Cognitive Science

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Professors

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Assistant Professors

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Introduction

Cognitive science is a young and diverse field which is unified and motivated by a single basic inquiry: What is cognition? How do people, animals, or computers 'think,' act, and learn? In order to understand the mind/brain, cognitive science brings together methods and discoveries from neuroscience, psychology, linguistics, philosophy, and computer science. UCSD has been at the forefront of this exciting new field and our Department of Cognitive Science was the first of its kind in the world. It is part of an exceptional scientific community and remains a dominant influence in the field it helped create.

In addition to preparing undergraduates for careers in a variety of sciences, the major also provides an excellent background for many professional fields, including medicine, clinical psychology, and information technology.

The concerns of cognitive science fall into three broad categories: the brain—the neurological anatomy and processes underlying cognitive phenomena; behavior—the cognitive activity of individuals and their interaction with each other and their sociocultural environment, including the use of language, information, and media; and computation—the capacity of mathematical and computer systems to model cognitive and neural phenomena and represent information, and the role of computers as cognitive tools.

The department collaborates closely with other academic departments and research communities, including the Center for Research in Language, the Center for Human Development, the Salk Institute for Biological Studies, the UCSD Medical Center, and the San Diego Supercomputer Center, providing many outstanding resources and opportunities.

Students are encouraged to participate actively in the department by sharing their ideas about curriculum, research, and other topics with faculty and staff. Undergraduate students may join the Students in Cognitive and Neurosciences (SCANS) organization, which provides opportunities for undergraduates to meet students and faculty from UCSD and other institutes, visit research laboratories, and make job contacts. Graduate students take an especially active role in shaping the department, both academically and administratively, while they gain experience in research, teaching, and managing both labs and department affairs.

The Undergraduate Programs

The department offers both a B.A. and a B.S. degree. The B.S. requires completion of more rigorous lower-division course work and three additional courses at the upper-division level. The B.S. degree may be taken optionally with a specified area of specialization. There is also an honors program for exceptional students in both degree programs.

Please note: Continuing students may choose to follow the old major requirements or the new major requirements. See department adviser for more information.

Grade Requirements for the Major

A minimum grade-point average of 2.0 is required for admittance to and graduation from the B.A. or B.S. degree program. Students must receive a grade of C– or better in any course to be counted toward fulfillment of the major requirements. All courses must be taken for a letter grade, with the exception of Cognitive Science 195, 198, and 199, which are taken Pass/No Pass.

Four-Year Plan of Study

The four-year plan of study below assures that all prerequisites and requirements for the cognitive science major are completed. The department does enforce course prerequisites and several courses are offered only once a year, so careful planning is important. It is recommended that lower-division courses be taken in the first two years, core courses in the third year, and electives in the final year. Check with a departmental adviser about which quarter cognitive science courses will be offered each academic year. Check with a college adviser about course planning to meet college requirements.

FRESHMAN YEAR: Twelve units of math (B.A.) or sixteen units of math (B.S.) chosen from Mathematics 10A-B-C, 20A-B, 21C, 21D, 20F, 15A or CSE 20, or 15B or CSE 21
College requirements

SOPHOMORE YEAR: Cognitive Science 1 (continuing students may take 17 or 1) 14, and 18
College requirements

JUNIOR YEAR: Nine core couses, chosen from a list of twelve (see *Core Sequences*)

SENIOR YEAR: Electives for the major

Lower-Division Requirements

All majors must complete lower-division courses in introductory cognitive science, calculus, methods, and computer programming:

B.A. Requirements

Twelve units of math (B.A.) or sixteen units of math (B.S.) chosen from Mathematics 10A-B-C, 20A-B, 21C, 21D, 20F, 15A or CSE 20, or 15B or CSE 21. Note: Students should check with the

math department for rules governing duplication of credit between the 10 and 20 series.
Cognitive Science 1 (continuing students may take 17 instead)
Cognitive Science 14
Cognitive Science 18

B.S. Requirements

Twelve units of math (B.A.) or sixteen units of math (B.S.) chosen from Mathematics 10A-B-C, 20A-B, 21C, 21D, 20F, 15A or CSE 20, or 15B or CSE 21. Note: Students should check with the math department for rules governing duplication of credit between the 10 and 20 series.
Cognitive Science 1 (continuing students may take 17 instead)
Cognitive Science 14
Cognitive Science 18

Upper-Division Requirements

The B.A. requires completion of twelve upper-division courses, and the B.S. requires fifteen. All majors must complete nine core sequence courses. Students are advised to complete these core courses in their junior year, especially if they intend to apply to the honors program. The remainder of the upper-division requirement is fulfilled by completing electives.

Core Sequences

The B.A. and the B.S. programs require nine core courses total; students must complete all three courses in one core sequence of their choice, and two of the three courses in each of the other three core sequences. Core sequences are:

Cognitive Science 101A-B-C
(Cognitive Theory and Phenomena)

Cognitive Science 102A-B-C
(Distributed Cognition, Everyday Cognition, Cognitive Engineering)

Cognitive Science 107A-B-C
(Cognitive Neuroscience)

Cognitive Science 108A-B-C
(Computational Models of Cognition)

Please note: Continuing students may choose to follow the old major requirements or the new major requirements. See department adviser for more information.

Electives

At least half of the electives for the major must be taken in the department. Only one Cognitive Science 19X course (190A, 190B, 190C, 195, 198, 199) may be used as an elective toward major requirements. A course taken outside the department must meet the following criteria:

1. The course must deal with topics and issues that are clearly part of cognitive science.
2. The material must not be available in a course offered inside the department.

This policy permits students and their advisers to be responsive to changes in course offerings. Majors must obtain departmental approval for electives taken outside of the department.

Areas of Specialization

A major may elect to receive a B.S. in cognitive science with a specified area of specialization. The areas of specialization are intended to provide majors with guidance in choosing elective courses and to make the specific interests and training of a major clear to prospective employers and graduate schools. Specifying an area of specialization is optional; however, students should take into consideration when planning for their specialization that approved courses are not necessarily offered every year.

To major in cognitive science with an area of specialization, the student must fulfill the requirements for the B.S. degree and must choose four of the required six elective courses from a list of approved electives for that area of specialization. (The lists of approved electives for each area of specialization are available from the department office.)

The following areas of specialization are currently offered by the department:

Specialization in Clinical Aspects of Cognition

This area of specialization is intended for majors interested in cognitive neuropsychology, psychiatry, cognitive disorders, and the effects of drugs and brain-damage on cognitive functions. Allowed electives include courses in those topics, as well as organic chemistry, biochemistry, and physiology.

Specialization in Computation

This area of specialization is intended for majors interested in software engineering or research in computational modeling of cognition. Allowed electives include advanced courses in neural networks, artificial intelligence, and computer science. Students interested in this specialization will most likely select courses from the computer science and engineering course offerings, as courses offered within the cognitive science department are limited.

