Proposal for Rice Neuroscience Minor
January 16, 2013

Neuroscience is the multidisciplinary study of the nervous system and its functions. The field seeks to bridge Mind, Behavior, Biology, Computation, and Engineering, and recent advances have made this possible as never before. As such, the field is intellectually ripe for an Interdisciplinary Minor. Combined with recent commitments from the Rice administration and the spate of recent and planned hires, we now have the resources to support a new Minor in Neuroscience. Rice University, in partnership with the Baylor College of Medicine and the University of Texas at Houston Medical Center, proposes to offer an outstanding and fully interdisciplinary minor in a research area that is becoming central in the 21st century.

We consider this minor to be the first step towards the development of additional interdisciplinary and inter-institutional programs at the undergraduate and graduate level for careers in neuroscience. A successful minor will provide a platform for the development of a major program, for which planning is in its early stages. If, as we anticipate, the university continues its support for the development of Neuroscience programs and inter-institutional collaborations with medical center institutions, notably Baylor and UTH, we foresee opportunities for the development of a unique inter-institutional graduate program that will allow Rice to leverage its proximity to the other Texas Medical Center institutions and take its place among the best top-tier institutions with leading programs in Neuroscience.

A. Intellectual Merit

Neuroscience is one of the forefronts of human research endeavors. The decade of the brain, as designated by NIH, has passed, but the quest for understanding brain function represents one of this century’s foremost research enterprises. Neuroscience knowledge affects all aspects of our lives, encompassing sensation, perception, psychophysics, cognition, language, behavior, consciousness, development, genetics, and disease and its treatments: all phenomena basic to human experience.

Neuroscience as a field has the scope to fully interconnect the natural and social sciences, the humanities and engineering; it has the depth to bridge the large gaps that disease, technology and experimental research continually expose in our empirical and theoretical understanding of the nervous system. Many of our best scientists have dedicated their lives to neuroscience and
received the highest endorsement to human endeavor, the Nobel Prize, including Buck, Heubel, Kandel, Torsten, and Weisel to name but a few (over 40 in the past century). The hard gaps span disciplines and typically attract the strongest minds to address neuroscience questions, as evidenced by the large number of Nobel Laureates from the natural sciences that turned their full, post-Nobel, attention to neuroscience, including Crick, Cooper, de Gennes, and Tonegawa. As a result, the best programs at our peer institutions are developing neuroscience programs that bridge divisions and schools.

1. **History and Development of the Field.** The field of neuroscience traces its origins to the turn of the 20th century. It did not achieve ‘discipline’ status until the late 1960s. The Society for Neuroscience (SfN) began in 1969 with 500 members and reached 10,000 members by 1985. Since then it has grown by 10,000 new members every 7 years. At present it has over 42,000 members and lists 56 undergraduate Neuroscience programs and 132 graduate Neuroscience programs in North America (see [http://www.sfn.org/](http://www.sfn.org/)).

The field is still a new one. Its methodologies have recently undergone explosive development and are rapidly evolving. Primary areas of focus range from chemical and biomolecular aspects of the nervous system (closely allied to the biological sciences) to investigation of brain functions and their behavioral correlates in higher animals (relating to cognitive science disciplines such as Psychology, Linguistics, and Philosophy). New areas include computational modeling of neural systems and also neuroengineering, specifically the development of biomedical devices for brain/cognition-related impairments. It is increasingly evident that the field of Neuroscience requires a great deal of interdisciplinary cooperation across many fields.

2. **Peer Institutions.** Among the 56 undergraduate Neuroscience programs in the U.S., we mention Brown, Johns Hopkins, MIT, Pitt, U. of Minnesota and Emory. At Brown, “[t]he undergraduate concentration in neuroscience offers a program of study in the fields of knowledge important to an understanding of brain function. Neuroscience is an interdisciplinary program bringing together neurobiology (anatomy, physiology, biochemistry, molecular biology, development) with elements of psychology and cognitive science, as well as mathematical and physical principles involved in modeling neural systems.” Brown has graduated 64, 63 and 90 majors in 2008-2011 respectively. Among their undergraduate population of 6118 the enrollment in their introductory Neuroscience course is ca. 400 per year.
3. **Collaborations in Neuroscience at Rice and Medical Center: Strong institutional ties.** Locally, there have long been individual ties between Rice faculty and faculty within Baylor College of Medicine's (BCM) Neuroscience Department and the department of Neurobiology and Anatomy at the University of Texas Health Science Center Houston (UTH). Such ties have led to sustained cross-institutional teaching arrangements and teaching collaborations between Rice and her Texas Medical Center (TMC) partners, and many adjunct appointments of TMC faculty at Rice. An important outcome has been the establishment of centers and academic programs reaching across institutional boundaries.

**Cross-institutional teaching**
Numerous faculty from BCM and UTH have been teaching courses at Rice for many years.

- BCM faculty have been teaching in our graduate Psychology and undergraduate Cognitive Sciences programs for at least 10 years. In recent years a group of 5-6 faculty in various departments at Baylor have been offering recurring courses at Rice.
- UTH has organized and directed the Rice Biopsychology course (PSYC 362) for a number of years. A UTH faculty member has co-taught the course for the last 3 years (2009-2011) and this arrangement is in place also for Spring 2012.

