250.205 Introduction to Computing or equivalent) and mathematical preparation (e.g., AS.110.107 Calculus II or equivalent) are essential.An optional, hands-on lab (AS.050.212) is offered to supplement this course. It is highly recommended that students with less extensive computational and mathematical experience register for this lab.
Distribution Area: Quantitative and Mathematical Sciences
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

AS.050.203. Neuroscience: Cognitive. 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, 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. Also offered as AS.050.603.It's strongly recommended that students have background in one of the following courses: AS.050.105 OR AS.200.141.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Science and Data (FA2), Ethics and Foundations (FA5)

AS.050.206. Bilingualism. 3 Credits.
How do we juggle multiple languages in our brain? 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 languages 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 cognitive and neural processes underlying bilingual and multilingual language processing. Also offered as AS.050.606.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Writing and Communication (FA1), Science and Data (FA2)
Writing Intensive

AS.050.212. Introduction to Computational Cognitive Science Lab. 0.5 Credits.
This course is a hands-on lab supplement for AS.050.202 Introduction to Computational Cognitive Science. While this lab is optional, it is highly recommended to students with less extensive computational and mathematical experience.
Corequisite(s): Must be registered for AS.050.202 in order to register for this optional lab.
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

AS.050.236. Neurolinguistics. 3 Credits.
This course provides an introductory survey of the cognitive neuroscience of language – a multidisciplinary field in the intersection of Linguistics, Psycholinguistics, and Neuroscience. We will explore current research on the neural bases of the perception, production, and acquisition or human language in neuro-typical and impaired individuals.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Writing and Communication (FA1), Science and Data (FA2), Projects and Methods (FA6)
Writing Intensive

AS.050.239. Cognitive Development. 3 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, and development 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 offered as AS.050.639.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Science and Data (FA2), Ethics and Foundations (FA5)

AS.050.244. Cognitive Neuroscience Lab. 3 Credits.
This course aims to provide a deeper understanding of cognitive neuroscience methods and theory on certain contemporary topics in the field through a series of labs and activities. Example labs include building psychophysical experiments using PsychoPy, exploring the brain using MRI images using MRIcron and developing artificial neural networks using simBrain. Basic cognitive neuroscience theories will be discussed in class before each lab/activity to bring everyone to the same page. Emphasis will be placed on developing a scientific mindset in approaching problems. You will build your own experiment from your own idea and execute it in-class. No pre-requisite required.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Writing and Communication (FA1), Science and Data (FA2), Projects and Methods (FA6)
Writing Intensive

AS.050.308. Acoustic Phonetics. 3 Credits.
This course explores theories of speech sound generation in the human vocal system, in order to learn the relationships between discrete linguistic classes of sounds and their articulatory and acoustic manifestations. Foundations for these theories include an understanding of the anatomy employed during speech, as well as principles of airflow and pressure, which are united in the source-filter theory of speech production. As speech unfolds in time, the resulting acoustic signal is altered according to the vocal tract's configuration, leading to characteristic acoustic manifestations for vowels and consonants. These phonetic cues, in turn, ground formal phonological representations via distinctive feature theory. The course includes a practical introduction to measurement of the acoustic correlates of speech sounds.
Prerequisite(s): AS.050.102 OR AS.050.325
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

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 to address a research question developed from readings. Students are expected to write a paper in a short 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 high-level visual processing.
Prerequisite(s): AS.050.105 OR AS.050.116 OR AS.050.203 OR AS.050.315 OR AS.050.332 OR AS.200.110
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

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 aphantasia (lack of visual imagery).
Prerequisite(s): 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.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Writing and Communication (FA1), Science and Data (FA2), Projects and Methods (FA6)
Writing Intensive

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.
Prerequisite(s): AS.050.107 OR AS.050.102 or AS.050.240 or instructor's permission.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

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.
Prerequisite(s): AS.050.102 OR AS.050.240 or equivalent/see instructor.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

AS.050.321. Syntax II. 3 Credits.
Building on AS.050.320, this course addresses and compares conceptions of syntactic theory that have emerged since the 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 motivates them. In particular, we will contrast the Principles and Parameters view where syntactic theory relies on a set of inviolable principles whose form admits a certain amount of cross-linguistic variation, and the Optimality Theory view whereby constraints are invariant though violable, and cross-linguistic variation is determined by the relative importance of satisfying the various principles. When possible, connections will be made to other areas of linguistic inquiry such as processing, acquisition, and computation. Meets with AS.050.621.
Prerequisite(s): B or higher in AS.050.320 Syntax I or equivalent or permission from the instructor
Distribution 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. Also offered as AS.050.625.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

