Behavioral Neuroscience Graduate Program

A Specialty of the Doctoral Program in Psychology at the University of Alabama at Birmingham
Pictured on the cover is a directionally selective rabbit retinal ganglion cell stained with lucifer yellow.
The biological bases of behavior, perception, learning, and memory are largely unknown. Graduate study in behavioral neuroscience is based on the belief that concomitant training in behavioral, systems, and cellular and molecular approaches to neuroscience is necessary to fully understand these and other complex processes. The Behavioral Neuroscience program draws together faculty from multiple departments who are interested in the interface between neurobiology and behavior, providing a rich training experience for students in this exciting field.

Neuroscience research at UAB occurs within an explicitly interdepartmental and interdisciplinary context. While the research training is highly individualized, all Behavioral Neuroscience graduate students receive training in cellular, molecular, and systems neuroscience, in statistical analysis and experimental design, and in relevant areas of psychology. Research opportunities for students in the Behavioral Neuroscience Program include:
• Neurobiology of Alzheimer's Disease
• Neural Mechanisms of Pain
• Neural Controls of Food Ingestion and Body Weight
• Computational Models of Visual Information Processing
• Information Processing in Visual Thalamus and Cortex
• Ocular Movement Controls
• Cholinergic Receptors in the Brain
• Visual Psychophysics
• Cognitive Neuroscience
• Motor Systems
• Plasticity in Adult Brain
• Limbic System Structure and Function
• Vision and Aging
• Central Phonetic Representations

Course of Study

Research experience. Students begin laboratory research upon entry into the program. To provide students with a broad research experience before they select a mentor, students do three to four laboratory rotations during their first year. Students select a laboratory in which to conduct their dissertation research based on these rotations.

Curriculum. The first year Behavioral Neuroscience curriculum includes an Overview of Behavioral Neuroscience, Integrative Neuroscience, Neurobiology of Learning and Memory, and courses in statistical analysis. During the second year, students study cellular and molecular neurobiology and select basic science and psychology courses that are germane to their interests.

The UAB Psychology Department ranks among the top 10 psychology departments in the U.S. in per capita extramural funding. UAB's nationally-ranked medical center and its associated graduate and professional schools provide an exciting, dynamic atmosphere for interdisciplinary graduate study. For a unique interdisciplinary classroom and laboratory experience, the Behavioral Neuroscience program collaborates with other UAB centers and departments:

• Department of Neurobiology
• Department of Cell Biology
• Department of Physiological Optics
• Vision Science Research Center
• Department of Biocommunication
• Civitan International Research Center
• Department of Psychiatry and Behavioral Neurobiology
• Department of Ophthalmology
• Cardiovascular Research and Training Center
• Department of Physiology
• Center for Nuclear Imaging Research

Active seminar programs at UAB in the Departments of Psychology, Neurobiology, Cell Biology, Vision Science, and Physiology bring numerous neuroscientists of national and international prominence to UAB each year. Intensive, yet informal, interaction with students is part of each speaker's visit.
Student Support

Graduate students in the Behavioral Neuroscience Program are supported by university fellowships, training grant fellowships, research assistantships and teaching assistantships. Students may apply for travel funds to present findings at scientific meetings and to visit laboratories where they may learn specialized methods relevant to their research. A number of students in Behavioral Neuroscience have been successful in obtaining individual fellowships for dissertation support.

Uniquely UAB

The University of Alabama at Birmingham is a comprehensive, urban research university. It is located in Alabama’s largest city. With an enrollment of more than 15,850 students—5,492 of them graduate and professional students—and faculty and staff numbering more than 15,833, UAB has become a nationally and internationally respected center for educational, research, and service programs. The UAB campus encompasses a 72-block area on Birmingham’s Southside, offering all of the advantages of a university within a highly supportive city.

The University is composed of 12 schools, as well as hospitals and clinics housing internationally-renowned patient care programs. UAB includes the Schools of Arts and Humanities, Business, Dentistry, Education, Engineering, Health Related Professions, Medicine, Natural Sciences and Mathematics, Nursing, Optometry, Public Health, and Social and Behavioral Sciences. The Graduate School administers doctoral programs in 32 areas and master’s level programs in 45 areas. A particular strength of the school is its many interdisciplinary programs, like the Behavioral Neuroscience Program, that cross departmental and school lines.

In 1997, UAB attracted $248 million in extramural research and development support, earning a ranking among the top public institutions in the country in extramural funding. UAB is nationally ranked in the top 20 for funds received from the National Institutes of Health for biomedical research support, and is nationally ranked in the top 30 for receiving federal funds for research and development from all federal agencies. The Psychology Department is ranked in the top 10 in the nation in extramural funding. The Civitan International Research Center was funded initially with a 20 million dollar grant from the Civitan International Foundation to study human development and developmental disabilities. The Department of Neurobiology recent-ly received a substantial award from the Keck Foundation to support its expansion. For graduate students, this funding status means availability of financial support, access to well-equipped research laboratories, and interaction with faculty members who have earned research support based on the favorable judgment of their colleagues nationwide.

The Behavioral Neuroscience program benefits from multidisciplinary centers in areas such as Cardiovascular Research and Training, Comprehensive Stroke Research, Vision Science Research, Aging, Alzheimer’s Disease, and development and developmental disabilities (i.e., the Civitan International Research Center). Each center brings together scientists from several departments to provide a multifaceted approach to an aspect of neuroscience. Active seminar programs in each center provide an additional forum for interaction and stimulation.