**Adjunct appointments**
Many BCM and UTH faculty have adjunct appointments and/or partial-salaried appointments in Rice Departments:
- Six BCM faculty have adjunct appointments in the Department of Psychology;
- An additional two BCM faculty members have part-time faculty appointments (Dora Angelaki, Chair of Neuroscience, in ECE, and J. David Dickman, in Psychology);
- One BCM faculty member has an adjunct appointment in Cognitive Sciences (David Eagleman);
- Ten UTH faculty have adjunct appointments in the Department of Psychology;
- One UTH faculty member (Jack Byrne) also has an adjunct appointment in Rice ECE and another (Michael Beauchamp) also has an adjunct appointment in Rice BioE.
Centers and programs
These strong institutional ties have generated larger activities:

- The Rice University Center for Neuroscience was established by Jim Pomerantz (PSYC) in 1999. The Center for Neuroscience has fostered significant research and teaching collaborations between the Rice Psychology Department and Baylor Neuroscience, and between Rice and UTH.
- Collaborations listed above provide the backbone for the Cognitive Neuroscience specialization area of the Rice Ph.D. in Psychology.
- The Gulf Coast Consortium for Theoretical and Computational Neuroscience was established by Steve Cox (CAAM) in 2003. Many new faculty collaborations between GCC institutions have formed under the rubric of this initiative.
- UTH and Rice Psychology have established a joint Ph.D. track for Systems and Cognitive Neuroscience. This adds a large group of faculty and graduate courses that focus on the highest level of cognitive and systems neuroscience, including executive function, language, cognition, memory, attention, and visual perception.

4. Student Interest and Research; Student Recruiting. Significant undergraduate student interest became very evident with the establishment of the student club Building Rice Academics in Neuroscience (BRAiN) by a group of undergraduates and sponsoring faculty in 2008. The club continues to meet and hold activities. At the curricular level, Rice has long offered a Neuroscience Focus Area to the Major in Cognitive Sciences, with students allowed to fulfill coursework at BCM and/or UTH. These classes, which include Neuroanatomy, Higher Brain Function, and the Neurobiology of Disease, are near impossible for students without a strong science-based introduction to Neuroscience. The numbers enrolled in these courses are small but increasing; due to lack of staff resources they have not been advertised and have been administered by faculty rather than staff. Still the students find their way to them. At the instigation of BRAiN, Rice’s Biochemistry & Cell Biology department offered its first introductory Neuroscience Course in Spring 2010: NEUR/BIOS 385 Fundamentals of Cellular and Molecular Neuroscience. It has been offered annually since then, and the BCB department has expressed its commitment to offering the course on a continuing basis.

The strong demand for conducting research in Neuroscience has resulted in undergraduates from many different departments finding their way into NEUR 485, an independent study/supervised research course that allows Rice students to do research in the labs of Neuroscience researchers in the
Texas Medical Center for credit. In Fall 2012, there were 10 undergraduate students enrolled in this course. In 2011-2012 more than 20 took this course. Many of these students are working in labs at Baylor and UT-Houston, while others are doing research in Rice labs including those in Bioengineering, BCB, ECE, and Psychology. This Supervised Research course is not advertised, as with the Baylor Neuroscience courses, due to shortage of administrative staff and support. Yet word of mouth among the BRAiN students and other student researchers who have engaged with this work is driving a significant increase in numbers. The growing activity in Neuroengineering at Rice is also playing a strong role in heightening undergraduate interest.

Rice students interested in Neuroscience also frequently work full time in TMC labs during the summers, supported by a variety of sources, including the UTH summer research program, individual grants held by TMC PIs, and the NSF-supported Research Experience for Undergraduates (REU) program; additionally, some have worked for Rice credit. Similar programs such as Amgen Scholars and NIH summer internships are also targets for our undergraduates desiring summer lab experience/internships in Neuroscience. Faculty administering the Neuroscience program have written many letters of recommendation for our students for these programs, showing the strength of demand for such programs (and indeed raising the possibility that Rice could successfully put on just such a program given the proximity of the medical center Neuroscience labs, to the benefit of both institutions).

An important reason for putting in place undergraduate programs in Neuroscience is to strengthen our competitiveness in recruiting blue-chip undergraduate applicants.

Due to an absence of any formal programs in Neuroscience, Rice has been losing top applicants to our peer institutions who have been building such programs to take advantage of persistently strong student interest at the national (and international) levels.

Top applicants who express an interest in Neuroscience currently get routed to Cognitive Sciences faculty with Neuroscience interests and experience for recruiting calls. Faculty then describe the Neurosciences concentration within Cognitive Sciences and the research opportunities available for undergraduates at Rice and TMC. However, the concentration program has not been sufficient to convince many of these students that Rice is a place where they can study Neuroscience at a sufficiently deep
level and with appropriate recognition (major status) that would enable them to enter the top Neuroscience graduate programs.