Specialization in Human Cognition

This area of specialization is intended for majors whose primary interests include human psychology and applications of cognitive science in design and engineering. Allowed electives include courses in cognitive development, language, laboratory research of cognition, anthropology, and sociology.

Specialization in Human Computer Interaction

This area of specialization is intended for majors interested in human computer interaction; Web; visualization; and applications of cognitive science in design and engineering. Additional electives may be petitioned from communication, computer science, computer engineering, and visual arts.

Specialization in Neuroscience

This area of specialization is intended for majors interested in neuroscience research or medicine. Allowed electives include courses in cognitive neuroscience, organic chemistry, biochemistry, and physiology.

Cognitive Science Honors Program

The Department of Cognitive Science offers an honors program for a limited number of majors who have demonstrated excellence, talent, and high motivation.

Eligibility Requirements

Students are eligible for admission to the program when they:

1. Complete all core courses
2. Have at least junior level standing
3. Have at least a 3.5 GPA in upper-division major courses and at least a 3.0 overall GPA

Eligible students will enroll in four units of 190A (Pre-Honors Project in Cognitive Science) under a faculty member who has agreed to advise them on a potential honors project. Students may apply the COGS 190A course as

an elective toward major requirements whether or not they enter the Honors Program. At the end of the 190A course, students will submit to their faculty mentor a written project proposal. The proposal will define the question to be investigated, survey existing literature, describe the approach and methods that will be used, explain how data will be collected if it is an empirical study, detail how human subjects requirements will be met if necessary, discuss expected results, and provide a timeline for project completion.

Acceptance in Honors Program

To formally enter the Honors Program, students must meet the eligibility requirements above, receive a grade of A– or better in COGS 190A, establish an honors committee of at least two faculty and one graduate student to review the proposal and advise them during the process of completing the honors project, and have their project proposal approved by their honors committee.

The honors committee must be kept informed of any deviations from the original approved project proposal and timeline. Students who fail to make satisfactory progress may be asked to withdraw from the program at any point the adviser or the department chair deems necessary.

Successful completion of the Honors Program requires:

1. Maintenance of a 3.5 GPA in upper-division major courses, and a 3.0 overall GPA
2. Completion of one cognitive science (or related) graduate level course (may be taken P/NP). Students may use the required graduate course as one of their electives for the major whether or not they complete the honors project
3. Completion of COGS 190B and 190C with letter grades of A- or better
4. Completion of COGS 190D (Preparation for Thesis Presentation), a 1-unit seminar given each spring (P/NP)
5. Completion of a written honors thesis describing the project
6. Approval of the thesis by the honors committee and the department chair
7. Satisfactory presentation of the honors thesis to the cognitive science community at the Honors Thesis Presentation Conference, spring quarter.

Students who successfully complete all of the requirements for the Honors Program will graduate *with Distinction in Cognitive Science* recorded on their transcripts.

Minors and Programs of Concentration

Each college has specific requirements, and students should consult with an academic adviser in their provost's office as well as a cognitive science adviser to be sure they fulfill requirements of the college and of the department.

To receive a minor from the Department of Cognitive Science, a student must complete a total of seven (four unit) courses; five of which must be upper-division. Lower-division requirements are normally fulfilled by completing (one of) Cognitive Science 3, 10 or 11 and (one of) Cognitive Science 14, 17 or 18. Upper-division requirements are normally fulfilled by completing two cognitive science electives and one of the following sequences:

Cognitive Science 101A-B-C

Cognitive Science 102A-B-C

Cognitive Science 107A-B-C

Cognitive Science 108A-B-C

All courses must be taken for a letter grade. No grade below C– is acceptable.

Transfer Credit

Students who wish to transfer from another institution to UCSD as cognitive science majors should work closely with university advisers to ensure that all lower-division requirements have been completed and are equivalent to those offered at UCSD. It is extremely important for students to have completed lower-division requirements by the end of their sophomore year so they are prepared for core courses in their junior year. Advanced UCSD students who wish to transfer to the department should consult with the departmental advisers about credit for courses already completed.

Education Abroad

Students majoring in cognitive science are encouraged to participate in the Education Abroad Programs (EAP), and to investigate other options of foreign study through the Opportunities Abroad Program (OAP). By petition, credits earned through EAP/OAP can fulfill UCSD degree and major requirements. Please visit the Web site at http://www/icenter/pao for further details. Financial aid is applicable and special study abroad scholarships are readily available.

The Graduate Programs

There are two Ph.D. programs, each with different admissions and graduation requirements. The *Department of Cognitive Science* offers a Ph.D. in cognitive science. Students are admitted to UCSD directly into the department and fulfill degree requirements of the department. The *Interdisciplinary Program in Cognitive Science* offers a joint Ph.D. in cognitive science and a home department (anthropology, communication, computer science and engineering, linguistics, neurosciences, philosophy, psychology, or sociology). Students are admitted to UCSD through the home department and fulfill the requirements of both the interdisciplinary program and the home department.

Ph.D. in Cognitive Science

This program provides broad training in neurological processes and phenomena; the experimental methods, results, and theories from the study of psychology, language, and social and cultural issues; and the studies of computational mechanisms. The first year is devoted to familiarizing the student with the findings and current problems in cognitive science through courses in foundations and issues.

By the second year, basic courses and laboratory rotations are completed, with the major emphasis on the completion of a year-long research project. Future years are spent completing the advancement to candidacy requirements and doing the thesis research. Throughout the program, there are frequent faculty-student interactions, including special lectures by the faculty or invited speakers and the weekly informal research discussions and cognitive science seminar.

Admissions

The application deadline is January 10. The admissions committee reviews each applicant's statement of purpose, letters of recommendation, GRE scores, previous education and work experience, and grade-point averages, then recommends candidates for admission to the entire faculty, who make the final decision.

Advising

An interim adviser is appointed to serve as general adviser and counselor for each entering student. The adviser helps chart a set of courses that fulfill the content area requirements, taking into account the student's prior training and interests. Students may change the interim adviser at any time (as long as the new interim adviser is willing). At the time of advancement to candidacy, students choose a permanent adviser who also functions as the chair of the dissertation committee.

All entering students are assumed to have basic prerequisite knowledge, and a list of basic readings will be provided to incoming students. Students who do not have this background can acquire it through self-study in the summer preceding arrival at UCSD or by taking self-paced study courses or relevant undergraduate courses at UCSD.