Campus life at UAB is characterized by the bustle and diversity of the university’s urban setting. UAB graduate students take advantage of a wide variety of cultural and recreational opportunities on and off campus, and numerous student organizations and associations invite participation. UAB has an active international community of students and faculty.

The recently completed Alys Robinson Stephens Performing Arts Center provides an acoustically superb setting for a broad range of world-renowned performers who are brought to the UAB campus. Several musical performing groups provide enrichment and performing opportunities for UAB students. There are small theatregoing groups on campus, as well as a UAB-affiliated community theater, Town and Gown Theater. Dance groups offer opportunities in ballet and jazz. Artwork is continuously exhibited in the Visual Arts Gallery and several other galleries on campus.

University programs include a lecture series, foreign and popular film series, and an assortment of special events, seminars and other activities. Many of these programs are free to students.

The UAB Blazers basketball team has earned berths in eight NCAA tournaments and five NIT tournaments. UAB’s intercollegiate sports program includes football, basketball, baseball, tennis, soccer, golf, volleyball, track, and cross-country. Intramural competition is offered in many sports.
Birmingham is a growing, progressive city with a greater metropolitan area that is home to more than 900,000 people. Located in the foothills of the Appalachians, Birmingham is a busy urban center of great natural beauty. The hospitality of the people and the temperate climate of the “Magic City” complement a wide variety of educational offerings, cultural and entertainment activities, and sporting events. Health care and education have replaced industry as Birmingham’s economic base, and UAB is now the city’s leading employer.

Birmingham was named the Most Livable City in the nation in 1989 by the U.S. Conference of Mayors. In the same year, Newsweek magazine included Birmingham in its “top ten” list of America’s best places to live and work.

A symphony orchestra, the Alys Stephens Center Concert Series, the Birmingham Opera Theater, the Birmingham Chamber Music Society, the State of Alabama Ballet, Southern Dance Works, and Ballet UAB offer variety in music and dance for area residents.

Theatre-goers choose from the offerings of numerous performing companies, along with three college-level companies and a children’s theater. National touring groups stage dramatic performances under the sponsorship of the city’s Civic Center.

City Stages, a three-day outdoor music and arts festival, takes place each summer in Linn Park, the heart of the downtown cultural and historic district. The festival attracts thousands of visitors from across the Southeast to hear the music of nationally-known and local artists.

The new Birmingham Civil Rights Institute exhibits a self-
directed journey through the civil rights movement, as well as temporary exhibits which include interactive video and computer programs. The Institute also houses a resource gallery for teachers, students and others seeking information on civil and human rights.

The Birmingham Museum of Art houses one of the most comprehensive permanent collections in the southeast, including the world’s largest collection of contemporary Chinese paintings outside China. The Red Mountain Museum, perched on the side of Red Mountain, chronicles the geological history of the area. The newly opened McWane Science Center provides interactive science exhibits and an IMAX theater.

Major local attractions include Vulcan, the massive iron-cast figure of the God of the Forge, overlooking the city from atop Red Mountain; the largest zoo in a nine-state area; the Birmingham Botanical Gardens; and the Riverchase Galleria, the largest enclosed shopping mall in the South.

For sports fans, Birmingham offers collegiate sports, such as basketball, soccer, baseball and football, as well as minor league baseball and hockey. Birmingham is frequently selected as the site for college basketball tournament events, including various rounds of the NCAA Tournament.

Birmingham’s temperate climate encourages year-round outdoor activities, with rivers and lakes within short driving distance. The state’s largest park, located just 15 miles south of town at Oak Mountain, offers boating, swimming, camping, hiking, golf, tennis, and fishing.

Birmingham is located approximately 150 miles west of Atlanta. New Orleans and the beautiful beaches of the Gulf of Mexico lie within a five-hour drive to the south, and the mountains, whitewater rivers, and snowslopes of Tennessee and North Carolina are five hours northeast.
Faculty Research
Visual Sensation and Perception

Franklin R. Amthor
Ph.D., Duke University
Associate Professor of Psychology

The retina is a crucial computational stage in visual sensory information processing, where retinal ganglion cells extract and encode visual features. Intracellular and multicell recording, neurochemical techniques, and quantitative modeling are being used to unravel the complex synaptic interactions in the retina's inner plexiform layer, where single neurons are sensitive to high order attributes of visual stimuli, such as the direction of motion of an object, and groups of neurons may encode coherence of motion.


Allan C. Dobbins
Ph.D., McGill University
Assistant Professor of Biomedical Engineering

Representation of visual space is essential for reaching and grasping, orienting and navigating, and for reasoning about interactions among objects and organisms in the world. Viewed objects change in retinal projection with pose and distance, and yet the visual system compensates for these incidental variations to an astonishing degree. Dr. Dobbins' laboratory investigates how representations of space and form interact in primate visual cortex. He is interested in how the visual system develops representations—for instance, of object shape—that are invariant with spatial position.

Computers provide a medium for posing and addressing questions about the function of complex systems that cannot be approached by any other means. If one is interested in naturally occurring complex systems, details of the system are necessary to constrain the modeling process. Dr. Dobbins' approach is both experimental and synthetic where experiments constrain the models and models suggest further experiments. The experimental approaches include recording from neurons in alert primates performing behavioral tasks, human psychophysics, and functional magnetic resonance imaging. The goal is to understand how the dynamics of visual circuits give rise to perception and guide action.