AS.050.326. Foundations of 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. Also offered 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.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Writing and Communication (FA1), Science and Data (FA2), Ethics and Foundations (FA5)
Writing Intensive

AS.050.332. Developmental Cognitive Neuroscience. 3 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.
Prerequisite(s): AS.050.101 OR AS.050.339 OR AS.200.132 OR AS.050.105 OR Instructor's Permission.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Writing and Communication (FA1), Science and Data (FA2), Ethics and Foundations (FA5)

AS.050.333. Psycholinguistics. 3 Credits.
This course examines the cognitive and neural mechanisms that allow us to use linguistic knowledge to produce and understand language in real time. You will learn about the key findings on language perception, production, and acquisition, while gaining hands-on, laboratory-style experience with some of the methods commonly used to study language performance. The focus of the class is on the relation between experimental findings and linguistic theory, addressing two core questions of psycholinguistics: How is language organized and implemented in the brain? How (if at all) does our mental machinery shape natural language? Also available as AS.050.633.
Prerequisite(s): AS.050.102 OR AS.050.240 OR AS.050.317 OR AS.050.320 OR AS.050.325 or instructor's permission.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Writing and Communication (FA1), Science and Data (FA2), Projects and Methods (FA6)

AS.050.337. Reading the Mind: Computational Cognitive Neuroscience of Vision. 3 Credits.
Recent advancements in neuroscience, computational cognitive science and machine learning have led to new possibilities for understanding the mind and brain. With the current neural network modelling and artificial intelligence (AI) techniques, scientists are able to decode neural representation to understand one's internal mental state. In this course, we will discuss how to utilize the latest technologies, including voxel-wise encoding models, convolutional neural networks (CNNs), generative adversarial networks (GANs) and transformers, to model neural representations with a focus on vision. Students will read latest primary research articles and gain hands-on neural modelling experience. Also offered as AS.050.637
Prerequisite(s): (AS.050.202 OR AS.250.205 OR AS.050.372) AND (AS.050.105 OR AS.050.116 OR AS.050.203) or equivalent with instructor permission.
Distribution Area: Natural Sciences, Quantitative and Mathematical Sciences
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

AS.050.347. Deep Learning for Cognitive Neuroscience. 3 Credits.
Over the last decade, there has been amazing progress in deep learning AI systems for vision and language, and more and more cognitive neuroscientists are using these tools to study the human brain. This course will give an overview of popular deep learning methods, including convolutional neural networks, recurrent neural networks, variational autoencoders, and transformers, with the goal of addressing two key questions: 1) to what extent do these deep learning systems act like humans, and 2) what questions can they help us answer about the human mind and brain. The class will involve a mix of lectures, hands-on coding assignments, and reading/discussion of primary research articles. The course will focus heavily on vision but will include some topics in language (including large language models) and social cognition.
Prerequisite(s): Students who have taken or are enrolled in AS.050.647 are not eligible to take AS.050.347.;(EN.500.112 OR EN.500.113 OR EN.500.114) AND (AS.050.383 OR AS.050.683 OR AS.050.372 OR AS.050.672 OR AS.110.201) AND (AS.050.203 OR AS.050.603)
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

AS.050.348. First Language Acquisition. 3 Credits.
This course provides an introduction to the fields of first and bilingual language acquisition by looking at questions such as the following: Can the grammar of a native language be learned solely on the basis of noticing statistical correlations among words? How does native language acquisition explain — or is explained by — the universal properties, shared by all languages, of words and grammars? How does being exposed to multiple languages from birth affect language acquisition and what happens when a child is not exposed to any language early in life? This is the first part of a two-part course sequence on first and second language acquisition.
Prerequisite(s): AS.050.240 OR AS.050.320 OR AS.050.325 OR AS.050.102 OR AS.050.206
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Science and Data (FA2), Ethics and Foundations (FA5)

AS.050.349. Second Language Acquisition. 3 Credits.
First language acquisition is natural and seemingly effortless. The situation is reversed when one tries to learn another language. This course discusses in what ways first and second language acquisition (SLA) differ and how individual differences of the learners as well as external factors contribute to the variability observed in rates and ultimate proficiency of second language learning in children and adults. We will discuss such topics as Universal Grammar access in early and late SLA, first language influence, critical periods, possibility of native-like attainment, and language attrition. Also offered as AS.050.649.
Prerequisite(s): AS.050.102 OR AS.050.206 OR AS.050.320 OR AS.050.325 OR AS.050.348
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