An undergraduate Neuroscience minor would go some ways to helping Rice recruit and retain such top applicants. An undergraduate major is in our view the best way to attract such students and keep them from going elsewhere. This is why we propose to move quickly toward a Neuroscience major when more resources become available.

In sum, it is clear that the proposed program will benefit Rice undergraduates, providing them options for a course of study as well as for getting involved in research in this highly desirable field of study. It will further benefit Rice by making us more competitive for the best and brightest applicants.

5. Recent Developments in Neuroscience at Rice. A number of recent events lend support to the proposed program:

- In Spring 2012, two recent hires at the Baylor College of Medicine Department of Neuroscience, Chair Dora Angelaki and Dr. J. David Dickman, were made adjunct faculty at Rice and have also been given partial appointments in ECE and Psychology, respectively.

- The Dept. of Electrical and Computational Engineering (ECE) hired Dr. Caleb Kemere, a full-time tenure track neuroscientist; he arrived in Spring 2012, has set up his laboratory, and his research is now well underway. Dr. Kemere has already begun working with undergraduates, training them up for research in his lab at the BRC.

- Other hires with interests and expertise in Neuroscience include Michael Stern and Peter Lwigale in Biochemistry and Cell Biology, who we believe will gradually become more involved in the proposed program, as their expertise fits it well.

- Still other departments have expressed their enthusiasm and support for Neuroscience at Rice (see letter from Chair Dannemiller in Psychology and Chair Braam in Biochemistry and Cell Biology.) A number of departments have also indicated the importance of Neuroscience in their current plans for replacement hires and their growth plans (see discussion under Faculty, under B. Proposed Curriculum, below.)
• In early 2010, a meeting was convened to bring together Neuroscience-interested faculty in a meeting with then-Provost Levy and President Leebron to call for a university-wide effort to develop programs in Neuroscience. Over 40 faculty attended this meeting and called for interdisciplinary Neuroscience initiatives and resources to develop them.

• In a followup development, in Fall 2011 the Neuroscience Steering Committee was formed by Dean Lyn Ragsdale of Social Sciences. The Steering Committee has 9 members, drawn from 4 Rice schools, including the Departments of Psychology (Social Sciences), CAAM (Engineering), Linguistics (Humanities), ECE (Engineering), Philosophy (Humanities), and Biochemistry and Cell Biology (Natural Sciences), and also two members from, respectively, the BCM Dept. of Neuroscience and the UTH Department of Neurobiology and Anatomy. The Steering Committee’s initial remit was to study how best to establish cross-institutional programs in Neuroscience, and its first outcome is this minor proposal, which this Committee will be charged with administering (see Administration below). The Committee will also continue to develop Neuroscience programs with the momentum provided by all the recent developments sketched here and with the clear support of the Rice administration for Neuroscience initiatives.

• The recent building and staffing of the Biosciences Research Collaborative provides unprecedented opportunities for cross-institutional collaborations in Neuroscience as well as opportunities for student research. There is currently a great deal of work going on among Rice, Baylor, UTH, and BRC administrators aimed specifically at addressing some of the problems that can arise with inter-institutional teaching and research programs. BRC Director and Vice Provost for Translational Biosciences Cindy Farach-Carson, Vice Provost for Academic Affairs Paula Sanders, and others, have been working out the many issues caused by the differences in academic calendars and academic cultures, as well as establishing guidelines and best practices for research supervision of Rice students by non-Rice faculty, and other such institutional issues. The Neuroscience Minor will be able to benefit from this ongoing work, which is already improving programs that straddle Rice, the other medical center institutions, and the Gulf Coast Consortium.
6. **Uniqueness.** Our proposed curriculum is distinct in purpose and form from any existing major at Rice. The closest program among all programs offered to undergraduates is the specialization track in Neurosciences within the Cognitive Sciences major, one of 4 specializations of that major. However, the two programs are quite distinct, as explained below.

The Cognitive Sciences specialization in Neuroscience came into being in 2001 to satisfy some of the undergraduates' demand for Neuroscience in the Rice curriculum. It was not designed as a full-fledged foundation program in Neuroscience, but as a way to give undergraduates the opportunity to learn something about a subject they were thirsting to know about and to allow them to enter the then brand-new field with some background, however minimal. It has served the latter purpose to some extent; not only have many students availed themselves of this specialization to help them on their path to medical school or other postgraduate training in allied fields, but also we have had some extremely high-performing and motivated students go on to excellent graduate programs in Neuroscience on the basis of just the 3 or 4 Neuroscience classes provided by this specialization. However, the main thrust of the Cognitive Sciences major is to give students a broad background in how the human mind works, using and integrating the perspectives of very different fields, including some areas of Neuroscience if they choose. The study of the brain is thus part of Cognitive Sciences, but not absolutely central to it.