Paul D. R. Gamlin
Ph.D., State University of New York at Stony Brook
Professor of Physiological Optics
Director of UAB Vision Science Research Center

Dr. Gamlin investigates the neural control of eye movements in primates. Specifically, he studies the neural control of vergence, ocular accommodation, and pupilloconstriction. When a near target is viewed, the two eyes converge the correct amount, they focus (accommodate) appropriately, and pupillary diameter is adjusted. When light intensity increases, pupilloconstriction occurs. Dr. Gamlin is using electrophysiological and neuroanatomical techniques to examine how the nervous system controls these eye movements.


Timothy J. Gawne
Ph.D., Uniformed Services University
Assistant Professor of Physiological Optics

Dr. Gawne's research examines how the coordinated activity of the many neurons in the visual system can allow us to see and recognize objects. At present we don't know how the brain does this, and we don't know how to do it by computer, either. Dr. Gawne addresses this problem through a variety of different techniques, including computer modeling and visual psychophysics, but mostly using single-unit electrophysiology. By recording from single neurons or small groups of neurons in the different parts of the visual system of behaving primates as varying visual scenes are presented, it should be possible to determine what aspects of neural signals are important for visual perception.


Kent T. Keyser
Ph.D., State University of New York at Stony Brook
Associate Professor of Physiological Optics

Dr. Keyser's laboratory studies neurotransmitters, especially acetylcholine, and their receptors in the eye and central visual system. Biochemical studies are directed at understanding the make-up and function of certain receptors. Immunocytochemistry studies help to determine what cells express these receptors, and how the pattern of expression changes during development and throughout life. Physiology studies give insight into the roles that neurotransmitter/receptor interactions play in the normal visual
Many neurotransmitters and their receptors play important roles in disease processes. For example, nicotinic acetylcholine receptors, which bind nicotine, are responsible for nicotine addiction. Decreases in the number of nicotinic acetylcholine receptors are associated with both Alzheimer’s and Parkinson’s diseases. Thus, the study of neurotransmitters and their receptors can yield information not only about normal nervous system functioning, but also about pathological conditions which affect the quality of life and its duration.


Michael S. Loop
Ph.D., Florida State University
Associate Professor of Physiological Optics

Dr. Loop works to understand the relationship between visual perception and nervous system activity. Current studies are designed to discover what aspects of visual system organization result in the better sensitivity of normal humans to color than to brightness. To this end color vision thresholds are being determined in a wide range of vertebrate species including goldfish, tree shrews, macaque monkeys, and cats.


Lawrence E. Mays
Ph.D., University of Virginia
Professor and Chair, Department of Physiological Optics

Dr. Mays' research is directed towards understanding the neuronal control of disjunctive, or vergence, eye movements and accommodation of the lens. Animals with binocular single vision, including humans, must make small, accurate vergence eye movements to maintain stereoscopic vision. Dr. Mays' laboratory studies the neuronal basis of vergence and accommodation control using monkey subjects that are trained to track visual targets presented via a 3D virtual reality display. The activity of single neurons from pontine and midbrain sites is recorded to identify steps in the processing of these control signals. Recent studies have investigated the brainstem circuitry responsible for non-linear interactions between the vergence and saccadic eye movement subsystems.


Thomas T. Norton
Ph.D., University of California, Los Angeles
Professor of Physiological Optics

Dr. Norton's laboratory is studying "Mind over Matter." During normal development, the retina (part of the brain and therefore, "Mind") controls the elongation of the eyeball ("Matter"), so that the length of the eye comes to match its optical power, producing an eye that is in good focus. Dr. Norton's laboratory uses optical, anatomical, biochemical, and molecular biology tools to learn how this occurs in an animal model (tree shrew) that is closely related to primates. A long-term practical goal of this work is to learn how myopia (nearsightedness) might be controlled or prevented in children. As a behavioral neuroscientist, Dr. Norton's interest is to learn how neural signals from the retina control the accumulation of non-neural substances, such as collagen and proteoglycans, in the sclera of the eye, thereby controlling the extensibility of the sclera.


Cynthia Owsley
Ph.D., Cornell University
Professor of Ophthalmology

Dr. Owsley’s research focuses on vision impairment, eye disease, and aging. A variety of research techniques are used to study the causes and consequences of vision impairment in the elderly, including psychophysical and epidemiological methods. The goal of this research is to describe the visual changes and deficits that occur in later life and to determine their underlying neural and optical bases.


Michael E. Sloane
Ph.D., Northwestern University
Associate Professor of Psychology

Research in Dr. Sloane’s laboratory involves the use of behavioral methods to investigate neural mechanisms underlying human vision. A major emphasis is the development and use of psychophysical procedures designed to examine the role of stimulus parameters known to be critical in neural coding in mammalian visual cortex. Current research focuses on three areas: 1) psychophysical assessment of vision in the elderly; 2) mental rotation; and 3) neural correlates of perceptual cognition.