AS.050.357. Sociophonetics. 3 Credits.
An introduction to the emerging field of sociophonetics, which lies at the interface between sociolinguistics and phonetics. Students will learn how to analyze phonetic data in service of research questions motivated by social factors including speakers' region of origin, gender, ethnicity, or other characteristics. Extensions will be made to articulatory phonetics, speech perception, and phonological formalizations. Knowledge of linguistics and phonology/phonetics, including the International Phonetic Alphabet and basic acoustic phonetics, is strongly recommended. The course will draw material from textbooks, scholarly articles, and hands-on phonetic analysis culminating in final projects on topics chosen by students. It is recommended that students have successfully completed AS.050.325 Phonology I prior to enrollment in this course.
Prerequisite(s): AS.050.102 or permission of instructor
AS Foundational Abilities: Science and Data (FA2), Citizens and Society (FA4), Projects and Methods (FA6)
EN Foundational Abilities: Engagement with Society (FA4)

AS.050.358. Language & Thought. 3 Credits.
Have you ever wondered about the relationships between language and thought? Philosophers, linguists, psychologists, evolutionary theorists and cognitive scientists have too and this course will survey the current thinking on this matter. Classical papers such as those by Whorf and Sapir, more recent philosophical papers by people such as Fodor and Dennett, and recent empirical work by linguists and psycholingists on the relationship between language and thinking in development and in adults will be covered. Discussions will focus on the theoretically possible relationships between language and thought and the empirical data that speak to these. Juniors and seniors only. Freshmen and sophomores by permission of instructor only.
Prerequisite(s): AS.050.102 OR AS.050.320 OR AS.050.325 or instructor permission.
Distribution Area: Humanities, Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Writing and Communication (FA1), Science and Data (FA2), Ethics and Foundations (FA5)
Writing Intensive

AS.050.365. Cracking the code: Theory and modeling of information coding in neural activity. 3 Credits.
One of the most foundational concepts in neuroscience is the idea that neural activity encodes information about an animal's sensory environment and internal mental states. This idea is closely connected to the concept of mental representation in cognitive science and philosophy, whereby the mind is proposed to contain internal symbols that represent things in the external world. There have been many fascinating discoveries about how neural signals encode information, but we are still far from a comprehensive theory of neural representation. Recent major developments in neuroscience and machine learning have opened up a new world of possibilities for investigating the underlying principles of information coding in the brains of humans and other animals.
In this course, we will discuss primary research articles on neural representation and information processing, and students will implement computational analyses that address issues in these domains. We will mostly focus on vision as a system that illustrates broader principles of information processing in the human brain. The reading material will include work from philosophy, neuroimaging, electrophysiology, and computational modeling. The topics covered include mental and neural representation, neural tuning, population coding, information theory, encoding and decoding models, dimensionality reduction, computational models, deep learning, and other applications of machine learning in neuroscience. Enrollment is limited to Juniors and Seniors. While this class does not have formal prerequisites, programming experience (e.g., AS 250.205 Introduction to Computing) and mathematical preparation (e.g., AS.110.107 Calculus II) are essential. It is also highly recommended that students have previously taken introductory courses in cognitive or systems neuroscience (e.g., AS.050.203 Neuroscience: Cognitive) and machine learning or neural network modeling (e.g., AS.050.372 Foundations of Neural Network Theory).
Distribution Area: Natural Sciences, Quantitative and Mathematical Sciences
AS Foundational Abilities: Writing and Communication (FA1), Science and Data (FA2), Projects and Methods (FA6)

AS.050.371. Bayesian Inference. 3 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. Also offered as AS.050.671.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

AS.050.372. Foundations of Neural Network Theory. 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. Recommended course background in Calculus I. This is a basic-level course not appropriate for students with significant math background. tudents who have completed both Calc III (AS.110.202 or AS.110.211) and Linear Algebra (AS.110.201 or AS.110.212 or EN.553.291) or an equivalent combination may not register. Also offered as AS.050.672.
Prerequisite(s): Students who have completed both (AS.110.202 OR AS.110.211) AND (AS.110.201 OR AS.110.212 OR EN.553.291) or an equivalent combination may not register.
Distribution Area: Natural Sciences, Quantitative and Mathematical Sciences
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

AS.050.375. Probabilistic Models of the Visual Cortex. 3 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. Also offered as EN.601.485.Required Background: Calculus I and experience in a programming language (Python preferred).
Prerequisite(s): Students who are currently enrolled in, or have already taken EN.601.485/EN.601.685/AS.050.675, are not eligible to take AS.050.375.;AS.110.106 OR AS.110.108
Distribution Area: Quantitative and Mathematical Sciences
AS Foundational Abilities: Science and Data (FA2)

