Undergraduate Program in Neuroscience and Cognitive Science

Program Learning Outcomes

Overview

The undergraduate program in Neuroscience and Cognitive Science (NSCS) resides in the School of Mind, Brain and Behavior of the College of Science. The NSCS major provides students the opportunity to gain a broad knowledge of Neuroscience and Cognitive Science and an in-depth knowledge of their particular sub-area of interest. The major is tailored to students seeking a strong overview covering several fields from neuroscience to cognitive science, including psychology, philosophy, and even linguistics.

The NSCS curriculum is customizable with 2 different foci in foundation and core courses and 7 different emphases to complete the major electives. NSCS students choose one of 2 foci, either Neuroscience or Cognitive Science. All students who complete the graduation requirements for NSCS will receive the same degree – a Bachelor of Science in Neuroscience and Cognitive Science – regardless of which focus they elect to follow. The major prepares students for graduate or professional school, positions in the pharmaceutical and health care industries, to be a high school or middle school science teacher, or to enter other disciplines that increasingly interact with the Science, Technology Engineering and Math (STEM) disciplines.

Admission to the major: There are no requirements to declare the NSCS major.

Coursework in the lower division is considered preparatory, providing students with the life-science, mathematics, and psychology foundation necessary to support study of the nervous system - both mind and brain.

The NSCS curriculum has 9 common supporting courses (23 units) and 6 common core courses (13-14 units) with the goal to provide students with a solid foundation for studying Neuroscience as well as Cognitive Science. All students have a basic core foundation in mathematics, biology, chemistry, physics, statistics, psychology & philosophy through supporting coursework.

Coursework in the upper division portion of the curriculum is divided into a set of core courses designed to provide students with a robust foundation in the principles, concepts, and technologies essential in neuroscience and cognitive science The NSCS major requires a common core curriculum (14-15 units) including a Neuroscience-Cognitive Science gateway course (NSCS 200), 2 core courses in Cognitive Science, 2 core courses in Neuroscience and a scientific programing course. In addition, each focus requires a focus-specific core curriculum consisting of 2 core courses in Neuroscience (6-7 units) or 3 courses in Cognitive Science (9 units). The additional courses in each focus are designed to enhance student knowledge and skills in the chosen content area.

Finally, the NSCS program requires elective courses in 1 of 7 emphases that constitute groups of courses aligned by theme. The emphases, including Cognition, Computation, Development and Aging, Language and Communication Science, Neurobiology, Philosophy of Mind, and Thematic, provide students the opportunity to substantially increase their depth of knowledge in a particular sub-area of Neuroscience or Cognitive Science. Students complete a minimum of 15 units per emphasis but up to 6 units can be upper-division research, internship, or thesis credit. Of these 6 units, a maximum of 3 units can be preceptorship credit. Lab research is encouraged in the NSCS program but not required.

The NSCS program also has three associated student organizations: the NSCS Association of Students, which is a student-led organization whose mission is to spread awareness of neuroscience and cognitive science to the UA student body and to the greater Tucson community; Nu Rho Psi -Alpha in Arizona, a chapter of the national neuroscience honorary organization; and the NSCS Ambassadors, student representatives of the NSCS program who act as liaisons of the program to the University of Arizona and Tucson community. Together, these organizations are key components of the NSCS community.

NSCS Program Learning Outcomes

The NSCS major is designed to accomplish the following two goals: 1) To provide students with broad knowledge of the fields of Neuroscience and Cognitive Science and in-depth knowledge in the field of specialization. 2) To provide a thorough education in the methods and ethics of scientific inquiry.

Students develop proficiency in the following abilities in core courses and enhance their competency in emphasis courses. The overarching goal is to provide graduates with a breadth and in-depth of understanding about the field of neuroscience and cognitive science that will render them well qualified for admission to graduate or professional schools such as medicine, dentistry, veterinary medicine, nursing, neuroscience, cognitive science, pharmacology, psychology, and related fields. They will be competitive for positions in a variety of health-related industries, in middle school, high school and adult education, and in disciplines that increasingly require understanding of biology and biotechnology, including law, policy-making and business.

A. Core knowledge-specific content

Students will develop a firm understanding of the theories, fundamental principles and concepts, and technologies of brain organization and function from both neuroscience and cognitive science perspectives. Foundation, core and upper-division core courses will provide the theoretical and conceptual knowledge and the technological skills that form the basis of the field of Neuroscience and Cognitive Science
Each course in the core builds on pre-requisite courses and on lower-level courses in the curriculum. Concepts are explored in greater depth at each level and course discussions, exams, and projects require increasing levels of knowledge, culminating at the upper-division level in assignments and exams that require synthesis, integration, critical evaluation, and experimental design. Assessment is primarily course-specific measures designed by the instructors but also includes pre- and post-program exams.