Rosalyn E. Weller
Ph.D., Vanderbilt University
Associate Professor of Psychology

Dr. Weller’s research focuses on determining the contributions that particular areas of visual cortex and thalamus make to vision in primates. The major focus concerns cortical areas of the inferior temporal lobe that subserve visual object identification and recognition. Although Dr. Weller has previously used neuroanatomical, physiological, and behavioral research methods to study visual areas, current emphasis is on neuroanatomical methods. In a typical experiment, tracers are injected into cortical areas in order to reveal their extrinsic and intrinsic connections. Dr. Weller is also beginning functional magnetic resonance imaging (fMRI) studies of brain structures involved in vision in humans using UAB’s high strength (4.1T) MRI facility.
Regulatory and Integrative Neurobiology

James E. Cox
Ph.D., Yale University
Associate Professor of Psychology

Dr. Cox is interested in the physiological controls of food intake and body weight in experimental animals. His research focuses on gastrointestinal and autonomic substrates of satiation, the processes involved in meal termination. One project investigates the actions of two abdominal peptides, cholecystokinin and gastrin-releasing peptide. These substances are released when food is ingested and are thought to act as negative feedback signals limiting further consumption. Experiments in progress seek to define the sites of action of these peptides and their interactions with the vagus nerve. A second project examines the satiating effects of nutrients within the small intestine and the possibility that enhancing these effects may be useful in the treatment of obesity.


Alan Randich
Ph.D., Dalhousie University
Professor of Psychology
Director of Behavioral Neuroscience Program

One line of research in Dr. Randich's laboratory deals with basic mechanisms of pain and pain modulation. Currently, Dr. Randich's research is directed towards understanding pain arising from inflammation. Laboratory techniques primarily include extracellular recording of spinal dorsal horn neurons which encode cutaneous pain and recordings of primary afferents from cutaneous structures. These studies will lead to a better understanding of pain mechanisms and treatments to alleviate pain associated with inflammation and nerve injury. A second line of research deals with mechanisms of satiety and recordings from vagal afferents innervating the small intestine.


Diane C. Tucker
Ph.D., University of Iowa
Professor of Psychology

Dr. Tucker's laboratory focuses on the interaction between genetic predisposition to disease and environmental factors. Dr. Tucker has recently extended her interest in genetics of disease to examination of how people understand genetic risk for disease and use this information in making decisions about health behaviors. In collaboration with psychoimmunologists on campus, she is examining the mechanisms by which psy-
chosocial interventions affect the development and progress of chronic diseases such as cancer.


James Michael Wyss
Ph.D., Washington University
Professor of Cell Biology

In Dr. Wyss's laboratory, research is underway to identify the structure and function of the "limbic" areas of the brain and the mechanisms and consequences of neuronal remodeling in these regions. Methods used in these studies include electrophysiology, biochemistry, receptor binding, behavioral, tract tracing, and transgenic model techniques. In a second series of studies, Dr. Wyss is investigating the role of the central and peripheral nervous systems in blood pressure control, especially as it relates to hypertension. These studies are focused on the mechanisms of neurotransmitter release from axon terminals in the hypothalamus and how this regulation alters sympathetic nervous system activity. These studies rely on high pressure liquid chromatography, radioimmunoassay, immuno histochemistry, receptor binding, transgenic mouse models, and microinjection/microdialysis methods.


Aging and Alzheimer's Disease

Lindy E. Harrell
M.D., Ph.D., University of Massachusetts
Professor of Neurology
Director of Alzheimer's Disease Center

The Alzheimer's Disease Center is conducting several studies including clinical drug trials for patients with mild to moderate dementia, the treatment of depressed Alzheimer's patients, and addressing the issue of how caregivers deal with the stress of Alzheimer's Disease.

Dr. Harrell's laboratory is directed toward the study of central cholinergic systems. She has investigated the behavioral effects of neuronal rearrangement in the hippocampal formation, and the cholinergic regulation of hippocampal metabolism. These studies have provided new information on cholinergic-adrenergic interactions and hippocampal function. Current studies include those investigating how cholinergic system changes and neuronal rearrangements affect hippocampal parameters such as phospholipase C activity, G-protein function, and amyloid precursor protein metabolism.


Gail V. W. Johnson
Ph.D., University of Delaware
Professor of Psychiatry

Dr. Johnson's research is directed towards understanding how the neuronal cytoskeleton participates in signal transduction. Classically, neuronal cytoskeletal proteins have been viewed as static, structural proteins; however, it is becoming increasingly evident that certain cytoskeletal proteins participate in cell signaling events. Her laboratory is particularly interested in the role that tau protein plays in the cell. In vitro, tau binds and stabilizes microtubules and is likely to participate in a similar function in vivo. However, tau also plays a role in neurite outgrowth independent of its ability to bind to microtubules, and there is evidence to suggest that tau is involved in the activation of phospholipase C-gamma. Considering these and other findings, it is clear that tau is likely to play a central role in neuronal cell function. Currently, Dr. Johnson's laboratory is investigating several aspects of tau protein metabolism and function, including specific signaling pathways that are involved in modulating the phosphorylation of tau, modulation of the turnover and localization of tau within the cell, and the role of oxidative stress in tau metabolism and function. These studies will help elucidate the role of tau protein and the cytoskeleton in signal transduction pathways. In addition, these investigations will increase our understanding of the role of tau protein in the pathogenesis of Alzheimer's disease and other neurodegenerative disorders.


