

University of Rochester

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Department of Brain and Cognitive Sciences

The Department of Brain and Cognitive Sciences was founded in 1996 to better allow undergraduate and graduate students, postdoctoral fellows, research associates, and faculty to pursue interdisciplinary studies of the mind and brain. Advances in neuroscience and in computer science, along with striking progress in the behavioral sciences during the last 15 years, have fundamentally altered the way we approach the study of perceptual, motor, linguistic, and cognitive behaviors. A growing understanding of how the brain performs its computations, and the resulting efforts to characterize this processing via formal models, have brought powerful new insights to our understanding of perception, language, and reasoning. The department was formed so that investigators using these different approaches to understanding the mind and brain—behavioral, neural, and computational—could easily interact and collaborate with one another, and could jointly train the interdisciplinary scientists of the future.

While we have active research programs on many topics within this large domain, there are three areas in which the department has notable concentrations of strength. These three programs focus on:

- **Understanding the organization and function of the visual system:** Members of this group use a range of behavioral, physiological, and computational methods to investigate information processing from the retina through higher levels in the visual system, to understand the perception of color, motion, and depth, the representation of space and objects, and the integration of visual perception with early experience and learning, memory, attention, and motor performance.
- **Nature of language processing and acquisition:** This research spans a broad set of topics, ranging from the perception of speech sounds and words, the production and comprehension of spoken and written language, the neural substrates for language processing, and the acquisition of spoken languages by young children and adults, to investigations of the structure, processing, and acquisition of signed languages.
- **Learning and developmental plasticity:** This concentration cuts across domains and links those who study perception, language, and neurobiology. The research ranges from investigating the development of perception and language in human infants and adults, the acquisition of complex motor skills, and the enhanced visual abilities resulting from early deafness and exposure to sign language, to the measurement and modeling of the neural and computational mechanisms that underlie developmental plasticity, Hebbian learning, and critical periods in the development of the brain and behavior.

Our commitment to research also entails a commitment to train future research scientists by attracting students of the highest caliber into our graduate program and investing heavily in them while they work

with us. Graduate students are closely mentored and advised by one or more faculty, are given the scholarly background and the methodological skills to begin collaborative research immediately, and are encouraged to tackle the most significant problems of our field, thereby enabling them to become the central figures of the next generation of scholars in the brain and cognitive sciences. Undergraduates too have a major place in this new enterprise: we believe that study of the brain and cognitive sciences provides a superb general intellectual training, and a marvelous opportunity for students to engage themselves in research with faculty and to learn the logic of scientific enquiry. This conviction is reflected in the structure of our undergraduate programs, which offer students a wide range of opportunities to explore the breadth and depth of our discipline.

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Graduate Program

Graduate education is a central part of academic life in the Department. All of our faculty are invested in research structured to include graduate students as essential partners. Graduate students in the Department are our junior colleagues and future peers – people who enrich our academic lives as much as we enrich theirs – and we commit a great deal to their training.

The essence of our graduate program is training for research in the disciplines that constitute the brain and cognitive sciences. Initially a student's research is likely to be undertaken with close guidance from a member of the faculty, but we expect and encourage students to develop rapidly into independent researchers, and to become major contributors to the intellectual life of the department. We attach great importance to the collegiality of contact among graduate students, postdoctoral fellows, and faculty, and the Department fosters this by encouraging students to work with several faculty members, concurrently or sequentially, and with one another. All students in our graduate program receive a tuition waiver and a competitive 12-month stipend.

The explosive growth of the brain and cognitive sciences results in large part from their capacity to draw on techniques and inspiration from a range of disciplines. The domain is quintessentially interdisciplinary, and for this reason our Ph.D. program emphasizes training in the range of research methods that drive the field. Because students come to the brain and cognitive sciences with a wide range of backgrounds, the curriculum offers a broad base designed to introduce students to parts of the domain they might not previously have studied, and to prepare them for advanced work. This core curriculum covers a range of topics in perception, action, cognition, language, learning, and development, each examined from the perspectives of behavioral, computational, and neural science.