B. Scientific inquiry

Students will develop the capacity to think critically and flexibility about complex problems involving the brain and mind, and will develop the capacity to skillfully communicate concepts and research results to professionals and to the public.

- Students will acquire a solid foundation of content knowledge about the nervous system and cognitive processes through core courses; these courses will address the distinction between popular beliefs about the brain and mind and what can be concluded on the basis of current scientific knowledge.
- Upper-division core and elective courses will introduce students to current research issues, and course assignments will require critical analysis of situations and research, in both written and oral formats, and including statistical analyses. Assessment is accomplished primarily through direct measures as developed by course instructors.
- Students are strongly encouraged to take on a project in a research lab or to complete independent studies/directed research with faculty, and to present their work in one of several forums (e.g., UBRP poster sessions, NSCS research presentations, lab meetings.)

C. Ethics and professionalism

Students will apply ethical and professional standards to their evaluation of brain and mind-related research and technical development in the context of their own work and in the context of issues in the larger societal community.

- Students will successfully complete the CITI online courses on the principles of scientific research and on research with human subjects.
- Coursework throughout the curriculum will include discussion of ethics and science policy questions relevant to the course topic; assessment is accomplished primarily through direct measures as developed by course instructors.
- Students are required to attend ethics and science policy seminars.

As the learning outcomes are quite general, sub-outcomes were developed that are more specific and allow qualitative assessment. Recognizing that students choose either the Cognitive Science or the Neuroscience Focus, and that these students have different paths towards in-depth knowledge, the program also developed focus-specific sub-outcomes.

For each sub-outcome, the course(s) in which the outcome is addressed is/are listed, those in bold indicating that the outcome is a major focus.

Sub-outcomes for Outcome A – Core Knowledge-Specific Content

For all Students

A.1) Describe the general organization of the brain and its relation to physiological and cognitive processes. Explain the fundamental principles of anatomical and functional organization of neuronal circuits and networks underlying the complex capacities of the mind. Analyze the inputs, outputs, and processes of the mind from different perspectives, including genetics, molecular and cellular mechanisms, systems-level and cognitive modes of processing, environmental or contextual considerations, and modeling.

- NSCS 200, NROS 307, CGSC 321, CGSC 320

A.2) Explain, including diagrams, the basic molecular and cellular mechanisms underlying neural excitability and synaptic physiology. Predict the consequences of disrupting various elements of the underlying mechanisms.

- NSCS 200, NROS 307, NROS 308

A.3) List and explain several common principles of sensory processing across modalities. Describe the basic features of the motor system and explain how sensory-motor signaling operates.

- NSCS 200, NROS 307

A.4) List and provide a basic explanation of the major foundations of cognitive science, including representation, computation, and functional analysis. Define the levels of explanation and explain the relationships between higher level and lower level explanations.

- NSCS 200, CGSC 320, CGSC 321

A.5) Give an overview of the concept of cognitive architecture and define the terms: modularity, domain specificity, distributed networks and central systems, and give examples.

- NSCS 200, CGSC 320

A.6) Summarize contemporary understanding of the biological bases of and the cognitive processes underlying behavior, including sensation, perception, language, attention, learning, memory, and action.

- NSCS 200, NROS 307, CGSC 321, CGSC 320

A.7) Describe the basic cognitive processes and the primary circuitry involved in language, decision- making, thinking/reasoning, motivation, emotion, and consciousness. Give examples of normal range of cognitive, emotional and behavioral variability over the lifespan.

- NSCS 200, CGSC 320

A.8) Using an evolutionary perspective, outline evolutionary principles that support use of animal model systems and explain how innate/genetic factors and environment/experience are understood to interact in development. Explain the relationship between molecular genetics and epigenetics and provide examples.

- NSCS 200, NROS 307

A.9) List the basic steps in establishing the wiring plan of the nervous system, including common molecular signaling pathways. Differentiate activity-independent and -dependent steps.

- NSCS 200

A.10) Describe the cognitive, genetic, molecular and cellular bases of several common diseases and disorders of the nervous system. Discriminate among these disorders in terms of their presentation and include the clinical tools typically used in diagnosis.