**Neurochemistry of Behavior and Emotion**

**Lewis R. Baxter, Jr.**

M.D., University of Florida
Professor of Psychiatry and Behavioral Neurobiology

Dr. Baxter examines neuroanatomical localization of brain functions that mediate the symptoms of psychiatric disorders, as well as the mechanisms by which medications and behavioral reconditioning alter the symptomatic expression of these illnesses. Work in Dr. Baxter's laboratories, both clinical and basic science, is presently targeted on obsessive compulsive disorder and unipolar depression, common illnesses afflicting millions of Americans, and on the social-territorial behaviors in amniote vertebrates which form the evolutionary substrate of these human afflictions.

Research techniques employed include PET scanning combined with drug and non-drug symptom manipulations in human patients with these illnesses, and animal models (monkeys, rats and lizards), studied with PET, autoradiography and in situ hybridization techniques after behavioral and drug manipulations of behaviors homologous to those seen in humans. Dr. Baxter seeks fundamental understanding of the relationship between the brain mechanisms and behavior studied—insights that can provide rational bases for the development of new treatments for psychiatric illnesses.


**Richard S. Jope**

Ph.D., University of California Los Angeles
Professor of Psychiatry and Behavioral Neurobiology

Dr. Jope's laboratory studies the neurochemical basis of behavior. Recent studies focus on the roles of signal transduction systems that produce second messengers, alterations of protein phosphorylation, and modulation of gene expression, and which are associated with abnormal cognition and/or behavior. This research involves studies in cultured cell model systems, postmortem human brain, and rat or mouse brain.

Dr. Jope's laboratory studies biochemical mechanisms which may contribute to psychiatric disorders, such as manic-depression, and the neurochemical and behavioral effects of therapeutic drugs on gene expression and on receptor-induced cellular responses to stimulation. The goal is to understand mechanisms that regulate the activity of signal transduction systems.

To study mechanisms causing memory impairment associated with aging and Alzheimer's Disease (senile dementia), Dr. Jope uses human brain tissue, cultured cells, and transgenic mice to study changes in receptor responses, transcription factor activation, and neurodegenerative mechanisms, especially those related to free radical formation. The goal is to understand the biochemical mechanisms underlying the impaired memory and neurodegeneration associated with dementia.

Hormones induced by stress influence many behaviors, cognition, and many diseases. Dr. Jope studies the effects of altered hormone levels on neuronal second messenger production and gene expression, and examines how hormones modulate neuronal responses to stressors, such as oxidative stress. The goal is to find how acute and chronic stress modifies neuronal function and alters behavior.


**Plasticity**

**Michael J. Friedlander**

Ph.D., University of Illinois
Professor and Chair of Neurobiology

Two of the most fundamental issues of contemporary neurobiology are how learning occurs and how the brain is assembled. Understanding these issues at the level of cellular and molecular mechanisms is likely to provide insights into the potential of the human mind and for overcoming afflictions such as dementia, mental retardation, and other cognitive disorders. Dr. Friedlander's laboratory addresses these problems as they relate to visual perception with basic molecular, electrophysiological, and structural studies of the mammalian forebrain—particularly in the thalamus and cerebral cortex of the central visual pathway. The role of patterned synaptic activity is evaluated as a triggering mechanism that activates the production of neuronal nitric oxide (NO) which in turn diffuses in extrasynaptic space. NO can effectively link neighboring synapses and chemical pathways, thus forming transient functional networks in a
microvolume of brain in a dynamic fashion. Current studies are directed at elucidating the molecular targets of NO, its role in strengthening and weakening synaptic transmission and the developmental expression of this mechanism in the neonatal brain. Additional experiments utilize quantitative analysis of the three-dimensional structure of growing dendrites and axons in the neonate in order to discover the cellular strategies for establishment of neuronal territory and the role of synaptic activity and diffusible factors in this process.


Jean D. Peduzzi
Ph.D., Wayne State University
Associate Professor of Physiological Optics

The aim of Dr. Peduzzi’s laboratory is to develop effective treatments for injuries of the central nervous system. In order to provide a substrate for restructuring of tissue after spinal cord injury, a hydrogel developed by Organogel is currently being evaluated in preparation for clinical trials. The possible use of various neurotrophic factors is also being investigated by determining the levels of growth factors in the cerebrospinal fluid before, during, and after the period of the regenerative (repair) attempt that occurs about three weeks after injury. From these data, the level and concentration of neurotrophic factors may be measured to reveal how the nervous system attempts to repair itself. The long-term continuous delivery of these and other growth factors is being planned.

Environmental enrichment is also being studied as a method to treat chronic spinal cord injury, either alone or in conjunction with other treatments. In a project under development, transgenic mice that have the human receptor for the polio virus will be used determine the feasibility of delivering instructions to motor neurons to produce one or several growth factors or agents to prevent cell death after injury. Another project under development is to investigate how blood flow to an injury site is modified by blood pressure and the functional consequences of modifying blood pressure after injury. In an effort to develop treatments that are clinically relevant, new animal models are being developed for spinal cord injury and diffuse axonal (head) injury. Methods routinely used in the lab include animal surgeries, behavioral training and testing, immunohistochemistry and morphometry.


Edward Taub
Ph.D., New York University
Professor of Psychology

Dr. Taub has developed a new set of techniques, termed Constraint-Induced Movement Therapy, effective in reducing the incapacitating motor impairment often associated with stroke. The work stems from research with monkeys given somatosensory deafferentation and is based on the hypothesis that a portion of the chronic motor deficit after injury is due to a learning phenomenon, termed "learned nonuse", rather than to the organic damage per se. Constraint-Induced Therapy has recently been shown to produce a substantial increase in "use-dependent cortical plasticity". Future research will correlate the motor improvement in stroke patients with changes in brain plasticity as revealed by magnetoencephalography (MEG), neuroelectric source imaging (EEG) and focal transcranial magnetic stimulation (TMS).