Summary of Requirements

1. Foundations courses
2. Approved study plan, which includes issues courses, methods courses, and laboratory rotations
3. Second-year project
4. Language requirement
5. Advancement to candidacy
6. Teaching
7. Cognitive Science 200 seminar
8. Participation in departmental events and committees
9. Ph.D. dissertation and defense

Description of Requirements

1. **Foundations Courses (Cognitive Science 201, 202, 203).** Students complete foundations courses in the areas of brain, behavior, and computation by the end of the second year. The department may waive some or all courses for students who already have the required knowledge.
2. **Study Plan.** Students complete a study plan recommended by their adviser. The normal plan includes:
   a. **Issues Courses.** A minimum of six issues courses are required, at least one in each of the areas of brain, behavior, and computation. At least four of the issues courses should be taken within the department. Department recommends completion by the end of the second year. Issues courses taken outside the department require the approval of the adviser in conjunction with the Graduate Committee.
   b. **Methods Courses.** Three methods courses are required. Students are required to take:
      - Psychology 201A or Cognitive Science 245
      - Psychology 201B
      - One methodology/analysis course. Course must be approved by the student's adviser and graduate committee.
   c. **Laboratory Rotations (Cognitive Science 290).** A total of three quarters of laboratory rotations in at least two different faculty laboratories are required. Each rotation is for one to two full quarters as required by the faculty laboratory. All rotations should be completed by the end of fall quarter of the second year.

      Students can meet this requirement in the following ways:
      - Three one-quarter rotations in three different laboratories, or
      - One one-quarter rotation and one two-quarter rotation in two different laboratories, or
      - Two two-quarter rotations in two different laboratories for a total of four quarters enrolled in COGS 290.

      Department recommends that student and adviser negotiate a topic and activity, then put the agreement in writing, sign, and give to the graduate coordinator.
3. **Second-Year Research Project (Cognitive Science 210A-B-C and 211A-B-C).** In the summer between the first and second year, students work with their adviser and a faculty committee to develop a prospectus for a research project. The year-long project culminates with written and oral presentations to the faculty at the end of spring quarter. During the second year, concurrent enrollment in Cognitive Science 210A-B-C and Cognitive Science 211A-B-C is required as part of the Second Year Project.
4. **Language Requirement.** The main goal of the language requirement is to give all students firsthand experience with some of the differences in structure and usage of languages and the several issues involved in the learning of second languages. This requirement can be satisfied by demonstrating satisfactory proficiency, by prior study in a language (e.g., two years of high school study), or by satisfactory completion of one quarter of study in a language course approved by the department.
5. **Advancement to Candidacy/Qualifying Paper and Oral Exam.** There are three components to advancement to candidacy:
   a. Competency. This requirement is met by satisfactorily completing items 1-4 above.
   b. Depth. This requirement is met by satisfactorily completing a talk to the entire department on their thesis topic by the end of the third year. It is recommended that a first draft of the thesis proposal be submitted to the student's adviser by the end of the third year. Students enroll in COGS 205 during winter and/or spring quarter of the third year.
   c. Dissertation Topic/Advancement Exam. The student prepares a proposal of the dissertation topic that must be approved by the student's doctoral committee. A written proposal is submitted to the committee at least two weeks prior to an oral defense of the proposal. The doctoral committee consists of at least five faculty members: three from the department and two from outside the department; one of the outside members must be tenured.
6. **Teaching (Cognitive Science 500).** All graduate students must serve as a teaching assistant at least one quarter of each academic year in residence. The undergraduate program offers a special challenge to instructor and student alike, and experience with the teaching of that program can provide a valuable part of the education of a cognitive scientist. Teaching assistantships performed in other departments must be approved by formal petition to the graduate committee to count toward the requirement. The department works closely with the Center for Teaching Development to design effective training and development programs for its teaching assistants. At the end

of each quarter, instructors prepare written evaluations of all teaching assistants.

7. **Cognitive Science 200 Seminar.** Students must enroll in this seminar for at least three quarters while in residence; frequent participation is encouraged.
8. **Participation in Departmental Events and Committees.** Students participate in departmental special events and committees and serve as student representatives for faculty meetings and the campus-wide Graduate Student Association. Students present their research in the undergraduate SCANS series.
9. **Completion of the Ph.D. Dissertation and Defense.** Candidates prepare a written dissertation demonstrating a substantive contribution to our understanding of cognition. An oral defense follows.

Master's Degree

The Department of Cognitive Science does not offer admissions to a master's program. However, candidates for the Ph.D. may be granted the M.S. degree after fulfilling the first three requirements listed above. This is usually at the end of the second year.

Evaluation of Performance and Progress

A formal evaluation of performance and progress for all students takes place at the end of spring quarter every year, with special attention given to the first and second years of study and at the time of qualification. The first-year evaluation is based in large part on the performance in foundations and issues courses. The second-year evaluation is based on the student's total performance, with heavy weight given to the student's second-year research project. The third-year evaluation focuses on the competency and depth requirements, and the following years on the progress made toward completion of the dissertation.

Special Events

The department intends to enhance student-faculty interaction and current awareness of active research issues by special "events":

- Lectures by invited speakers or faculty members.
- A full day of faculty/student overview and information at the start of each year, with emphasis on ongoing research activity.
- Presentations of second-year research projects to the entire faculty at the end of each year.
- Final defense of the dissertation accompanied by a public lecture and celebration.

Time Limits to Ph.D.

Students must be advanced to candidacy by the end of spring quarter of their fourth year. Total university support cannot exceed seven years. Total registered time at UCSD cannot exceed eight years.

Financial Aid

Financial support is available to qualified students in the form of fellowships, loans, and assistantships. Students are encouraged to seek fellowships and research awards from outside the university. Please refer to the Graduate Studies section for more information.

The Interdisciplinary Ph.D. Program

FACULTY

Professors

Norman H. Anderson, Ph.D., *Emeritus, Psychology*
Richard C. Atkinson, Ph.D., UC President, *Cognitive Science and Psychology*
Elizabeth Bates, Ph.D., *Cognitive Science*
Ursula Bellugi, Ph.D., *Adjunct/Psychology*
Patricia S. Churchland, B.Phil., *Philosophy*
Paul M. Churchland, Ph.D., *Philosophy*
Aaron V. Cicourel, Ph.D., *Emeritus, Cognitive Science and Sociology*
Michael Cole, Ph.D., *Communication*
Garrison W. Cottrell, Ph.D., *Program Director, Computer Science and Engineering*
Jeffrey L. Elman, Ph.D., *Cognitive Science*
Yrjö Engeström, Ph.D., *Communication*
Gilles R. Fauconnier, Ph.D., *Cognitive Science*
Philip M. Groves, Ph.D., *Psychiatry and Neurosciences*
Steven A. Hillyard, Ph.D., *Neurosciences*
James D. Hollan, Ph.D., *Cognitive Science*
Edwin L. Hutchins, Ph.D., *Cognitive Science*
Edward S. Klima, Ph.D., *Emeritus, Linguistics*
Marta Kutas, Ph.D., *Cognitive Science*
Ronald W. Langacker, Ph.D., *Linguistics*
George Mandler, Ph.D., *Emeritus, Psychology*
Jean M. Mandler, Ph.D., *Emeritus, Cognitive Science*
Hugh B. Mehan, Ph.D., *Sociology*
Donald A. Norman, Ph.D., *Emeritus, Cognitive Science*
Dennis D. M. O'Leary, Ph.D., *Adjunct/ Neurosciences*
Carol Padden, Ph.D., *Communication*
Harold E. Pashler, Ph.D., *Psychology*
David M. Perlmutter, Ph.D., *Linguistics*
Maria Polinsky, Ph.D., *Linguistics*
Vilayanur S. Ramachandran, Ph.D., *Psychology*
David P. Salmon, Ph.D., *In-Residence, Neurosciences*
Walter J. Savitch, Ph.D., *Computer Science and Engineering*
Terrence J. Sejnowski, Ph.D., *Biology and Neurobiology*
Martin I. Sereno, Ph.D., *Cognitive Science*
Larry R. Squire, Ph.D., *In-Residence, Psychiatry, Psychology and Neurosciences*
Joan Stiles, Ph.D., *Cognitive Science*
David A. Swinney, Ph.D., *Psychology*
David Zipser, Ph.D., *Cognitive Science*
Stuart M. Zola, Ph.D., *Psychiatry and Neurosciences*