- NSCS 200, NROS 307

A.11) At a fundamental level, explain the common methodologies and experimental designs used in research in neuroscience and cognitive science. Evaluate the soundness of the methodological design of descriptive, correlational, and experimental research. Design, interpret, and evaluate simple cognitive, behavioral and cellular experiments. Synthesize research findings from the neuroscience and cognitive science literature in the evaluation of questions surrounding the neurophysiology, mind/brain or information processing. Explain how the study of atypical cases, either natural or accidental, has greatly enhanced our knowledge about mind-brain interactions.

- NSCS 200, NSCS 307, NROS 308, CGSC 320, CGSC 321

Core knowledge-specific content for Cognitive-Science focus students

CS.12) Illustrate the complex relationship between mental faculties and brain structure, providing examples and comparing in several brain structures of how critical features of cognitive architecture, including modularity, domain specificity, distributed networks and central systems are organized.

- CGSC 320 and course selections from Philosophy and Cognitive Psychology menus

CS.13) Describe the major principles of computational modeling, and compare and give an example of each of the following kinds of models: logic-based models, connectionist models, and Bayesian models.

- CGSC 320, CGSC 344, CGSC 410, course selection from Computational Methods menu, and course selection from Philosophy, Linguistics and Cognitive Psychology menus

CS.14) Explain how perception of the world works and how the brain interprets the world from limited inputs and prior knowledge; construct examples.

- CGSC 310, CGSC 410, course selections from the Cognitive Psychology menu, course selections from the Philosophy and Computational Methods menus

CS.15) Describe, providing examples, how cognitive function changes during development and during aging; apply poverty-of-the-stimulus arguments to cognitive development.

- CGSC 320, CGSC 305, course selection from the Cognitive Psychology menu, course selections from the Philosophy and Linguistics menus

CS.16) Explain what language is and explain the mechanisms underlying its acquisition. Analyze language samples, indicating examples of syntactic structure, word segmentation, recursion, language processing, word recognition, and indicating level of language acquisition.

- CGSC 320, CGSC 340, CGSC 305, course selection from Linguistics menu, course selections from the Philosophy, Cognitive Psychology and Computational Methods menus

CS.17) Summarize what is currently understood about the cognitive processes involved in decision making, reasoning, moral judgment and action.

- CGSC 201, course selection from the Philosophy menu, course selection from the Cognitive Psychology menu

Core knowledge-specific content for Neuroscience-focus students

NS.12) Describe the basic processes by which macromolecules are assembled and used to carry out common cellular processes (e.g. molecular genetics, signal transduction, second-messenger pathways,

organelle assembly, cell division, cytoskeleton) as used in neurons and glial cells. Design an experiment to test involvement of various pathways in a particular process in neurons or glial cells.

- NROS 310

NS.13) Explain how neurons detect and process sensory information, including receptor function, transduction processes, and conduction properties. Compare and contrast these processes in various sensory modalities.

- NROS 310, NROS 418 (former PSIO 465)

NS.14) Describe the anatomical organization (include diagrams) and functional properties of the somatosensory, visual, auditory/vestibular and olfactory and taste systems.

- NROS 418 (former PSIO 465)

NS.15) Describe the anatomical organization (include diagrams) and network function of the circuits responsible for emotion and arousal.

- NROS 418 (former PSIO 465)

NS.16) Explain how motor behaviors are generated, including the basic anatomy of reflex and descending motor pathways, central pattern generators, and regulation of motor activity by higher order circuits in the brain.

- NROS 418 (former PSIO 465)

NS.17) For any of the pathways in NS.14-16, predict the consequences of lesions within those pathways.

- NROS 418 (former PSIO 465)

NS.18) Explain the major mechanisms understood to underlie cortical plasticity. Use an example to illustrate at least two mechanisms.

- NROS 310

B. Scientific inquiry

B.1) Think critically about complex problems involving the brain and the mind.

- NSCS 200, NROS 307, NROS 301, CGSC 320, CGSC 321

B.2) Develop strategies to solve complex problems creatively and with cognitive flexibility.

- NROS 307, NROS 307, CGSC 321, CGSC 320; also research opportunities

B.3) Engage in self-initiated learning and discovery.

- All courses, especially upper division ones; also research opportunities

B.4) Read and critically evaluate both formal scientific literature and scientific results disseminated through the mass media.

- NROS 308, CGSC 321, all upper division courses including elective courses

B.5) Effectively communicate (orally, written or electronic) the principles and concepts of biological and cognitive sciences to other scientists and to the public.