Associated Faculty

Kathleen H. Berecek Ph.D. Professor (Physiology and Biophysics) Role of central nervous system neuropeptides in regulation of arterial blood pressure and development of hypertension.

Anjan Chatterjee M.D. Associate Professor (Neurology) Behavioral neurology, cognitive neuropsychology, brain-behavioral relationships, cognitive neuroscience, neglect, aphasia.

Edwin W. Cook III Ph.D. Associate Professor (Psychology) Psychophysiological studies of human emotion; startle reflex as an indicator of emotional state and psychopathology.

Leon S. Dure Ph.D. Assistant Professor (Pediatrics) Excitotoxic brain injury resulting from hypoxia, hypoglycemia, and neurodegenerative diseases.

Roger Fillingim Ph.D. Assistant Professor (Psychology) Sex-related influences in pain perception; experimental pain assessment in healthy volunteers and clinical populations.

James E. Flege Ph.D. Professor (Biocommunications) Developmental changes in second language speech learning and in the perception of vowels and consonants in the second language.

Craig C. Garner Ph.D. Associate Professor (Neurobiology) Molecular biological studies of synaptic specializations and dendrites; regulation of assembly of synaptic junctions.

Vithal K. Ghanta Ph.D. Professor (Biology) Interaction between the nervous system and the immune system, with focus on the mechanisms responsible for this communication.

G. Yancey Gillespie Ph.D. Professor (Neurosurgery) Immunobiology of malignant gliomas; novel treatment approaches including gene therapy, viral vectors and antiangiogenesis treatments; role of transforming growth factor-beta and vascular endothelial growth factor in pathology of glioblastoma.

John J. Hablitz Ph.D. Professor (Neurobiology) Biophysical properties of glutamate receptors in the mammalian neocortex studied using whole cell patch clamp recordings from visually identified cells in cortical slices.

Raymond N. Hiramoto Ph.D. Professor (Microbiology) Psychoneuroimmunology; mechanisms of mind-body interactions in health and disease.

Robin A.J. Lester Ph.D. Assistant Professor (Neurobiology) Cellular and molecular regulation of neuronal nicotinic receptors in the central nervous system under physiological and diseased conditions.

Stuart Mangel Ph.D. Associate Professor (Neurobiology) Retinal neurobiology; synaptic plasticity and circadian rhythmicity in the retina; neurotransmitter function.

Anthony P. Nicholas M.D., Ph.D. Assistant Professor (Neurology) Pathophysiology of brain monoamine pathways associated with neurodegenerative and behavioral disorders.

Michael W. Quick Ph.D. Assistant Professor (Neurobiology) Regulation of neurotransmitter transporters, ion channels, and receptors; focused on understanding and treating neurological disorders such as addiction.

Kevin D. Reilly Ph.D. Professor (Computer and Information Science) Simulation and artificial intelligence. Biologically inspired computation, including neural networks, genetic algorithms, fuzzy systems, and rough sets; animation.

David L. Roth Ph.D. Associate Professor (Psychology) Psychophysiological and emotional effects of stress; effects of physical exercise on negative consequences of stress.

Harald W. Sontheimer Ph.D. Associate Professor (Neurobiology) The role of glia in nervous system function and in diseases of the nervous system.

Amanda C. Walley Ph.D. Associate Professor (Psychology) Development of spoken language abilities in early through middle childhood, and their relationship to early reading success.

David S. Weiss Ph.D. Associate Professor (Neurobiology) Use of molecular biological, electrophysiological, and ligand binding techniques to gain insight into the mechanism of activation, ion conduction, modulation, and regulation of recombinant GABA receptors.

Rex A. Wright Ph.D. Associate Professor (Psychology) Cardiovascular responsivity: effort determinants, sex differences, and social evaluation influence.
Requirements
Requirements for Doctoral Candidacy

Predissertation Research Requirement.
By the end of the second year, students complete a research project under the direction of their mentor. A copy of a manuscript submitted for publication or a written research report is submitted to the Behavioral Neuroscience Steering Committee to satisfy the predissertation research requirement.

Qualifying Examination
Students complete one of two options for the comprehensive exam requirement of the Graduate School. The student’s choice is proposed in consultation with the research mentor and approved by the qualifying examination committee.

Grant Proposal Option. The student completes a grant proposal on a topic area outside his or her research area. The student analyzes existing research and proposes one or more experiments to answer a key question. Experiments using at least three methodological approaches are proposed.

Review Paper Option. A comprehensive, integrative review paper is prepared on a topic related to the student’s research. The goal of this paper is to increase the student’s breadth of knowledge in the area, synthesizing available research with the goal of achieving new insights that may guide future inquiry. Publication of the paper is encouraged.

Dissertation Proposal
The dissertation proposal is prepared in the format of a National Institutes of Health R01 grant proposal. Students are encouraged to submit the proposal to an extramural agency and thereby be considered for independent fellowship support. After the proposal is approved by the dissertation committee, the student is admitted to candidacy.

Doctoral degree
The doctoral degree is awarded after successful defense of the dissertation and submission of a final copy to the Graduate School.