Associate Professors

Farrell Ackerman, Ph.D., *Linguistics*
Gerald J. Balzano, Ph.D., *Music*
John D. Batali, Ph.D., *Cognitive Science*
Richard Belew, Ph.D., *Computer Science and Engineering*
Charles P. Elkan, Ph.D., *Computer Science and Engineering*
David J. Kirsh, D.Phil., *Cognitive Science*
Robert E. Kluender, Ph.D., *Linguistics*
James J. Moore, Ph.D., *Anthropology*
John C. Moore, Ph.D., *Linguistics*
Jaime A. Pineda, Ph.D., *Cognitive Science*

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Karen R. Dobkins, Ph.D., *Psychology*
Rafael Nuñez, Ph.D., *Cognitive Science*
Emanuel Todorov, Ph.D., *Cognitive Science*
Jochen Triesch, Ph.D., *Cognitive Science*

The interdisciplinary Ph.D. program is distinct from the departmental Ph.D. program (see previous section) both in admissions and graduation requirements. There are four aspects to graduate study in the interdisciplinary program: (a) a primary specialization in one of the established disciplines of cognitive science; (b) a secondary specialization in a second field of study; (c) familiarity with general issues in the field and the various approaches taken to these issues by scholars in different disciplines; and (d) an original dissertation project of an interdisciplinary character. The degree itself reflects the interdisciplinary nature of the program, being awarded jointly to the student for studies in cognitive science and the home department. Thus, students in linguistics or psychology will have degrees that read "Ph.D. in Cognitive Science and Linguistics" or "Ph.D. in Cognitive Science and Psychology."

Admission to the Program

Students enter UCSD through admission to one of the affiliated departments, which then serves as their home department, and which specifies their primary specialization. The affiliated departments are anthropology, communication, computer science and engineering, linguistics, neurosciences, philosophy, psychology, and sociology. Students may apply for admission to the interdisciplinary program at the same time they apply to the home department or after entering UCSD. Students must have an adviser from their home department who is a member of the interdisciplinary program faculty. If a student does not have such an adviser, a member of the Instructional Advisory Committee will be appointed as interim adviser. The Instructional Advisory Committee is made up of one interdisciplinary program faculty person from each of the home departments. The committee member that will serve as interim adviser for a student will come from the same home department as the student.

Note: Admission to the interdisciplinary Ph.D. program is contingent upon applying to and being accepted in a home department.

Primary Specialization

Primary specialization is accomplished through the home department. Students are expected to maintain good standing within their home departments and to complete all requirements of their home departments through qualification for candidacy for the Ph.D. degree.

Secondary Specialization

The power of an interdisciplinary graduate training program lies in large measure in its ability to provide the student the tools of inquiry of more than one discipline. Students in the cognitive science interdisciplinary program are expected to gain significant expertise in areas of study outside of those covered by their home departments. Such expertise can be defined in several ways. The second area might coincide with that of an established discipline, and study within that discipline would be appropriate. Alternatively, the area could be based upon a substantive issue of cognitive science that spans several of the existing disciplines, and study within several departments would be involved. In either case, students work with their adviser and the Instructional Advisory Committee to develop an individual study plan designed to give them this secondary specialization. A list of courses in cognitive studies at UCSD is available. This requirement takes the equivalent of a full year of study, possibly spread out over several years. Often it is valuable to perform an individual research project sponsored by a faculty member in a department other than the student's home department.

The following list demonstrates some ways to fulfill the secondary specialization requirement. It should be emphasized that these programs are only examples. Students will devise individual plans by working with their advisers and the advisory committee. Ideally, students who elect to do research in their areas of secondary interest will be able to accomplish a substantive piece of work, either one of publishable quality or one that will be of significant assistance in their dissertation projects.

Cognitive Psychology. Get a basic introduction to cognitive psychology through the Cognitive Psychology Seminar (Psychology 218A-B) and acquire or demonstrate knowledge of statistical tools and experimental design (this can be done either by taking the graduate sequence in statistics, Psychology 201A-B, or through the standard "testing out" option offered to all psychology graduate students). Finally, and, perhaps of most importance, the student should do a year-long project of empirical research in psychology with the guidance of a member of the Department of Psychology.

Cognitive Social Sciences. A course sequence from sociology and anthropology, including one or two courses in field methods and a research project under the direction of a cognitive social sciences faculty member. The course sequence and project should be worked out with the advisory committee to reflect the interests and background of the student. Examples of courses include Cognitive Anthropology (Anthropology 218), Distributed Cognition (Cognitive Science 234), Seminar in Comparative Cognitive Research (Psychology 216), and Text and Discourse Analysis (Sociology 204). In addition, courses on field methods are offered by both anthropology and sociology.

Computer Science and Artificial Language. This specialization requires a thorough background in computer science. For those who enter the program without much formal training in this area, the secondary specialization in computer science includes some upper-division undergraduate courses (CSE 100, 102, 105) and a minimum of two graduate courses (CSE 250AB). (Note that these courses require basic knowledge of programming and discrete mathematics areas that may require some additional undergraduate courses for those who lack these skills.) Students with stronger backgrounds in computer science may go straight to graduate courses. For all students interested in this specialization, the course sequences and any projects should be worked out on an individual basis with the student's adviser.

Discourse Structure and Processing. This specialization is highly interdisciplinary, spanning linguistics, computer science, psychology, sociology, philosophy, and anthropology. Research within this specialization depends upon which discipline is given emphasis. Therefore, the specialization will have to be developed according to the interests of the student. All students will have to demonstrate awareness and knowledge of relevant studies and the approaches of the various disciplines.