AS.050.383. Computational Social Cognition. 3 Credits.
Humans are a fundamentally social species with amazing capabilities beyond that of any other biological or artificial system. Yet the cognitive and neural computations underlying our vast social abilities are largely unknown. Advances in machine learning and naturalistic neuroscience paradigms are revolutionizing the way cognitive scientists study social cognition. This course will explore new research in computational social cognition, drawing from topics in development, artificial intelligence, and cognitive neuroscience. Our goal is to understand the motivation, methodology and implications of recent research. The class will be heavily focused on social vision, but will also explore other aspects of social cognition including theory of mind and moral reasoning. This is a discussion-based class that will consist primarily of reading and discussing primary research articles, as well as student-led presentations. While there will not be any hands-on computational exercises, a background in both cognitive neuroscience and computational methods are important to understanding the readings and other course material.
Prerequisite(s): AS.050.203 AND AS.050.202 or equivalent.
Distribution Area: Natural Sciences, Quantitative and Mathematical Sciences
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

AS.050.500. 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. Independent mode of transportation required. Co-listed as AS.080.505 in Neuroscience. Find out more about the practicum site at https://www.leagueforpeople.org/scale.
Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.;A- or Better in AS.050.105 OR AS.050.203 OR AS.050.311 or instructor's permission.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

AS.050.510. Cognitive Science Internship. 1 Credit.
For internships in cognitive science-related fields. Graded S/U only. Student cannot recieve credit for paid internships. A Cognitive Science faculty sponsor is required and must be named in the Independent Academic Work form. Please read the relevant independent academic work FAQ. KSAS primary majors, visit https://advising.jhu.edu/research-internships-and-independent-study/. WSE primary majors, visit https://engineering.jhu.edu/advising/advising-questions/.
Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

AS.050.515. Readings in Cognitive Science. 1 - 3 Credits.
Assigned readings on current topics in cognitive science. Instructor approval required. Letter-graded.
Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.
AS Foundational Abilities: Science and Data (FA2)

AS.050.550. Undergraduate Teaching Practicum in Cognitive Science. 1 - 3 Credits.
By invitation, qualified students may serve as undergraduate Teaching Assistants for cognitive science courses and receive credit. This practicum is graded S/U. Each section instructor will determine TA responsibilities based upon departmental policy. Students who accept an invitation should make a request in SIS to add the instructor's teaching practicum section. Students may not both receive credit and be paid for the same undergraduate teaching position. This course may not be used toward cognitive science major degree requirements.
Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.
AS Foundational Abilities: Science and Data (FA2)

AS.050.599. Research in Cognitive Science. 1 - 3 Credits.
Research current topics in cognitive science. Instructor approval required. Graded S/U.
Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.
AS Foundational Abilities: Writing and Communication (FA1), Science and Data (FA2), Projects and Methods (FA6)
Writing Intensive

AS.050.602. Introduction to Computational Cognitive Science. 3 Credits.
How does the mind work? Cognitive science addresses this question from a multidiscliplinary perspective, drawing upon methods and ideas from psychology, neurophysiology, neuroscience, philosophy, linguistics, and computer science. Within this framework, computational cognitive science has two related goals. The first is to create computational models of human cognition, computer programs that simulate certain aspects of the mind. The second is to understand how to produce intelligent behavior in machines, taking cues from humans. The computational frameworks we will discuss include symbolic structured representations, probabilistic inference and artificial neural networks, as applied to concept learning, language and vision. Some programming experience and mathematical preparation are essential if interested in this course. Interested undergraduate students should enroll in AS.050.202.
Prerequisite(s): Students who have taken, or are currently enrolled in, AS.050.202 are not eligible to take AS.050.602.

AS.050.603. Intro to Cognitive Neuroscience. 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, 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. Also offered as AS.050.203.
Distribution Area: Natural Sciences, Social and Behavioral Sciences

AS.050.606. Intro to 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. Also listed as AS.050.206.

AS.050.608. Acoustic Phonetics. 3 Credits.
This course explores theories of speech sound generation in the human vocal system, in order to learn the relationships between discrete linguistic classes of sounds and their articulatory and acoustic manifestations. Foundations for these theories include an understanding of the anatomy employed during speech, as well as principles of airflow and pressure, which are united in the source-filter theory of speech production. As speech unfolds in time, the resulting acoustic signal is altered according to the vocal tract's configuration, leading to characteristic acoustic manifestations for vowels and consonants. These phonetic cues, in turn, ground formal phonological representations via distinctive feature theory. The course includes a practical introduction to measurement of the acoustic correlates of speech sounds.

AS.050.612. 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 to address a research question developed from readings. Students are expected to write a paper in a short 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 high-level visual processing. Cross-listed with Neuroscience and Psychology.