The behavioral, computational, and neural methods students master for approaching their own research may vary. However, as preparation for entering a highly interdisciplinary field, all students must acquire some methodological expertise through research activities or coursework in at least two methodological approaches. Students also take advanced courses and seminars in one or more areas of specialization. At all stages of their graduate careers, students are heavily engaged in research. Generally students complete most of their course work during the first two years. During the third year students take a qualifying exam covering the scholarly literature surrounding their area of specialization, and thereafter typically devote themselves fully to their research. The PhD is awarded upon the completion of a dissertation containing original research in the field, typically in the fifth year of study.

Graduates of our program have gone onto successful careers in academia and industry. Students who have graduated from our program within the past several years now hold faculty positions at Brown University, Columbia University, Cornell University, Indiana University, Rochester Institute of Technology, State University of New York at Buffalo, Texas A&M University, University of Calgary, University of California at Irvine, University of California at Riverside, University of Massachusetts, University of Pennsylvania, University of Southern California, and the University of Wisconsin at Madison. Other graduates are currently postdoctoral fellows at Johns Hopkins University, NASA Ames Research Center, New York University, Scripps Research Institute, Stanford University, State University of New York at Stony Brook, University of Arizona, University of Colorado, University of California at San Diego, University of Pittsburgh, University of Oxford, and the University of Wisconsin at Madison. Graduates who have chosen to go into industry hold positions at Inso Corporation, Merck Pharmaceuticals, Neurogene Corporation, Olympus Corporation, Visionics Corporation, and Xerox Corporation.

Undergraduate Program

The department participates in three undergraduate programs at the University: We teach the natural science courses within the psychology major, which is administered by the Department of Clinical and Social Sciences in Psychology (for further information, see www.psych.rochester.edu/undergrad). We run the undergraduate neuroscience program, which is a track within the University Program in Biology and Medicine, leading to a B.S. degree in Biological Sciences (for information, see www.bcs.rochester.edu/neuro). We also offer our own undergraduate major in Brain and Cognitive Sciences, which we describe in detail here.

The undergraduate major in Brain and Cognitive Sciences offers a rigorous but accessible natural science concentration for students interested in cognition and the brain. The program has two aims: to provide sound general intellectual training that will benefit students in a wide range of careers, and to provide a disciplinary qualification for students contemplating graduate or professional training in the behavioral and neural sciences.

The curriculum integrates biological, behavioral, and computational approaches to the study of perception, language, thinking, learning, and the development of these capacities. The concentration consists of twelve courses. Two foundation courses provide a general introduction to the field; one examines the neural machinery that underlies behavior, and the other introduces the domain of cognitive science. Three core courses build on this introduction by providing a fuller exploration of major

scientific domains we study-perception and action, cognition, and language and psycholinguistics. Through a laboratory course and a statistics course that introduces the fundamentals of experimental design and analysis, students learn first-hand the methods used to discover what we know about the brain and behavior. The brain and cognitive sciences draw on a wide variety of scientific methods, and students can choose from among three laboratory courses that emphasize different techniques. All courses stress analytical thinking and technical writing, and provide a solid grounding for students to undertake major research projects. Beyond the core curriculum, students have considerable freedom to explore special topics that interest them. They take four upper-level elective courses that form a coherent group, or 'track.' A track can be relatively narrowly focused or it can be broader in scope, and drawn from a collection of approved tracks or assembled by a student with guidance from a faculty member. Students complete their majors with the Senior Seminar, a course that focuses on research, with presentations by faculty, graduate students, and seniors.

There is no formal curricular requirement to undertake a research project, but we encourage students to take advantage of the many research opportunities available in the department. All of the faculty in Brain and Cognitive Sciences have active research programs (grants currently held by our 17 faculty total \$5,000,000 annually), and qualified undergraduates can enhance their educational experience by participating directly in scientific discovery through Independent Research courses and the Honors Program.