Linguistics. Students who elect a secondary specialization in linguistics should specialize either in the general area of syntax/semantics or in the general area of phonetics/phonology. Those who specialize in syntax/semantics should plan to take three courses in this area and one course in phonetics/phonology. Conversely, those who specialize in phonetics/phonology should plan to take three courses in this area and one course in syntax/semantics. The specific courses recommended will depend on the individual student's interests and should be arranged in

conjunction with the Department of Linguistics faculty liaison to the Cognitive Science Interdisciplinary Program.

In addition, students will prepare a research paper (preferably originating in one of the above courses) that demonstrates control of the methodology and knowledge of important issues in their area of specialization.

Neurosciences. A student specializing in neurosciences would take a program of courses emphasizing brain-behavior relationships, including Behavioral Neuroscience (Neurosciences 264) and the Physiological Basis of Human Information (Neurosciences 243). In addition, depending upon the student's individual interests, one or more of the neurosciences core courses would be taken in the areas of Mammalian Neuroanatomy (Neurosciences 256), Neuro-psychopharmacology (Neurosciences 277), and/or Neurochemistry (Neurosciences 234). In most cases, the student would also take a research rotation in the laboratory of a member of the neurosciences faculty.

Philosophy. Students who elect a secondary specialization in philosophy will focus on philosophy of science, philosophy of mind, philosophy of psychology, philosophy of neuroscience, or philosophy of language, depending on their area of primary specialization. Courses suitable for this program include Contemporary Topics in the Philosophy of Science (Philosophy 212), Philoso-phy of Language (Philosophy 235), Contemporary Epistemology and Metaphysics (Philosophy 270), Philosophy of Mind (Philosophy 274), and Semi-nar on Special Topics (Philosophy 285), which will frequently focus on issues relevant to cognitive science. The course sequence should be worked out with the student's adviser.

Acquisition of Perspective on the Field

The cognitive science faculty offers a special seminar, Cognitive Science 200, that emphasizes the interdisciplinary approach to the field and that covers a variety of different problems, each from the perspective of several disciplines. All students are required to enroll in this seminar a total of six quarters while in residence; most students regularly attend the seminar even after fulfilling the requirement. Students may substitute a Cognitive Science Foundations course for a Cognitive Science 200. A maximum of two quarters may be substituted.

Prequalifying Examinations

Students must complete any prequalifying and field requirements of their home department.

Qualifying Examinations

The Dissertation Advisory Committee. As soon as possible, students form a dissertation committee consisting of:

At least three members from the student's home department, including the student's adviser; and at least three members of the Cognitive Science Program, at least two of whom are not members of the student's home department.

University regulations require that at least one of the faculty members of the committee from outside the home department must be tenured. The committee must be approved by the interdisciplinary program, the home department, and by the dean of Graduate Studies. The dissertation committee is expected to play an active role in supervising the student and to meet with the student at regular intervals to review progress and plans.

In the qualifying examination, the student must demonstrate familiarity with the approaches and findings from several disciplines relevant to the proposed dissertation research and must satisfy the committee of the quality, soundness, originality, and interdisciplinary character of the proposed research.

Interdisciplinary Dissertation

It is expected that the dissertation will draw on both the primary and secondary areas of expertise, combining methodologies and viewpoints from two or more perspectives, and that the dissertation will make a substantive contribution to the field of cognitive science.

Overview

The program can be summarized in this way: In the first years, basic training within the student's primary specialization, provided by the home departments;

In the middle years, acquisition of secondary specialization and participation in the Cognitive Science Seminar;

In the final years, dissertation research on a topic in cognitive science, supervised by faculty from the program.

Time Limits. Time limits for precandidacy, financial support, and registration are those established for the home department. Normative time is six years.

COURSES

LOWER-DIVISION

1. Introduction to Cognitive Science
A team-taught course highlighting development of the field and the broad range of topics covered in the major. Example topics include addiction, analogy, animal cognition, artificial life, brain damage, cognitive development, distributed cognition, human-computer interaction, language, neuroimaging, neural networks, reasoning, robots, and real-world applications.

3. An Introduction to Computing (4)
A practical introduction to computers and how you can use their power. Designed for undergraduates in the social sciences. Topics include: basic operations of personal computers (MAC, PC), UNIX, word processing, email, spreadsheets, and creating web pages using the World Wide Web. *No previous background in computing required.*

10. Cognitive Consequences of Technology (4)
The role of cognition and computation in the development of state-of-the art technologies such as human computational interaction in aviation, air traffic control, medical diagnosis, robotics and telerobotics, and the design and engineering of cognitive artifacts.

11. Introduction to Cognitive Science: Minds and Brains (4)
How damaged and normal brains influence the way humans solve problems, remember or forget, pay attention to things; how they affect our emotions; and the way we use language in daily life.

14. Design and Analysis of Experiments (4)
Design, statistical analysis, and interpretation of experiments in the main areas of cognitive science: brain, behavior, and computation. Introduction to mathematical foundations of probability and statistical decision theory. Decision theory is applied to the problem of designing and analyzing experiments. Students will participate in a group project in which they must design scientific experiments, collect data and analyze results. May fulfill general education requirements; ask a college adviser.

17. Neurobiology of Cognition (4)
Introduction to the organization and functions of the nervous system. Topics include molecular, cellular, developmental, systems, and behavioral neurobiology. Specifically, structure and function of neurons, peripheral and central nervous systems, sensory, motor, and control systems, learning and memory mechanisms. (Students may not receive credit for both Biology 12 and Cognitive Science 17. This course fulfills general-education requirements for Marshall and Roosevelt Colleges as well as Warren by petition.)

18. Introduction to C Programming for Cognitive Modeling (4)
An introduction to the C programming language and its use in modeling cognitive phenomena. Other topics include: fundamentals of computer architecture, programming languages, operating systems, algorithms and data-structures. Modeling applications include: symbolic artificial intelligence, neural networks, genetic algorithms and computer graphics. *Prerequisite: Math-ematics 10A or 20A.*

90. Undergraduate Seminar (1)
Issues and contemporary research in cognitive science are introduced. (May be repeated when topics vary.)

91. SCANS Presents (1)
The department faculty and the Students for Cognitive and Neurosciences (SCANS) offer this seminar exploring issues in cognitive science. It includes informal faculty research presentations, investigations of topics not covered in the curriculum, and discussions on graduate school and careers. (May be repeated when topics vary.)