AS.050.617. Semantics I. 3 Credits.
Also offered as AS.050.317. 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.
Distribution Area: Natural Sciences, Social and Behavioral Sciences

AS.050.620. 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.050.320.

AS.050.621. Syntax II.
Co-taught with AS.050.321. Building on AS.050.320, this course addresses and compares conceptions of syntactic theory that have emerged since the 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 motivates them. In particular, we will contrast the Principles and Parameters view where syntactic theory relies on a set of inviolable principles whose form admits a certain amount of cross-linguistic variation, and the Optimality Theory view whereby constraints are invariant though violable, and cross-linguistic variation is determined by the relative importance of satisfying the various principles. When possible, connections will be made to other areas of linguistic inquiry such as processing, acquisition, and computation.
Distribution Area: Natural Sciences, Social and Behavioral Sciences

AS.050.625. 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. Also offered as AS.050.325.
Distribution Area: Natural Sciences, Social and Behavioral Sciences

AS.050.626. Foundations of Cognitive Science. 3 Credits.
Also offered as AS.050.326. 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. Also offered as AS.050.326.
Distribution Area: Natural Sciences, Social and Behavioral Sciences
Writing Intensive

AS.050.632. Developmental Cognitive Neuroscience. 3 Credits.
In-depth examination of the current literature on cognitive development in the context of developmental cognitive neuroscience. Meets with AS.050.332.

AS.050.633. Psycholinguistics. 3 Credits.
This course examines the cognitive and neural mechanisms that allow us to use linguistic knowledge to produce and understand language in real time. You will learn about the key findings on language perception, production, and acquisition, while gaining hands-on, laboratory-style experience with some of the methods commonly used to study language performance. The focus of the class is on the relation between experimental findings and linguistic theory, addressing two core questions of psycholinguistics: How is language organized and implemented in the brain? How (if at all) does our mental machinery shape natural language? Also available as AS.050.333.

AS.050.636. Intro to Neurolinguistics. 3 Credits.
This course provides an introductory survey of the cognitive neuroscience of language – a multidisciplinary field in the intersection of Linguistics, Psycholinguistics, and Neuroscience. We will explore current research on the neural bases of the perception, production, and acquisition or human language in neuro-typical and impaired individuals. Also listed as AS.050.236.

AS.050.637. Reading the Mind: Computational Cognitive Neuroscience of Vision. 3 Credits.
Recent advancements in neuroscience, computational cognitive science and machine learning have led to new possibilities for understanding the mind and brain. With the current neural network modelling and artificial intelligence (AI) techniques, scientists are able to decode neural representation to understand one's internal mental state. In this course, we will discuss how to utilize the latest technologies, including voxel-wise encoding models, convolutional neural networks (CNNs), generative adversarial networks (GANs) and transformers, to model neural representations with a focus on vision. Students will read latest primary research articles and gain hands-on neural modelling experience. Recommended course background: At least one course in each cognitive neuroscience and introduction to computing. Also offered as AS.050.373

AS.050.639. Cognitive Development. 3 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, and development 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 offered as AS.050.239.

AS.050.647. Deep Learning for Cognitive Neuroscience. 3 Credits.
Over the last decade, there has been amazing progress in deep learning AI systems for vision and language, and more and more cognitive neuroscientists are using these tools to study the human brain. This course will give an overview of popular deep learning methods, including convolutional neural networks, recurrent neural networks, variational autoencoders, and transformers, with the goal of addressing two key questions: 1) to what extent do these deep learning systems act like humans, and 2) what questions can they help us answer about the human mind and brain. The class will involve a mix of lectures, hands-on coding assignments, and reading/discussion of primary research articles. The course will focus heavily on vision but will include some topics in language (including large language models) and social cognition.
Prerequisite(s): Students who have taken or are currently enrolled in AS.050.347 are not eligible to take AS.050.647.;(AS.050.383 OR AS.050.683 OR AS.050.372 OR AS.050.672) AND (AS.050.203 OR AS.050.603). Graduate students are also recommended to have taken a Gateway Computing or programming/coding course.

AS.050.648. First Language Acquisition. 3 Credits.
This course provides an introduction to the fields of first and bilingual language acquisition by looking at questions such as the following: Can the grammar of a native language be learned solely on the basis of noticing statistical correlations among words? How does native language acquisition explain — or is explained by — the universal properties, shared by all languages, of words and grammars? How does being exposed to multiple languages from birth affect language acquisition and what happens when a child is not exposed to any language early in life? This is the first part of a two-part course sequence on first and second language acquisition.