The minor program we propose, in contrast, is squarely centered on the field of Neuroscience, which specifically studies the brain and how it relates to mental processes. The proposed minor is intended to give Rice students a much stronger foundation in brain science and make them more competitive for graduate study in the now established, albeit still rapidly evolving field. The centrality of biology is directly reflected in the requirements of the proposed minor.

A comparison of the two programs (Neurosciences specialization of Cognitive Sciences vs. Neuroscience minor) shows the distinctness in purpose and coverage of these programs. The Cognitive Sciences major requires of all students a 5-course core drawn from its foundational disciplines, Psychology, Philosophy, Linguistics, and the computational sciences. The proposed minor, in contrast, does not require Philosophy, Linguistics, or computational theory/skills, although students may take some of these courses as electives. The coverage of these cognitively-
computationally-oriented areas will be necessarily be less in the Neurosciences minor because of the different core courses required.

The difference in core leads to the most significant difference between the two programs: the difference in the coverage of the **biosciences**. Within the Cognitive Sciences major, only the Neurosciences track has biosciences subjects in its offerings, but even there these are not required; students can fill the Neurosciences requirements with non-biology courses on topics such as brain imaging, or they can take courses on higher-level aspects of brain organization such as neural anatomy or neurophysiology. Cognitive sciences Neuro-track students are not required to learn basic cellular or molecular level neuroscience or the biological foundations of brain systems.

The proposed minor program, in contrast, has the basic biological aspects of the brain present in its core material. All students in the minor must take the new course NEUR/PSYC/BIOC 380 Fundamentals of Neuroscience Systems, which includes an introduction to basic brain biology and neural systems and is designed to effectively bridge the study of mind and brain. For the second core course, the students choose from either NEUR/BIOC 385 Fundamentals of Cellular & Molecular Neuroscience, which focuses specifically on the biological aspects of the brain, or NEUR/PSYC 362 Biopsychology, which covers the basic neural correlates of behavior.

Currently, about a third of the approximately 75 Cognitive Sciences students follow the Neuroscience track (ca. 10 graduates in this specialization per year), and the rest focus on the various cognitive-behavioral research areas outside Neuroscience. We do not anticipate a high overlap in the populations of students following these different programs. A Cognitive Sciences student in the Neuroscience specialization could get the Neuroscience minor by completing the additional two core courses of the latter program, and by also selecting Additional Courses in a judicious way, seeking courses that count for both programs but also choosing so as to not violate the breadth requirement of Cognitive Sciences, which allows no more than 4 Additional Courses (electives) from the same area. But we think that students interested in Neuroscience who want to go on to graduate study specifically in the Neuroscience are likely to choose the minor over the specialization, as will many or most of the pre-medical students who currently are in the specialization. Many students desire a stronger foundation in Neuroscience than the specialization provides, and they are standing in wait for the opportunity to get the minor, and in fact the major when it develops. A major in
Neuroscience is eagerly awaited by our undergraduates and the sooner we can develop it, the better, in their view.

We anticipate that the approval of a Neuroscience minor will likely lead to friendly modification of the Cog Sci Neurosciences specialization, so as to offer consistent advice (across our two already intersecting steering committees) to undergraduates wishing to prepare themselves for specifically for graduate study in Neuroscience as opposed to areas related to and utilizing Neuroscience. The Cognitive Sciences Steering Committee of 6 faculty shares 3 faculty members with the Neurosciences Steering Committee, and thus the two Steering Committees have been working with each other and will continue to do so as the minor and other programs develop.

B. Proposed Curriculum

The Neuroscience minor will consist of 6 courses: 2 Core courses and 4 Electives.
The two core courses comprise:

1 required Core course

NEUR/PSYC/BIOC 380: Fundamental Neuroscience Systems

1 Core elective chosen from

NEUR/BIOC 385: Fundamentals of Cellular & Molecular Neuroscience
NEUR/PSYC 362: Biopsychology

The 4 elective courses are chosen from two tracks, Humanities & Social Science (HS), and Natural Science & Engineering (SE), in consultation with a Neuroscience advisor. At least one elective must be chosen from each track. Recommended electives, by track, are listed below.

The one required course, NEUR/PSYC/BIOC 380, is a new course, to be offered for the first time in Spring 2013. Its syllabus is appended to this proposal. It will be offered annually by Dr. J. David Dickman, a tenured BCM faculty member who has a nearly half-time Rice appointment. This required course views the brain from the systems level, i.e., from the crossroads where the cellular/molecular approaches meet the behavioral/cognitive approaches. It thus provides a great common entry point to the study of Neuroscience.
The two core electives are existing and highly successful Rice courses. The first (NEUR/BIOC 385) follows a bottom-up approach (molecules and cells) and prepares our students for the SE electives, while the second (NEUR/PSYC 362) is more top-down, taking the viewpoint of higher-level mind functions. The latter prepares our students for the HS track. Students who wish to get a solid grounding in both focal areas can take both courses, one as a Core course and the other as an elective.

**Prerequisites.** These core courses presume previous exposure to university level biological/psychological thinking. Students without such preparation will not be turned away, but will be advised that they face a steep learning curve.