UPPER-DIVISION

101A. Sensation and Perception
An introduction to the experimental study of cognition with a focus on sensation and perception. *Prerequisite: Cognitive Science 1.*

101B. Learning, Memory, and Attention
A survey of the experimental study of learning, memory, and attention. Topics include conditioning, automaticity, divided attention, memory systems, and the nature of mental representation. *Prerequisites: Cognitive Science 1. Recommended: Cognitive Science 101A.*

101C. Language
An introduction to structure of natural language, and to the cognitive processes that underline its acquisition, comprehension, and production. This course covers findings from linguistics, computer science, psychology, and cognitive neuroscience to provide an integrated perspective on human language abilities. *Prerequisite: Cognitive Science 1. Recommended: Cognitive Science 101A.*

102A. Distributed Cognition
Distributed cognition extends beyond the boundaries of the person to include the environment, artifacts, social interactions, and culture. Major themes are the study of socially distributed cognition and the role of artifacts in human cognition. *Prerequisite: Cognitive Science 1.*

102B. Cognitive Ethnography
This course examines memory, reasoning, language understanding, learning, and planning directly in everyday, real-world settings. The coursework will include discussions of both the findings and the methodology of naturalistic studies of cognition. *Prerequisite: Cognitive Science 102A.*

102C. Cognitive Engineering
Applications of cognitive science for the design of human-centered systems are explored. An extensive project analyzing an existing system or product or designing a new prototype application is required. *Prerequisites: Cognitive Science 102A and 102B recommended.*

107A. Neuroanatomy and Physiology
This first course in the sequence focuses on principles of brain organization, from neurons to circuits to functional networks. It explores developmental plasticity, neuronal connectivity, cellular communication, complex signaling, and how these various dimensions form functional brain systems. *Prerequisite: Cognitive Science 1.*

107B. Systems Neuroscience
This course is a rigorous introduction to the neurophysiological and neuroanatomical basis of human and animal cognition, covering cellular neurophysiology and circuit modeling, development, visual, somatosensory, auditory, motor, and limbic systems; neuroimaging and language. *Prerequisite: Cognitive Science 107A.*

107C. Cognitive Neuroscience
This course studies brain systems implicated in attention, language, object recognition, and memory. Neurobiological evidence for functional subsystems within these processes and the way specialized systems develop are considered using findings from animal studies, human development, and behavioral and brain imaging. *Prerequisites: Cognitive Science 107B and its prerequisites.*

108A. Programming Methods for Cognitive Science
The design, implementation, and analysis of algorithms and data structures. Applications include: symbolic artificial intelligence, neural networks, genetic algorithms, computer graphics, and human computer interaction. *Prerequisites: Cognitive Science 1 and Cognitive Science 18 or CSE 9A or CSE 10, or permission of instructor.*

108B. Neural Network Models of Cognition I
This course is an elementary introduction to neural networks and their use in cognitive science. Students will learn how to construct and train neural networks to solve problems at both the psychological and neurological levels of cognition. (Course previously offered as Cognitive Science 108C.) *Prerequisite: Cognitive Science 108A.*

108C. Advanced Programming Methods for Cognitive Science
This course focuses on providing students with additional programming experience in the design of cognitive science applications and modeling. Each time it is offered a specific application or modeling area will be covered. With change of topic, the course may be repeated for credit. *Prerequisite: Cognitive Science 108A.*

113. Cognitive Development (4)
This course examines the foundations and growth of mind, discussing the development of perception, imagery, concept formation, memory, and thinking. Emphasis is placed on the representation of knowledge in infancy and early childhood. (Credit may not be received for both Psychology 136 and Cognitive Science 113.) *Prerequisite: Cognitive Science 101B or Psychology 105 or Psychology 101.* Not offered in 2002–2003.

115. Neurological Development and Cognitive Change (4)
This course provides an overview of neurological development and explores the relations between physiological change and the experience of the child from the prenatal period through adolescence. *Prerequisite: Cognitive Science 17 or equivalent.*

120. Human Computer Interaction (4)
This course is an introduction to the field of human computer interaction (HCI). It provides an overview of HCI from the perspective of cognitive science. *Prerequisites: Cognitive Science 10 and an introductory programming course, or consent of instructor.*

121. Human Computer Interaction Programming
This course is an introduction to human computer interaction (HCI) programming. It focuses on architectures, implementation techniques, and cognitive issues involved in designing interactive interfaces. *Prere-quisite: Cognitive Science 120 or consent of instructor.*

142. Philosophy of Cognitive Science (4)
An examination of the philosophical foundations and implications of cognitive science. Emphasis is placed on understanding how philosophical issues and arguments are relevant to the theory and practice of modern cognitive science. May be repeated for credit where topics vary. *Prerequisite: upper-division standing.*

150. Semantics (4)
This course is an introduction to the study of meaning, reasoning, and understanding. It examines the ways in which natural language reflects complex human thinking processes. *Prerequisite: upper-division standing preferred.*

151. Analogy and Conceptual Systems (4)
Human thought and meaning are deeply tied to the capacity for mapping conceptual domains onto each other, inducing common schemas and performing mental simulation. This course examines major aspects of this cognitive activity including metaphor, conceptual blending and embodied cognition. *Prerequisite: upper-division standing.*

153. Language Comprehension (4)
The processes and representations involved in understanding language–processing words, syntax, semantics, and discourse–are examined in light of evidence from both psychological experiments and computer simulations. The course emphasizes connectionist models: how they work and how they simulate psychological results. *Prerequisites: introductory cognitive science and programming are recommended. Cognitive Science 108C is recommended.* Not offered in 2002–2003.

154. Communication Disorders in Children and Adults (4)
The course will begin with neural bases of language use in normal adults, and the neural bases of language and communication development in normal children. It will review recent evidence on the nature of language and communication deficits in several clinical populations of adults (especially aphasia and dementia) and children (including specific language impairment, focal brain injury, retardation, and autism). (Credit may not be received for both Psychology 174 and Cognitive Science 154.) *Prerequisites: Cognitive Science 10, 11 or Psychology 101 or Cognitive Science 101AB or Psychology 101AB or Psychology 145 or Psychology 105 or Psychology 2 and 3.*

156. Language Development (4)
A comprehensive survey of theory, method and research findings on language development in children ranging from the earliest stages of speech perception and communication at birth to refinements in narrative discourse and conversational fluency through middle childhood and adolescence. (Credit

may not be received for both Psychology 126 and Cognitive Science 156). *Prerequisites: upper-division standing and background in developmental psychology and/or linguistics is recommended.*

160. Upper-Division Seminar on Special Topics (1-4)
Special topics in cognitive science are discussed. (May be repeated when topics vary.) *Prerequisite: department approval.*

170. Natural and Artificial Symbolic Representational Systems (4)
This course develops a detailed analogy between the evolution and architecture of language comprehension in human primates and symbol processing at the level of individual cells, contrasting this with the analogy between cognition and computation. *Prerequisites: Cognitive Science 17 or Biology 12; Cognitive Science 18 or Computer Science and Engineering 62AB recommended.*

172. Brain Disorders and Cognition (4)
A review of the patterns of impaired and intact cognitive abilities present in brain-damaged patients in terms of damage to one or more components of a model of normal cognitive functioning. (Cognitive science majors may not receive elective credit for both Psychology 139 and Cognitive Science 172.) *Prerequisite: Cognitive Science 107A.*

174. Drugs: Brain, Mind and Culture (4)
This course explores how drugs interact with the brain/mind and culture. It covers evolutionary and historical perspectives, brain chemistry, pharmacology, expectancies and placebo effects, and models of addiction. It also provides a biopsychosocial survey of commonly used and abused substances. *Prerequisite: upper-division standing.* Midterm, final, paper.