AS.050.649. Second Language Acquisition. 3 Credits.
First language acquisition is natural and seemingly effortless. The situation is reversed when one tries to learn another language. This course discusses in what ways first and second language acquisition (SLA) differ and how individual differences of the learners as well as external factors contribute to the variability observed in rates and ultimate proficiency of second language learning in children and adults. We will discuss such topics as Universal Grammar access in early and late SLA, first language influence, critical periods, possibility of native-like attainment, and language attrition. Recommended background in at least one of the following: AS.050.102 Language and Mind, AS.050.606 Bilingualism, AS.050.620 Syntax I, AS.050.625 Phonology I, AS.050.648 First Language Acquisition, or equivalent. Recommended background in at least one prior linguistics course.

AS.050.658. Language & Thought. 3 Credits.
Have you ever wondered about the relationships between language and thought? Philosophers, linguists, psychologists, evolutionary theorists and cognitive scientists have too and this course will survey the current thinking on this matter. Classical papers such as those by Whorf and Sapir, more recent philosophical papers by people such as Fodor and Dennett, and recent empirical work by linguists and psycholingists on the relationship between language and thinking in development and in adults will be covered. Discussions will focus on the theoretically possible relationships between language and thought and the empirical data that speak to these.

AS.050.665. Cracking the code: Theory and modeling of information coding in neural activity. 3 Credits.
One of the most foundational concepts in neuroscience is the idea that neural activity encodes information about an animal's sensory environment and internal mental states. This idea is closely connected to the concept of mental representation in cognitive science and philosophy, whereby the mind is proposed to contain internal symbols that represent things in the external world. There have been many fascinating discoveries about how neural signals encode information, but we are still far from a comprehensive theory of neural representation. Recent major developments in neuroscience and machine learning have opened up a new world of possibilities for investigating the underlying principles of information coding in the brains of humans and other animals.
In this course, we will discuss primary research articles on neural representation and information processing, and students will implement computational analyses that address issues in these domains. We will mostly focus on vision as a system that illustrates broader principles of information processing in the human brain. The reading material will include work from philosophy, neuroimaging, electrophysiology, and computational modeling. The topics covered include mental and neural representation, neural tuning, population coding, information theory, encoding and decoding models, dimensionality reduction, computational models, deep learning, and other applications of machine learning in neuroscience. Enrollment is limited to Juniors and Seniors. While this class does not have formal prerequisites, programming experience (e.g., AS.250.205 Introduction to Computing) and mathematical preparation (e.g., AS.110.107 Calculus II) are essential. It is also highly recommended that students have previously taken introductory courses in cognitive or systems neuroscience (e.g., AS.050.203 Neuroscience: Cognitive) and machine learning or neural network modeling (e.g., AS.050.372 Foundations of Neural Network Theory).

AS.050.671. Bayesian Inference. 3 Credits.
Also offered as AS.050.371. 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.
Distribution Area: Natural Sciences, Social and Behavioral Sciences

AS.050.672. Foundations of Neural Network Theory. 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. Recommended course background in Calculus I. This is a basic-level course not appropriate for students with significant math background. Students who have completed both Calc III and Linear Algebra or an equivalent combination may not register. Also offered as AS.050.372.

AS.050.675. Probabilistic Models of the Visual Cortex. 3 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. Also offered as EN.601.685.Required Background: Calculus I and experience in a programming language (Python preferred).
Prerequisite(s): Students who are currently enrolled in, or have already taken EN.601.485/EN.601.685/AS.050.375, are not eligible to take AS.050.675.

AS.050.683. Computational Social Cognition. 3 Credits.
Humans are a fundamentally social species with amazing capabilities beyond that of any other biological or artificial system. Yet the cognitive and neural computations underlying our vast social abilities are largely unknown. Advances in machine learning and naturalistic neuroscience paradigms are revolutionizing the way cognitive scientists study social cognition. This course will explore new research in computational social cognition, drawing from topics in development, artificial intelligence, and cognitive neuroscience. Our goal is to understand the motivation, methodology and implications of recent research. The class will be heavily focused on social vision, but will also explore other aspects of social cognition including theory of mind and moral reasoning. This is a discussion-based class that will consist primarily of reading and discussing primary research articles, as well as student-led presentations. While there will not be any hands-on computational exercises, a background in both cognitive neuroscience and computational methods are important to understanding the readings and other course material.

AS.050.800. Directed Readings in Cognitive Science. 1 - 10 Credits.
Directed readings on current topics in cognitive science. Instructor approval required.

AS.050.801. Research Seminar in Cognitive Neuropsychology. 2 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.

AS.050.802. Research Seminar in Cognitive Processes. 2 Credits.
Permission required. Current issues and ongoing research on human cognition are discussed.