Typical Sequence of Graduate Training in Behavioral Neuroscience

Year 1:
Laboratory Rotations (1/quarter)
Core curriculum in Neuroscience and Psychology

Year 2:
Predissertation Research Project
Complete coursework

Year 3:
Qualifying Examination
Dissertation Research Proposal

Year 4:
Complete dissertation research
Formal presentation of dissertation research

Curriculum
Year 1
August
Introduction to Neurobiology, 4 hrs

Fall Quarter
Overview of Behavioral Neuroscience, 3 hrs
Introduction to Statistics, 3 hrs
Seminar in Behavioral Neuroscience, 1 hr
Predissertation Research, 3 hrs

Winter Quarter
Integrative Neuroscience, 5 hrs
Applied Statistical Analysis, 4 hrs  
Seminar in Behavioral Neuroscience, 1 hr  
Predissertation Research

**Spring Quarter**  
Neurobiology of Learning and Memory, 3 hrs  
Statistics Elective  
Seminar in Behavioral Neuroscience, 1 hr  
Predissertation Research

**Summer Quarter**  
Predissertation Research, 6 hrs

**Year 2**  
**Fall Quarter**  
Cellular and Molecular Neurobiology, 5 hrs  
Seminar in Behavioral Neuroscience, 1 hr  
Predissertation Research, 6 hrs

**Winter Quarter**  
Psychology or Basic Science Elective, 3-5 hrs  
Seminar in Behavioral Neuroscience, 1 hr  
Predissertation Research, 6 hrs

**Spring Quarter**  
Psychology or Basic Science Elective, 3-5 hrs  
Seminar in Behavioral Neuroscience, 1 hr  
Predissertation Research, 6 hrs

**Year 3 & 4**  
Complete remaining elective requirements  
Complete qualifying examination  
Complete doctoral dissertation

**Behavioral Neuroscience Core Curriculum** *(Required)*

**Overview of Behavioral Neuroscience**  
Behavior and its neural substrates; neural systems that control motor behavior, regulatory behaviors, learning, memory, sensation and perception, higher cognitive functions and neural plasticity.

**Cellular and Molecular Neurobiology**  
Electrical properties of neurons; structure and function of ion channels and synapses; physiology and pharmacology of neurotransmission; second messenger systems and signal transduction.

**Neurobiology of Learning and Memory**  
Theory of associative and nonassociative learning, a discussion of issues related to the neurobiology of learning, stimulus encoding, and memory at the cellular and system levels.

**Integrative Neuroscience**  
Systems-oriented approach to sensory, motor, and autonomic processes; learning and plasticity; control of cardiovascular system; fluid and energy balance.

**Introduction to Statistics**  
Probability, descriptive statistics, sampling distributions, null hypothesis testing, comparisons between means, power analyses; tests on categorical data, bivariate and multiple regression.

**Applied Statistical Methods**  
Univariate analysis of variance and factorial designs; interpretation of data from multifactor experimental designs.

**Research Design**  
Traditional and nontraditional approaches; includes univariate and multifactor experimental designs.

**Multivariate Statistical Methods**  
Multiple regression, multivariate analysis of variance and covariance, canonical correlation, principal components analysis, and discriminant analysis.

**Computational Neuroscience Methods**  
Computer-based analysis techniques, linear systems theory, neural networks, basic electrical circuits and applications to neuronal models, filtering and image processing.

* Either Research Design, Multivariate Statistical Methods, or Computational Neuroscience Methods is required. If more than one are taken, they are considered psychology electives.

**Basic Science Elective Courses** *(Two required)*

**Introduction to Neurobiology**  
Introduction to neuroanatomy and neurophysiology of marine invertebrates and vertebrates. Didactic and laboratory instruction in electrophysiology, sensory transduction, sensorimotor transformations and neurobiological bases of behavior. Course offered at Dauphin Island Sea Lab during the last two weeks of August prior to the first year.

**Developmental Neurobiology**  
Birth, migration, growth and differentiation of neurons; establishment of synaptic connections; regulation and plasticity.

**Biochemistry**  
Structure and biochemical properties of proteins, enzymes, and coenzymes; anabolic metabolism, structure of DNA, structure/function relationships of membranes.

**Physiology**  
General principles of organ system physiology.

**Cellular and Molecular Physiology**  
Topics in cell biology and morphology, membrane transport, and control of cell function.

**Introduction to Neuroscience**  
Introduction to neuroanatomy, neurophysiology, and cellular
and molecular approaches to the study of the nervous system. Emphasis is on human systems from a medical perspective.

**Psychology Elective Courses** (Two Required)

[Representative Examples]

**Sensory and Perceptual Processes**
Sensory physiology; diagnostic techniques for pathophysiology of sensory systems; human psychophysics and principles of perception.

**Sensory Information Processing**
Survey of current models of neural networks; computer models and physiological representation of information processing.

**Cognitive Neuroscience**
Study of the way the brain implements the complex processes of the mind, such as perception, memory, language, attention and behavior; study of neurons, their patterns of connection and activity, and the relationship between this activity and mental processes.

**Cognition**
Attention, memory, learning, and information processing; theoretical issues and evaluation of relevant research.

**Human Psychophysiology and Experimental Neuropsychology**
Theoretical and applied issues in quantifying human physiological responses; localization of cognitive function, theories of emotion and arousal.