Recommended **Electives.** Students must choose 4, with at least 1 from each track. Students may propose alternates to their Neuroscience Minor Advisor.

**Humanities & Social Science (HS) Track**
- LING 212: Speech and Hearing Science
- LING 306: Language, Thought, and Mind
- LING 411: Neurolinguistics
- PHIL 103: Philosophical Aspects of Cognitive Science
- PHIL 312: Philosophy of Mind
- PHIL 352: Philosophy of Psychology
- PHIL 353: Philosophy of Language
- PHIL 354: Philosophy of Perception
- PSYC 308: Memory
- PSYC 309: Psychology of Language
- PSYC 351: Psychology of Perception
- PSYC 353: Psychology of Emotion and Motivation
- PSYC 432: Brain and Behavior
- PSYC 430: Computational Modeling of Cognitive Processes
- PSYC 471: Introduction to fMRI
- PSYCH 574/ GS140173: Introduction to Cognitive Neuroscience
- PSYCH 575/ NEUR 501/ GS140023: Cognitive Neuroscience I
- GS14 1022: Theory, Content, and Execution in Cognitive Neuroscience
- BCM-NE 438: Law, Brain and Behavior

**Natural Science & Engineering (SE) Track**
- BIOE/ELEC 381: Fundamentals of Nerve and Muscle Electrophysiology
- BIOE/COMP/ELEC 485: Fundamentals of Medical Imaging I
- BIOE/COMP/ELEC 486: Fundamentals of Medical Imaging II
- BIOE 492: Sensory Neuroengineering
BIOC 415: Experimental Physiology  
ELEC 301: Signals and Systems  
ELEC 303: Random Signals in Electrical Engineering Systems  
ELEC 431: Digital Signal Processing  
CAAM 415: Theoretical Neuroscience: Cells, Circuits and Systems  
CAAM 416: Theoretical Neuroscience: Learning, Perception and Cognition  
CAAM/MATH 435: Dynamical Systems  
COMP 440: Artificial Intelligence  
COMP 450: Algorithmic Robotics  
BCM-NE 470J: Functional Neuroanatomy & Development  
BCM-NE 464: Cellular Neurophysiology  
BCM-NE 462J: Concepts of Learning and Memory  
BCM-NE 434: Higher Brain Function  
BCM-NE 433: Neurobiology of Sensation & Movement  
BCM-NE424: Physiology of the Visual System  
BCM-NE422: Neurobiology of Disease  
UTH-GS 140063: Molecular Neurobiology  
UTH-GS 140143: Cellular Neurophysiology  
UTH-GS 141181: Graduate Neuroanatomy

Although the BCM and UTH courses are ostensibly for graduate students and meet on a schedule that is not synchronous with Rice’s, our undergraduates have consistently acquired permission of the instructor, registered, and done well when prepared. Our two BIOC core courses will provide ample preparation for the other Neuroscience options at BCM and UTH.

**Faculty.** The required Core course, NEUR/PSYC/BIOC 380, will be offered by Dr. J. David Dickman (BCM/Rice Psychology). The core electives, NEUR/BIOC 385 and NEUR/PSYC 362 are taught by Dr. David Caprette (BCB) and Dr. Christopher Hamilton (PSYC) respectively.

The electives are drawn from regularly offered courses in many departments. The PHIL department committed to building in Neuroscience some years ago; it now has existing faculty strength, and associated courses, in areas with significant neuroscience content. LING has long had a Neurolinguist teaching the popular course Ling 411, and cognitive linguistics faculty interested in Neuroscience. Although the Ling 411 instructor Sydney Lamb is now retiring from teaching, Neurolinguistics is incorporated in the LING department’s strategic plan in two ways. LING has a pending replacement hire in Speech Science, the perceptual and motor aspects of spoken language, and plans to seek a candidate with some neuroscience interests and expertise; in addition,
its next growth hire will be in Psycholinguistics/Neurolinguistics. The ECE and CAAM departments both offer Neuroscience courses; Neuroengineering is an important new area of development in these departments. ECE has made a recent new hire in Neuroscience as indicated in Section A above, and is actively searching for new neuroscience faculty. We therefore include letters of support from the chairs of ECE and CAAM.

C. Administration

The minor will be administered by a steering committee of nine faculty members, initially:

Behnaam Aazhang (ECE)
Dora Angelaki (BCM & partial appt. in Rice ECE)
Janet Braam (BCB)
Jack Byrne (UT Houston & Adjunct in Rice ECE and Rice PSYC)
Steve Cox (CAAM)
J. David Dickman (BCM & partial appt. in Rice PSYC)
Suzanne Kemmer (LING/CSCI)
Casey O’Callaghan (PHIL)
Jim Pomerantz (PSYC)

The committee will be chaired by the Director of Neuroscience (currently Suzanne Kemmer; after program is approved, J. David Dickman) and will meet at least once each semester to review course offerings, enrollments and opportunities for strategic structured growth through cluster hires across our four schools and jointly with BCM and other institutions as appropriate. Initially, Steve Cox and Jim Pomerantz will serve the student body as Minor Advisors within their respective tracks. In particular, Cox and Pomerantz will sign minor declaration forms, advise students on electives, and approve final transcripts for graduation.