175. The Neuropsychological Basis of Alternate States of Consciousness (4)
This course will review the literature that correlates brain rhythms in the human EEG with aspects of cognition, behavioral states, neuropsycho-pharmacology, and psychopathology in order to understand the psychological and neurophysiological underpinnings of these experiences. *Prerequisites: Cognitive Science 101A or Cognitive Science 107A.*

179. Electrophysiology of Cognition (4)
This course surveys the theory and practice of using recordings of electrical and magnetic activity of the brain to study cognition and behavior. It explores what brain waves reveal about normal and abnormal perception, processing, decision making, memory, preparation, and comprehension. *Prerequisites: Cognitive Science 107A or Psychology 106; Cognitive Science 101A or Psychology 105.*

181. Neural Network Models of Cognition II (4)
This course is a continuation of the study of neural models of cognitive systems with an emphasis on applications and a term-long student project. *Prerequisites: Cognitive Science 108C and its prerequisites.*

182. Artificial Intelligence Modeling II (4)
The course is an advanced study of artificial intelligence models of control and representation. (Course previously offered as Cognitive Science 108D.) *Prerequisites: Cognitive Science 108B and its prerequisites.* (Not offered in 2002–2003)

183. Artificial Life (4)
This class will explore models of life as it could be, in artificial as well as biological contexts. An attempt will be made to understand the characteristics which distinguish living from nonliving systems. Coursework includes computer simulations of artificial lifeforms. *Prerequisites: Cognitive Science 18, CSE 5A and 5B, or CSE 11, or equivalent.* (Not offered in 2002–2003)

184. Modeling the Evolution of Cognition (4)
Mathematical and computational modeling of the evolution and mechanisms of simple cognitive functions. Theoretical background, including topics in population genetics, behavioral ecology, evolutionary game theory, dynamical systems theory, genetic algorithms and neural networks will be applied to questions concerning the evolution of behavioral strategies, the relation between evolution and learning, and the evolution of cooperation, communication and other aspects of social behavior. *Prerequisites: Cognitive Science 18, Mathematics 20ABC.*

187A-B. Multimedia Design (4)
This sequence will examine the cognitive basis of successful multimedia designs. We will be interested in what makes an interactive system effective: what makes images easy to understand, animations clear and helpful, and why some sequences of images, text and sounds make more sense than others. Students will learn web design, how to evaluate CD ROMs and assess their usability, and gain first hand experience with the problems of visualization. No programming skills are presupposed but we do assume a strong familiarity with computer software.

190A. Pre-Honors Project in Cognitive Science (4)
This independent study course is for advanced students who wish to prepare for and apply to the Cognitive Science Honors Program. After completing this course, students may be admitted to the Honors Program contingent upon significant progress made during the course. (See "Cognitive Science Honors Program" section for more information.) Students should contact faculty whose research interests them to discuss possible projects. *Prerequisite: upper-division standing; instructor and department approval.*

190B. Honors Studies in Cognitive Science (4)
This course will allow cognitive science honors students to explore advanced issues in the field of cognitive science. It will also provide honors students the opportunity to develop an honors thesis on the topic of their choice and begin preliminary work under faculty supervision. Students will receive an "IP" grade in 190B and the grade assigned for 190C, when completed, will replace the "IP" in 190B. *Prerequisites:* Cognitive *Science 190A with grade of A- or better and formal admittance to the Cognitive Science Honors Program.* (See "Cognitive Science Honors Program" section for more information.)

190C. Honors Thesis in Cognitive Science (4)
This course will provide honors candidates an opportunity to complete the research on and preparation of an honors thesis under close faculty supervision. Oral presentation of student's thesis is required to receive honors; additionally, student must receive grade of A- or better in 190B and 190C to receive honors. *Prerequisite: Cognitive Science 190B with grade of A- or better and formal admittance to the Cognitive Science Honors Program.* (See "Cognitive Science Honors Program" section for more information.)

190D. Preparation for Thesis Presentation (1)
This course is affiliated with the honors program (190A-B-C) and is required of honors students during spring quarter. Its aim is to prepare students to present research results to an audience. Emphasis will be on the oral presentation (organization, wording, graphics), but there will also be some discussion about written research reports. Seminar style format with occasional short lectures wherein students will practice oral presentations and provide constructive criticism to each other. *Prerequisite: must be concurrently enrolled in 190B or 190C.*

191. Laboratory Research (1-4)
Students engage in discussions of reading of recent research in an area designated and directed by the instructor and also participate in design and execution of original research. Assignments include both oral and written presentations and demonstrating the ability to pursue research objectives. *Prerequisites: consent of the instructor and department approval.* (May be repeated for credit, but not to exceed 8 units).

195. Instructional Apprenticeship in Cognitive Science (4)
Students, under the direction of the instructor, lead laboratory or discussion sections, attend lectures, and meet regularly with the instructor to help prepare course materials and grade papers and exams. Applications must be submitted to and approved by the department. *Prerequisites: upper-division standing; 3.0 GPA; instructor and department approval.* P/NP only.

198. Directed Group Study (4)
This independent study course is for small groups of advanced students who wish to complete a one-quarter reading or research project under the mentorship of a faculty member. Students should contact faculty whose research interests them to discuss possible projects. *Prerequisites: upper-division standing; 2.5 GPA; consent of instructor and department approval.*

199. Special Project (1-4)
This independent study course is for individual, advanced students who wish to complete a one-quarter reading or research project under the mentorship of a faculty member. Students should contact faculty whose research interests them to discuss possible projects. *Prerequisites: upper-division standing; 2.5 GPA; consent of instructor and department approval.*

GRADUATE

200. Cognitive Science Seminar (4)
This seminar emphasizes the conceptual basis of cognitive science, including representation, processing mechanisms, language, and the role of interaction among individuals, culture, and the environment. Current developments in each field are considered as they relate to issues in cognitive science. (May be repeated for credit.)

201. Systems Neuroscience (4)
This course is a rigorous introduction to the neurophysiological and neuroanatomical basis of human and animal cognition, covering cellular neurophysiology and circuit modeling; development; visual, somatosensory, auditory, motor, and limbic systems; neuroimaging and language.