- NROS 308, CGSC 321, upper division courses including elective courses

B.6) Analyze quantitative data, showing an understanding of fundamental concepts of statistics and computational approaches to data analysis.

- Pre-requisite statistics course, upper division courses including elective courses

C. Ethics and Professionalism

C.1) Apply ethical and professional standards to their own practice of research and to their evaluation of cases/situations.

- Students must complete the online course on Responsible Conduct of Research as part of their NSCS 315B course requirement.
- Students must attend an annual seminar on ethical issues.
- All courses address ethical and professional issues that arise in their content or discussions.

C.2) Articulate the complex interrelationship among science, technology, and society.

- Students must attend an annual seminar on science policy.
- Students will read Stine (2009) or another guide to the structure of the science-policy making enterprise in the US and must pass a short exam about the interrelationships among these elements.

Assessment activities

Direct Assessment

All courses use direct assessment strategies that include exams, quizzes, in-class presentations, homework, and projects.

NSCS 200
NROS 307
NROS 308, CGCS 321
CGCS 320

The small size of the initial graduating class {2013) made it possible for the faculty members of the Curriculum Committee to design an exit interview focused on the knowledge-specific outcomes. The interviews were carried out by the Curriculum Committee members and additional faculty, with each interview lasting about 30 minutes. There was no consequence to the students, but even taking into account that some students clearly were not highly motivated, the interviews revealed gaps in the students' knowledge. This information was summarized and conveyed to the teaching faculty, who made small changes in their courses; because the number of students was small, and because the curriculum was changed to have two tracks, it was decided to wait and re-assess before making major changes.

At the program level beginning in AY2015/16, students will take a multiple-choice exam written by core teaching faculty to specifically assess core knowledge, scientific-inquiry skills, and ethical and professional behaviors. Students will take the exam at the beginning of their suite of core courses (NSCS 200) and will take the same exam at the end of their program as a requirement for graduation, allowing us to carry out both within and between-subject analyses of student achievement.

Indirect assessment

These assessments are carried out by faculty, the program director and program coordinator, the NSCS advisor, members of the Undergraduate Studies and the Curriculum Committees, and the chairs of each of the MBB departments. Extended discussion and evaluation is planned on a 3-year schedule; annual assessments identify short-term concerns that can be addressed rapidly and also identify areas for development or modification in the longer term. Surveys were designed by the program coordinator and the program director, the results are reviewed by the Curriculum Committee, and changes suggested in that review are incorporated into the following year's surveys.

Program integrity

- Annual documentation of learning objectives for each course (specified in course syllabi)
- Annual review of course content by review of syllabi
- Annual course listing updated (core, track and emphasis courses)
- Faculty/Student ratio to ensure accurate projections of resources needed

- Faculty teaching loads and faculty changes
- Annual faculty survey

Student characteristics and progress indicators

- Student demographics and characteristics
- Student recruitment, retention, time to degree completion, degree completion,
- Percent honors students, percent completing theses
- Student engagement
- Percent students engaging in research, # of semesters of involvement
- Labs taking undergraduate students for research
- Attendance at local, regional, and national meetings
- Authorship on publications
- Annual faculty survey

Student satisfaction

Annual survey of students in the major to assess the goodness of student advising, teaching effectiveness, program supports, research experience and involvement in NSCS programs and outreach. These are subjective reports of their experiences, and the results are used in program analysis and improvement. The instrument vary with the level of the student - pre-majors, full majors, graduating students and alumni.

Alumni *placement*

Alumni tracking will include job placement or continuing education, assessed at 1 and 5 years after graduation.

Course evaluation

- Within courses, students may be asked to evaluate their own and each other's projects using the same rubric or one similar to that used by the faculty. Instructors of all NSCS-program courses are strongly encouraged to regularly engage students in assessing their own learning.
- Every course provides students the opportunity to complete a course evaluation that includes an assessment of quality of instruction, at minimum the relatively generic online report that is provided by the University (TCE reports). Instructor-devised course-specific questions may be included on these reports. Instructors of NSCS and NROS also may have their own course-specific evaluation tools. Both are used by the instructors for course improvement. The TCE reports are available to the NSCS Curriculum Committee for use in curriculum review.

Curriculum assessment

- Annual assessments are carried out in the NSCS Curriculum Committee
- 3-year reviews. These sessions are attended by all core teaching faculty and by the heads of the departments comprising the School of Mind, Brain and Behavior.
- Annual faculty survey