D. Program Planning and Program Sustainability

We anticipate an initial intake of minimally about 70 students into the Minor, with a probable rise to 100 within a few years. These estimates are drawn from current enrollments and expressions of interest from students.

This significant demand will obviously require ongoing resource commitments. We have the support of the Rice administration and specific relevant departments and deans for the minor as detailed below. We have further support from the Chair of the Dept. of Neuroscience at Baylor, who is
contributing resources in the form of faculty time and graduate student TA time.

Further program-building in Neuroscience, including an anticipated major and subsequent graduate programs is under discussion by the Rice administration as a candidate for development of inter-institutional programs in the biosciences between Rice and the TMC. Paula Sanders, Vice Provost for Academic Affairs and Dean of Graduate Studies, and Cindy Farach-Carson, Vice Provost for Translational Biosciences, have been working closely with TMC administration and faculty for many months to lay the groundwork for inter-institutional collaborations between Rice and the other medical center institutions, including working out budgetary details for this proposed program. They foresee an important role for Neuroscience in moving a broad swatch of initiatives forward that Rice sees as key to establishing pre-eminence in important areas.

**Support for main core course.**
The minor’s central core course, NEUR/PSYC/BIOC 380, Introduction to Neuroscience Systems, described below under **B. Proposed Curriculum**, is being offered Spring 2013.

BCM has committed faculty time for an instructor for the core course NEUR/PSYC/BIOC 380. Rice has committed funds for salary support for this instructor (cf. forthcoming letter of support from Rice Provost, detailing budgetary commitment). During this period it is anticipated that Neuroscience will undergo further development, and the level of staffing for the course will be adjusted for level of enrollments reached. The course will be offered annually.

Support for TAs: Registration for the initial run of NEUR/PSYC/BIOC 380 in Spring 2013 was originally capped at 78 but was raised to its current 87 due to high demand and because additional TAs were able to be secured. $6,000 was initially provided by Dean Sanders in the Rice Office of Graduate Studies and this has now been raised to $12,000. The Rice-funded TAs will be Rice Psychology graduate students who have qualifications in Neuroscience. In addition, BCM is lending several of its own Ph.D. students who wish to gain teaching experience by serving as Teaching Assistants for the course.

**Support for other core courses.**
The Department of Biochemistry and Cell Biology has committed to staffing the SE-track core course NEUR/BIOC 385 Introduction to Neuroscience on an
annual basis (as it has been offered for the last 4 years) for the foreseeable future. (See accompanying letters of support by BCB Chair Janet Braam and NS Dean Dan Carson.)

The Department of Psychology has been annually staffing the third core course, HS track course PSYC 362 Biopsychology, and continuation is anticipated. See accompanying letters of support by Chair of Psychology Dannemiller and Social Sciences Dean Ragsdale.

**Support for elective courses.**
There are a wide variety of elective courses for the major drawn from many departments, both at Rice and at BCM and UT-Houston. We anticipate no difficulty staffing a sufficient number and range of elective courses that will enable students to complete the minor in 4 years.

**Support for program administration.**
The initial Chair of the Neurosciences Steering Committee, appointed in 2011, has been Suzanne Kemmer (Linguistics and Cognitive Sciences). This role is a modified incarnation of the Director of Neuroscience role that she took over from Jim Pomerantz in 2010. She will continue as Director of Neuroscience/Chair of Steering Committee until the minor is approved (aim: early Spring 2013). She is also willing to continue in an advisory role to the new director, if needed, to ensure a smooth transition and to provide continuity in supervision of current students involved in research.

BCM has committed to providing faculty time for a Director of Neuroscience who will also serve as Neuroscience Steering Committee Chair (forthcoming letter of support from BCM Neuroscience Chair Dora Angelaki and BCM VP for Research Adam Kuspa). Rice will provide salary support for this position (cf. forthcoming letter of support from Rice Provost McClendon, detailing budgetary commitment).

The Director role will be filled by Prof. Dickman (BCM/Rice) once the minor program is approved. His initial appointment in these roles will be for 3 years, which provides time for development and further building of Neuroscience between Rice and other medical center institutions. Prof. Dickman’s responsibilities for the program are spelled out in a Professional Services Agreement, currently being finalized, which includes administration of the program, teaching, research supervision of NEUR 485, and other tasks of the Director.
Note that the role of Director and Steering Committee Chair need not always be filled by the instructor of NEUR/PSYC/BIOC 380, and moreover the individual(s) filling these roles may change. A certain amount of personnel change is normal and expected in the academy. However, crucially, the support for personnel for these functions remains a commitment of Rice and BCM by joint agreement. Thus we believe that the program is fundamentally sustainable, and indeed with the university’s current focus and plans for future programs as they have been communicated to us by the Provost’s office, is virtually assured.