202. Cognitive Science Foundations: Computational Modeling of Cognition (4)
This course surveys the development of symbolic and connectionist models of cognition. Selected readings from the late 1940s to the present are covered. Topics include: Turing machines, information theory, computational complexity, search, learning, symbolic artificial intelligence, and neural networks.

203. Cognitive Science Foundations: Theories and Methods in the Study of Cognitive Phenomena (4)
Surveys a variety of theoretical and methodological approaches to the study of human cognition. Topics include language structure, language processing, concepts and categories, knowledge representation, analogy and metaphor, reasoning, planning and action, problem solving, learning and expertise, and emotion.

205. Introduction to Thesis Research (4)
This course is taken to focus the students' development of a thesis topic and research proposal. Students prepare an outline of thesis proposal and make an oral public presentation of the proposed topic prior to the end of the third year.

210A-B-C. Introduction to Research (4-4-4)
This sequence is an intensive research project. Students under faculty mentorship perform a thorough analysis of the problem and the literature, carry out original studies, and prepare oral and written presentations. Students should aim for a report of publishable quality. *Letter grade required.*

211A-B-C. Research Methods in Cognitive Science (2-2-2)
Issues in design, implementation, and evaluation of research in cognitive science are discussed. Students will present and comment on their own research projects in progress. Discussions also include presentations of research to various audiences, abstracts, reviews, grant process, and scientific ethics. *Letter grade required.*

212. Mechanisms of Learning and Cognition (4)
This course explores the behavior and mechanisms that underlie a cognitive process from acquisition to expert performance. The emphasis is on the computational mechanisms required to learn skilled performance. Topics vary by quarter, e.g., implicit learning, speech recognition, and mathematics word-problem solving.

213. Issues in Cognitive Development (4)
This course examines current issues in human development of interest to cognitive scientists. An emphasis is placed on the foundations of mind and how information is represented at various stages of learning and development. (May be repeated once, when topics vary.)

215. Neurological and Cognitive Development (3)
This course is presented in two sections. The first part of the course focuses on early neurological development. The second part addresses questions concerned with the relations between cognitive brain development, and linguistic and affective development.

220. Information Visualization (4)
This seminar surveys current research in information visualization with the goal of preparing students to do original research. The focus is on the cognitive aspects of information design, dynamic representations, and computational techniques. Topics vary each time course is offered.

234. Distributed Cognition (4)
This course focuses on aspects of individual and socially distributed cognition. Empirical examples are drawn from natural and experimental settings which presuppose, tacitly or explicitly, socially distributed knowledge among participants. The class examines the way locally managed, pragmatic conditions influence how decisions are framed.

238. Topics in Cognitive Linguistics (1–4)
Basic concepts, empirical findings, and recent developments in cognitive and functional linguistics. Language viewed dynamically in relation to conceptualization, discourse, meaning construction, and cognitive processing. (As topics vary, may be repeated for credit.)

241. Ethics and Survival Skills in Academia (2–4)
This course will cover ethical issues which arise in academia, including: dishonesty, plagiarism, attribution, sexual misconduct, correcting errors, political activity, dealing with collaborators, etc. We will also discuss 'survival' issues, including job hunting, grant preparation, journal reviews, writing letters of recommendation, mentoring, etc. This course is open to students from any deparment.

245. Introduction to Probability Theory (4)
This is a one quarter introductory course on probability theory and applications. The target audience is researchers in the cognitive, computational and neural sciences. The course also introduces scientific programming in MatLab. The grade is based on homework, project, or a combination of both.

250. Connectionist Models of Language (4)
This course covers topics in computational psycholinguistics. The primary focus will be on connectionist models, but will also include work in statistical natural language processing as well as experimental psycholinguistics.

251. Aphasia (3)
Research and theory on language breakdown in brain-damaged adults is surveyed. Topics include an historical overview from linguistics, psycholinguistics, and neuroscience (especially brain imaging techniques). Credit may not be received for both Psychology 245 and Cognitive Science 251.

253. Semantics and Cognition (4)
This course explores current issues in the study of meaning and its interaction with other areas of cognitive science. The focus is on cognitive semantics, pragmatics, and meaning construction in general.

256. Language Acquisition (4)
Discussion of the acquisition of language by young children, including such topics as its stages, mechanisms, and relation to nonlinguistic development.

260. Seminar on Special Topics (1-4)
Specific topics in cognitive science are discussed. (May be repeated when topics vary.)

271. Cognitive Neuropharmacology (4)
This course provides a review of the neurochemistry of cognition. Topics include functional anatomy of neurotransmitter circuitry, computational properties of neuromodulation, interaction of psychoactive substances with brain and behavior, neuropharmacological accounts of cognitive disorders (e.g., addiction, depression, schizophrenia). Not offered in 2002–2003.

272. Topics in Theoretical Neurobiology (4)
The main focus of this course is the relationship between nervous system function and cognition. It covers broad theoretical issues and specific topics. Material comes from lectures, papers, and the text. Topic varies each time the course is offered. (May be repeated for credit.)

273. Biological Basis of Attention (4)
A survey of the research and theories of attention with special emphasis on the current anatomical, physiological, and biochemical basis of attention.

274. Advanced Cognitive Neuroscience (4)
This seminar surveys current research investigating the neural systems important in attention, language, memory, and object recognition. Factors important in their development and several different experimental approaches employed in their study are also considered.

275. Visual Modeling (4)
Visual system neurophysiology and neuroanatomy, and neurally realistic and artificial intelligence modeling approaches are covered. Topics are: dendrites, orientation and edges, motion, stereo, shading and color, eye movements, and pattern recognition. Students prepare computer modeling projects or research papers.

279. Electrophysiology of Cognition (4)
This course surveys the theory and practice of using recordings of electrical and magnetic activity of the brain to study cognition and behavior. It explores what brain waves reveal about normal and abnormal perception, processing, decision making, memory, preparation, and comprehension. Graduate students will be required to do additional readings for the material each week (different for each grad) and to present orally (as well as in a written page) a critical analysis of the readings. *Prerequisites: COGS 107A or PSYC 106; COGS 101A or PSYC 105.*

290. Cognitive Science Laboratory Rotation (2)
Laboratory rotations provide students with experience in the various experimental methods used in cognitive science. *Prerequisite: consent of instructor. S/U only.*

291. Laboratory Research (1-4)
Students engage in discussions of reading of recent research in an area designated and directed by the instructor and also participate in the design and execution of original research. Students are expected to demonstrate oral and written competence in presenting original research. *Prerequisite: consent of the instructor and departmental approval.* (May be repeated for credit.)

298. Directed Independent Study (1-12)
Students study and research selected topics under the direction of a member of the faculty.

299. Thesis Research (1-12)
Students are provided directed research on their dissertation topic by faculty advisers.

500. Teaching Apprenticeship (1-4)
This practicum for graduate students provides experience in teaching undergraduate cognitive science courses. *S/U only.*