AS.050.806. Research Seminar in Cognitive Neuroscience and Machine Learning. 2 Credits.
Participants in this seminar will read and discuss current research articles in the fields of cognitive neuroscience, computational neuroscience, machine learning, and artificial intelligence. The seminar will focus on research that provides insights into the representations and algorithms of the human brain, with an emphasis on vision and natural semantic understanding.

AS.050.811. Research Seminar in Language & Cognition. 1.5 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.

AS.050.812. Research Seminar in Computational Cognitive Neuroscience. 1.5 Credits.
This seminar will discuss papers and ongoing research in the areas of computational cognitive neuroscience, with a focus on different areas of visual and social perception.

AS.050.813. Research Seminar in Grammar Formalisms. 2 Credits.
Cognitive Science and Computer Science graduate students with interest in sentence-level linguistics are encouraged to attend.

AS.050.814. Research Seminar in Computer Vision. 2 Credits.
This seminar is based on topics in computational vision with the option of attending additional subgroup meetings on specific topics.

AS.050.817. Research Seminar in Semantics. 2 Credits.
A critical analysis of current issues and debates in natural language semantics. Discussion of on-going research. Permission required.

AS.050.819. Research Seminar in Psycholinguistics. 2 Credits.
Discussion of current computational and experimental research on human language processing.

AS.050.822. Research Seminar Syntax. 3 Credits.
A critical analysis of current issues and debates in theoretical syntax. Discussion of on-going research.

AS.050.826. Research Seminar in Formal Approaches to Cognitive Science. 2 Credits.
Readings and research presentations on varying topics in mathematics, computation, and formal linguistics with bearing on cognitive science.

AS.050.827. Research Seminar in Language Acquisition. 3 Credits.
Focus is on current research in acquisition of syntax.

AS.050.829. Research Seminar on Formal Theory in Cognitive Science. 2 Credits.
Topics range from mathematical analysis of neural networks to computational studies of linguistic structure. Focus is ongoing research and current literature.

AS.050.831. Research Seminar in Language Learning, Creation, and Evolution. 1.5 Credits.
Participants in this graduate seminar will read and discuss current research articles in language learning, creation, and evolution. To enroll, students must be actively carrying out empirical or theoretical research in these areas. Permission required.

AS.050.833. Research Seminar in Experimental Syntax. 2 Credits.
This seminar offers a critical exploration of foundational issues and current debates in experimental syntax. Students will engage with recent empirical studies, develop methodological skills, and design their own experiments to investigate syntactic phenomena. Topics will range from data collection and analysis to the interpretation of experimental results in relation to the central findings of theoretical syntax.

AS.050.834. Research Seminar in Computational Neurolinguistics. 2 Credits.
Participants in this graduate seminar discuss papers and ongoing research within the area of computational neurolinguistics. To enroll, students must be actively carrying our empirical or theoretical research in this area.

AS.050.839. Research in Cognitive Science. 1 - 20 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.

AS.050.849. Teaching Practicum. 3 Credits.
Permission required. Essential for Teaching Assistants.

AS.050.850. Current Advances in Cognitive Science. 1 Credit.
Introduces advanced research topics in cognitive science to graduate students through a series of speakers and discussions.

AS.050.860. Professional Seminar in Cognitive Science. 0.5 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.

Cross Listed Courses

Computer Science

EN.601.485. Probabilistic Models of the Visual Cortex. 3 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 modelling of these phenomena taking into account recent progress in probabilistic models of computer vision and developments in machine learning, such as deep networks. Programming experience (Python preferred).
Prerequisite(s): Students who have taken AS.050.375/AS.050.675/EN.601.685 are not eligible to take EN.601.485.;AS.110.106 OR AS.110.108
Distribution Area: Quantitative and Mathematical Sciences
AS Foundational Abilities: Science and Data (FA2)

EN.601.685. Probabilistic Models of the Visual Cortex. 3 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 modelling of these phenomena taking into account recent progress in probabilistic models of computer vision and developments in machine learning, such as deep networks. Programming experience (Python preferred).
Prerequisite(s): Students who have taken AS.050.375/AS.050.675 are not eligible to take EN.601.685.
Distribution Area: Quantitative and Mathematical Sciences

EN.601.783. Vision as Bayesian Inference. 3 Credits.
This is an advanced course on computer vision from a probabilistic and machine learning perspective. It covers techniques such as linear and non-linear filtering, geometry, energy function methods, markov random fields, conditional random fields, graphical models, probabilistic grammars, and deep neural networks. These are illustrated on a set of vision problems ranging from image segmentation, semantic segmentation, depth estimation, object recognition, object parsing, scene parsing, action recognition, and text captioning. Required course background: calculus, linear algebra (AS.110.201 or equiv.), probability and statistics (AS.550.311 or equiv.), and the ability to program in Python and C++.