**Research Design** (see above)*

**Multivariate Statistical Methods** (see above)*
General Information

Admissions
Application materials for graduate study in Behavioral Neuroscience are submitted to the UAB Graduate School by January 15 of the year preceding admission. Notification will be made in late winter or early spring.

Students admitted to the Behavioral Neuroscience Graduate Program must have demonstrated excellence in academic performance, typically by:
- outstanding undergraduate academic performance, including courses in experimental psychology, biology, physics, chemistry and mathematics
- Verbal and Quantitative Graduate Record Examination scores above 600 and a Verbal + Quantitative sum above 1200;
- undergraduate research experience

Because of its interdisciplinary nature, the program attracts students with diverse backgrounds in the behavioral, biological and physical sciences. Students not broadly trained in basic science or psychology can make up deficits after enrollment. Previous research experience in psychology, neuroscience or physiological psychology is strongly encouraged. Applications are solicited both from students with bachelor's degrees and from advanced standing students who may already have completed some graduate study.

An affirmative action/equal opportunity process is followed to ensure that each applicant is evaluated on an individual basis. The Behavioral Neuroscience faculty strongly encourages applications from students of diverse ethnic backgrounds.

Financial Aid
Entering students are supported by university fellowships. Behavioral Neuroscience students can be considered for predoctoral fellowship support by training grants. Faculty within the Behavioral Neuroscience program have extramural funding sources which are used to support graduate research assistants. In addition, students are encouraged to write grant proposals for externally funded predoctoral fellowships to provide support during their dissertation research.

Advisement
The Behavioral Neuroscience Training Program is built around a mentor model. The mentor is the primary source of advice to the student. In addition, the Steering Committee reviews the progress of each student annually, monitoring the selection of electives and other academic matters.

Research Experience
Laboratory research is a cornerstone of the graduate training program in behavioral neuroscience. During the first year, students gain research experience in three or four laboratories, selecting one laboratory rotation each quarter during the academic year. Laboratories of both primary and associated faculty are open to the students. The laboratory rotations allow students to increase their breadth of experience in behavioral neuroscience before making a commitment to one faculty member's research program. Students select a research mentor at the beginning of Year 2 and begin work on their predoctoral research project. Through close collaboration with their mentor, students develop a systematic line of research which culminates in the dissertation project. Collaboration among laboratories occurs frequently at UAB, affording students the opportunity to further broaden their research experience.

Seminar in Behavioral Neuroscience
All students in the Behavioral Neuroscience Training Program enroll in the Seminar in Behavioral Neuroscience each academic year. This seminar is a weekly forum for discussion of recently published research, systematic exploration of topics of mutual interest, and presentation by students of their research. Behavioral Neuroscience faculty also attend the seminar, providing a venue for discussion among faculty and students. Through participation in the seminar, students gain experience in making research presentations and in critical evaluation of research.

Graduate Student Association
UAB graduate students are represented by the Graduate Student Association (GSA), which works closely with the Graduate School and other offices of the university administration in formulating policy and meeting student needs. All graduate students are automatically members of the GSA. The GSA provides partial support for graduate student travel to academic meetings, for thesis and dissertation photocopying, computer searches, and interlibrary loans.

Affirmative Action
The University of Alabama at Birmingham administers its educational programs and activities, including admission, without regard to race, color, religion, sex, national origin, handicap or Vietnam era or disabled Veteran status. (Title IX of the Education Amendments of 1972 specifically prohibits discrimination on the basis of sex. Direct inquiries to Academic Affirmative Action Officer, the University of Alabama at Birmingham, Birmingham, Alabama 35294.)
Recent Behavioral Neuroscience Dissertation Topics

A Role of NMDA Channels in Rabbit Retinal Direction Selectivity
Darrel S. Tjepkes / Franklin Amthor, Advisor

Aging and Dark Adaptation
Gregory R. Jackson / Cynthia Owsley, Advisor

The Effects of Aging on the Parallel Guidance of Visual Search
Kerri Burton-Danner / Cynthia Owsley, Advisor

Angiotensin II Receptor Subtype Location in and Growth of the Developing Heart
Rachel A. Hunt / Diane Tucker, Advisor

The Role of Area Infraradiata in Autonomic Control
Gary D. Fisk / Michael Wyss, Advisor

A Functional and Neurophysiological Examination of Cerebellar Output in the Genetically Dystonic (dt) Rat
Mark S. LeDoux, M.D. / Joan Lorden, Advisor

Olivocerebellar Function in the Dystonic Rat
Mary Hernandez Thorstad / Joan Lorden, Advisor

Extrinsic and Intrinsic Connections of Rostral Inferior Temporal Cortex in Squirrel Monkeys
Gregory E. Steele / Rosalyn Weller, Advisor

Hippocampal Sympathetic Ingrowth and the Modulation of Protein Kinase C in the Rat Hippocampus Following Medial Septal Lesions
Viswaprabha Ayyagari / Lindy Harrell, Advisor

An Immunocytochemical and Morphological Examination of the Cerebellum of Mutant Dystonic (dt) Rats and Rats with 3-acetylpyridine Lesions
Jacqueline Goldstein / Joan Lorden, Advisor

The Functional Role of GABA-Mediated Inhibition in the Control of Visual Signal Transmission at the Lateral Geniculate Nucleus of the Thalamus
Dwayne W. Godwin / Thomas Norton, Advisor

Neurophysiology of Convergence Adaptation
Carlos Armando Tello / Larry Mays, Advisor