Administrative support for the minor will be provided by the Gulf Coast Consortium, which has an office staff on the Rice campus. GCC personnel will work with the Director to build and maintain the website and deal with undergraduate enrollments, special registrations, grade entry, and administrative troubleshooting. Funding for this administrative work will be provided by the Rice Provost’s Office (see the forthcoming letter of support from Provost McClendon.)

The initial Minor advisors will be Steve Cox (CAAM) and Jim Pomerantz (Psychology). There are far and away sufficient faculty interested in Neuroscience at Rice and teaching in the program to form a good-sized pool for selection of advisors.

In sum, sufficient resources have been committed to sustain the program through a start-up phase taking at least one class through graduation. Moreover, during that time we expect that cooperative agreements between Rice and the other medical center institutions will only increase the available resources (TAs, etc.) The Vice Provosts Sanders and Farach-Carson, as mentioned above, have been working steadily to create long-term yet flexible agreements for programs in the biosciences that will benefit the participating institutions, allowing them to build on each others’ strengths. Thus we expect that Neuroscience at Rice will grow and flourish.

E. Proposed General Announcements Text for 2013-2014

Neuroscience

The School of Social Sciences, Natural Science, and the George R. Brown School of Engineering
Degrees Offered: Interdisciplinary Minor

Neuroscience is an interdisciplinary field that uses very diverse methodologies to investigate the human mind and brain and the relation between them. Its subject ranges from the study of cognitive processes and representations via the empirical study of behavior, to investigations of the biochemical processes that occur in brain functions, and all of the interactions and correlations between brain, behavior, and biology that can be observed and/or modeled. The primary aim of neuroscience is to provide an understanding of how the cognition and behavior of organisms are embodied in neural processes. Such an understanding of mind and brain, bringing to bear many types of knowledge, is necessary as a basis for understanding and solving many practical problems: understanding the neurophysiology of disease; devising treatment for many pathologies related to aging, stroke, autism, and hearing and other impairments; improved understanding of human behavior relating to risk, addiction, and social pathologies; addressing practical problems in memory, learning, and acquisition of literacy; understanding the neural basis of emotion and its relation to human perception and behavior; and many other applications.

Course Requirements for the Interdisciplinary Minor in Neuroscience

A minor in neuroscience requires the successful completion of at least six courses (a minimum of 18 credit hours). At least three courses must be
at the 300-level or higher, and no more than two courses can apply from study abroad or transfer credits.

Depending on a student’s interest, those wishing to minor in neuroscience may choose from one of two unique tracks, either a Humanities and Social Science (HS) track, which represents cognitive and behavioral approaches to neuroscience, or a Natural Science and Engineering (SE) track, representing cellular and molecular-level investigations and approaches.

**Required classes:**
- Core Course (regardless of track):
  NEUR/PSYC/BIOC 380 *Fundamental Neuroscience Systems*

- Core Elective (dependent on chosen track):
  NEUR/PSYC 362 *Biopsychology* (HS track)  
  NEUR/BIOC 385 *Cellular and Molecular Neuroscience* (SE track)

**Elective Classes:**
Students must select four electives (of at least three credits each), and should be chosen in accordance with the track selected by the student for the core. At least one elective, however, must be chosen from the opposite track, to provide breadth. No more than two of these electives can be used also to fulfill a student’s major requirements.

For a list of approved elective courses, in either of the two tracks, please review neuroscience.rice.edu and/or speak with the minor advisors.

Note: the website for Neurosciences will be developed and put into place Spring 2013 by the Gulf Coast Consortium, under Prof. Dickman’s supervision.

**Current electives:**

**Humanities & Social Science (HS) Track**
LING 212: Speech and Hearing Science  
LING 306: Language, Thought, and Mind  
LING 411: Neurolinguistics  
PHIL 103: Philosophical Aspects of Cognitive Science  
PHIL 312: Philosophy of Mind  
PHIL 352: Philosophy of Psychology
PHIL 353: Philosophy of Language
PHIL 354: Philosophy of Perception
PSYC 308: Memory
PSYC 309: Psychology of Language
PSYC 351: Psychology of Perception
PSYC 353: Psychology of Emotion and Motivation
PSYC 432: Brain and Behavior
PSYC 430: Computational Modeling of Cognitive Processes
PSYC 471: Introduction to fMRI
BCM-NEUR 438: Law, Brain and Behavior

Natural Science & Engineering (SE) Track
BIOE/ELEC 381: Fundamentals of Nerve and Muscle Electrophysiology
BIOE/COMP/ELEC 485: Fundamentals of Medical Imaging I
BIOE/COMP/ELEC 486: Fundamentals of Medical Imaging II
BIOE 492: Sensory Neuroengineering
BIOC 415: Experimental Physiology
ELEC 301: Signals and Systems
ELEC 303: Random Signals in Electrical Engineering Systems
ELEC 431: Digital Signal Processing
CAAM 415: Theoretical Neuroscience: Cells, Circuits and Systems
CAAM 416: Theoretical Neuroscience: Learning, Perception and Cognition
CAAM/MATH 435: Dynamical Systems
COMP 440: Artificial Intelligence
COMP 450: Algorithmic Robotics
BCM-NEUR 470J: Functional Neuroanatomy & Development
BCM-NEUR 464: Cellular Neurophysiology
BCM-NEUR 462J: Concepts of Learning and Memory
BCM-NEUR 434: Higher Brain Function
BCM-NEUR 433: Neurobiology of Sensation & Movement
BCM-NEUR 424: Physiology of the Visual System
BCM-NEUR 422: Neurobiology of Disease
UTH-GS 140063: Molecular Neurobiology
UTH-GS 140143: Cellular Neurophysiology
UTH-GS 141181: Graduate Neuroanatomy