First Year Seminars

AS.001.146. FYS: Nature, Nurture, Cognition. 3 Credits.
Using both seminal and contemporary readings as a foundation, we will explore the foundations of cognition and how they support human cognitive development, focusing on how 'nature' and 'nurture' collaborate to shape development of the human mind. This semester, we will read at least three, and possibly four books, along with supplementary readings, as appropriate. Our focus will be on understanding the roles of nature and nurture in the context of typical and atypical development, including an understanding of how knowledge about objects, language, number, and other minds all emerge during human development, from infancy to adulthood, in typically and atypically developing individuals.
Distribution Area: Humanities, Social and Behavioral Sciences

AS.001.189. FYS: Language, Advertising, and Propaganda. 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 Gricean pragmatics, theories of speech acts, linguistic theories of presuppositions, and more. Students will collect, analyze, and discuss advertisements in all mediums.
Distribution Area: Humanities, Social and Behavioral Sciences

AS.001.248. FYS: Who has an accent? Dialects of English. 3 Credits.
Language is at the heart of human interaction. What are the linguistic habits that unite or divide us? This First-Year Seminar introduces students to dialects of English speakers around the world. Students will explore the major properties that cross-cut different varieties of English, including regional or socially-driven accents of North America, the United Kingdom, New Zealand and Australia, as well as other World Englishes. Particular attention will be paid to pronunciation, so students will practice the International Phonetic Alphabet and learn acoustic analysis through hands-on activities, but discussion will also focus on dialectal differences in word choice, sentence structure, and linguistic meaning. We will engage with known and emerging varieties of English by drawing on academic sources, multimedia materials, and real-world experience. Who speaks with an accent? Everyone!

AS.001.253. FYS: The Drama of Artificial Intelligence. 3 Credits.
From the rise of machine consciousness to the ethics of automation, artificial intelligence has captured the human imagination. This First-Year Seminar explores how playwrights and theater artists engage with AI as a dramatic subject, a creative tool, and a lens for examining the human condition. Through an interdisciplinary approach, and co-taught by faculty in Psychological and Brain Sciences and Theatre, students will analyze plays and performances that grapple with the hopes and anxieties surrounding AI. Works such as Karel Capek's R.U.R. (which introduced the word "robot"), Jordan Harrison's Marjorie Prime, Jennifer Haley's The Nether, and Nick Payne's Constellations will serve as key texts alongside contemporary plays such as Julia Cho's The Language, Rolin Jone's The Intelligent Design of Jenny Chow, The Effect by Lucy Prebble, and Photograph 51 by Anna Ziegler. We will also discuss experimental performances that integrate AI technologies.

AS.001.289. FYS: Origins of Language: Creation, Acquisition, and Invention. 3 Credits.
Any list of human accomplishments will include natural language. While every human society has a language, no other animal has a communication system with this scope and complexity. How do languages emerge and evolve, and how are they learned? What happens when a child is born into an environment with no accessible language (e.g., deaf children who are born to hearing parents who do not know a sign language)?In this seminar, we'll explore how children acquire – or even create – language in different environments. Case studies include international adoptees, blind children, deaf children, and autistic children. We'll also examine real-world cases like homesign systems, pidgins and creoles, and Lengua de Señas Nicaragüense (also known as Nicaraguan Sign Language). We'll also discuss languages which have been consciously and painstakingly designed (Game of Thrones, Avatar, etc.), constructed international systems (Esperanto, International Sign), and large language models (e.g., ChatGPT4). This course invites students to think critically about what language is, where it comes from, and variation in human experiences.

Psychological & Brain Sciences

AS.200.313. Models of Mind and Brain. 3 Credits.
This is a seminar surveying computational approaches to understanding mental and neural processes, including sensory and conceptual representation, categorization, learning and memory. The course will also develop familiarity with computational tools such as numerical simulation, linear transformation and data visualization. Enrollment limited to Juniors and Seniors. Recommended Course Background: AS.110.106 / Calculus I OR AS.110.108 Calculus I, AS.050.101 / Cognition OR AS.200.211 / Sensation & Perception OR AS.080.105 / Introduction to Neuroscience OR other introductory coursework in cognitive & neural sciences. Some basic experience with computer programming (any language) is recommended, although not required.
Distribution Area: Quantitative and Mathematical Sciences, Social and Behavioral Sciences
AS Foundational Abilities: Science and Data (FA2), Projects and Methods (FA6)

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