F. SUMMARY

We contend that the time for Neuroscience at Rice is now. The interest and enthusiasm of the Rice undergraduates for the study of Neuroscience has been building for years and shows no sign of abating; in fact it is increasing yearly. The Rice faculty have made strong collaborative connections with faculty at
Baylor, UT Houston, and other neighboring institutions that also increase yearly. The Rice and Baylor administrations have been working together on shared hires, collaborative procedures and frameworks, and budgetary issues, in ways that can be built on and adapted for collaborations with other institutions. The administrations of Rice and the other TMC institutions have expressed significant mutual interest in capitalizing further on these enhancements.

With the Neuroscience Minor, a major under initial development, and ultimately a Ph.D. program that we foresee growing out of these programs and ongoing cross-institutional interactions, Rice students will have an unprecedented opportunity to receive a first-rate, truly interdisciplinary training in a field which is a crucial part of every top-tier institution. The Minor program we propose is a first, but significant step in this direction.

Respectfully submitted,

Steve Cox and Suzanne Kemmer
On behalf of the Neuroscience Steering Committee
December 2012

APPENDIX 1
Syllabus for proposed required core course NEUR/PSYC/BIOC 380.
Submitted to the Rice Registrar as a new course on 2/23/2012; registration activated Fall 2012 for Spring 2013; current pre-enrollment 87.

NEUR/PSYC/BIOC 380 Fundamental Neuroscience Systems
Spring 2013
Dr. David Dickman, Baylor Dept. of Neuroscience and Rice University

The primary purpose of the course will be to provide a broad overview of neural systems that integrate perception, learning, and behavior. The course will consist of an eclectic series of lectures and discussions that are designed to provide an insightful perspective of neural systems functions. Each week there will be 2 lectures; the third weekly class will be a discussion session.

The course will be highly integrative with various thematic content including: functional organization of the nervous system, neural encoding and decoding, sensory systems, motor systems, arousal &
attention, and higher level processing. Students will be asked to read review articles and primary literature and be prepared to discuss them in class.

**Proposed Syllabus**

Lecture 1: Elements of Neural Systems I Review  
Neurons, generation of action potentials

Lecture 2: Elements of Neural Systems II Review  
Synapses, EPSP, IPSP, Transmitters

Lecture 3: What is reality? Psychophysics

Lecture 4: That Grey and White Stuff: Components of the Brain

Lecture 5: Finer scale brain architecture

Lecture 6: Receptors/Neural Coding

Lecture 7: To Know is to See: The Retina

Lecture 8: Visual Sensory Processing From Retina to Primary Cortex


Lecture 10: Visual Recognition: form, color, objects

Lecture 11: Visual Motion Processing

Lecture 12: Neural Constructs for Collision Avoidance

Lecture 13: Hear Ye! The Ear and it’s Mechanics

Lecture 14: Auditory System Processing From Cochlea to Brainstem

Lecture 15: Auditory Processing of Pitch and Intensity

Lecture 16: Localization of Sound in Space

Lecture 17: Touch Me - Somatosensory Receptors

Lecture 18: Why don't I crush the paper cup when I hold it? Somatic Sensation

Lecture 19: Ouch! Mechanisms of Pain

Lecture 20: La chocolate: Taste

Lecture 21: Oh to smell a rose! Olfaction

Lecture 22: Roller Coasters and Sea Sickness: Vestibular System

Lecture 23: How do I find CityCentre? The Navigation Circuit

Lecture 24: Multisensory Integration: Motion Perception

Lecture 25: Spinal Mechanisms of Movement

Lecture 26: How can I read this? Eye Movement Reflexes

Lecture 27: Keep Your Eye on the Ball! Directing Gaze

Lecture 28: Motor Cortex Control of Movement

Lecture 29: Golf swings, Piano, Karate: Refining Movement Patterns via the Cerebellum

Lecture 30: Mechanisms of Animal Flight

Lecture 31: Limbic System: Motivation, Reward, Addiction

Lecture 32: Magnetoreception
**Textbook**  
Purves, Augustine, Fitzpatrick, Katz, LaMantia, McNamara, and Williams, *Neuroscience*, 4th edition

**Grading**
There will be 11 quizzes: approximately one/1.5 week for 33% of the grade.
Two exams: mid-term and final: each for 33% of the grade.
Two extra-credit assignments equal to 1 quiz each.