

## **Redesign of neuroscience courses as part of the Trinity Common Curriculum**

A proposal submitted to the Associated Colleges of the South

Introductory Science Courses for Non-Majors Program

Course redesign and reimplementation.

Trinity University

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## **Redesign of neuroscience courses as part of the Trinity Common Curriculum.**

**2. Summary** The goal of this project is to redesign the existing Introduction to Neuroscience (NEUR 2310) and the Introductory Laboratory in Neuroscience (NEUR 2110) courses as Common Curriculum courses. Neuroscience is a rapidly growing field whose findings are bound to affect our lives in the future through their effects on education, health, bioengineering, information technology, marketing and philosophy. The redesigned courses will provide non-science major students with an opportunity to learn the general notions of scientific research as well as the basic processes of the brain and their relationship to behavior. The project will 1) redesign of the current Introduction to Neuroscience lecture course by clarifying the goals of each session within an general theme that will allow students to quickly orient themselves at each step throughout the course, 2) redesign the laboratory course by the careful selection of the practices involved and the information they offer the students in a manner that parallels the lecture course and 3) the development of software simulations to be used in both courses to exemplify neural processes. The redesigned neuroscience courses will favorably impact Trinity's ability to offer science courses for non-science majors as part of the Common Curriculum.

### **3. Project Description**

**Goals and Objectives:** The goal of this project is to redesign the present Introduction to Neuroscience (NEUR 2310) and the Introductory Laboratory in Neuroscience (NEUR 2110) courses as Common Curriculum courses. The redesign will be geared towards producing courses that will provide non-science majors with an experience that 1) will provide them with useful knowledge regarding the way humans perceive and interact

with their world and 2) helps them understand the details of how that knowledge was obtained in order for them to employ critical thinking skills to understand information to which they will be exposed to in the future.

***Background and Significance:*** Neuroscientific research has enjoyed a boom since the 1990s were declared the “Decade of the Brain” by then president George H. Bush. In the 15 years since, the field has grown from isolated groups studying very specific problems at a basic level to large communities involved in research at every level of description. Lately, the fields of Cognitive and Social Neuroscience have grown into robust research programs whose goals are to use the knowledge derived from the more basic levels to help explain human experiences.

Given the interest of the public on these matters, neuroscientific findings are quick to make it to the news media. Every week there are a few reports in the news explaining the results of new findings, with varying degrees of success at communicating the outcomes and implications of the research. Common myths regarding neuroscience notions abound and are repeated time after time regardless of their original context and of the caveats provided by new knowledge. For example, students commonly refer to the known fact that we “only use 10% of our brains” or that the left brain hemisphere is “more logical” than the right. Clearly, neuroscientific information, irrespective of its accuracy, will make it into people’s conception of the world. The newly developed neuroscience lecture and laboratory will provide a good opportunity to produce savvy consumers of such information.

### *The Centralized Mindset*

Conveying the ideas of neuroscience to young people with relatively little scientific training or even to those with a few biology and chemistry courses under their belts is not an easy proposition. But most of the difficulty does not stem from necessarily complex processes, but mainly from what has been termed the “centralized mindset” (Resnick, 1994). This notion mainly suggests that our experience of the everyday world tells us that causal chains follow clear paths and that agents have specific goals to which they direct their actions. From that centralized point of view, the idea that millions of single cells can coordinate to guide behavior can be at best confusing and, at worst, incomprehensible. While careful descriptions of neural processes and their experimental evidence provide students with useful information, the best method to facilitate this conceptual shift is to have students develop first-hand experience with the processes themselves. Therefore, an effective approach for the new courses will be the introduction of computer simulations that not only demonstrate multi-agent processes but also allow for the personal exploration and experimentation that encourage students to ask questions and answer them through experience.

The software package *StarLogo* (Resnick, 1994) and its descendants (*StarLogoT*, *NetLogo*) allow for the design and implementation of multi-agent simulations in an intuitive graphical interface with a minimal learning curve (students typically run an example in less than 10 minutes). In the summer of 2006 I wrote a few simulations of neural processes under *NetLogo* (Wilensky, 1999) and used them during the fall semester as the basis for take-home assignments (see appendix) with great success.

While there are other simulation packages for neuroscience, some of which have been used successfully in undergraduate settings (Av-Ron & Baxter, 2006; Molitor et al., 2006), they are based on two-dimensional cartesian graphs and do not communicate the multiple processes working in parallel that are critical for understanding neural system function. The simulations I have so far developed are primarily visual depictions of the processes under study (you can actually see “cells” migrate or “ions” move across a membrane and you can experiment with them).

*Neuroscience in undergraduate programs.*

Generally Neuroscience or Biological Psychology courses are taught as catalogs of brain area/function with little cohesion between topics. The main reason for this is that Neuroscience is a relatively young field that has grown in many different directions. From molecular biology and biophysics to computational and cognitive processes, there is a large number of concepts and assumptions as well as a great diversity in the methodologies employed in their study. It has been only in the last few years that unifying concepts have been advanced between the different levels. The main conclusion to date is that nervous systems are designed to guide behavior based on sensory input (sensorimotor control) and to modify behavior based on previous experience in a predictive fashion. At present there are no textbooks that take this point of view, leaving it to the individual professor to either attempt to bring the material under a single framework or to simply expound it as though each function was a stand-alone system. My goal for these courses is to present a basic conceptual framework onto which all other information can be placed in or derived from. This basic framework will serve as the

scaffolding for learning and understanding the information discussed during the course, from perceptual systems to emotions to cognition.

### *Neuroscience at Trinity*

The Introduction to Neuroscience course at present forms part of the core requirements for the newly instituted B.S. degree in Neuroscience. The course is also taken by students in Psychology, Biology and Chemistry and, more rarely, by students in Computer Science and other disciplines. This fall semester, however, both the Introduction to Neuroscience and the Introductory Laboratory in Neuroscience were accepted as Common Curriculum (CC) courses. As a liberal arts institution, Trinity strives to provide its students with meaningful academic experiences in a set of five Understandings as part of the CC. Among these, the *Understanding of Natural Science and Technology* requires students to take one course on the fundamentals of a natural science and one course which actively involves the student in the use of scientific methods. The introduction to neuroscience course and the introductory lab will be redesigned to fulfill these requisites.

***Detailed Project Plan:*** The project involves three main goals: 1) redesign of the current Introduction to Neuroscience course by defining clearly the goals of each session within the overall goal, 2) redesign of the lab by the careful selection of the practices involved and the information they offer the students, and 3) the development of software simulations to be used in both courses to exemplify neural processes.

During summer 2007 I will be organizing materials (readings, audiovisual clips) and assignments (anatomy exercises, computer simulations) within the conceptual framework described above. During my time at Trinity and Williams I have accumulated

a large amount of material that has the appropriate level of difficulty for the course. While I have been introducing some of into my regular courses, I feel this would be a great opportunity to put together a cohesive curriculum for the introductory course. This new organization will allow the students to orient themselves within the scope of the course at any time and will foster understanding of the relationships between the different systems within the brain.

The laboratory in neuroscience has so far been taught only once. With the next offering, I plan to introduce a new design that will include Common Curriculum objectives such as the basics of scientific epistemology, experimental design, and statistical analysis. These concepts will be taught in the context of laboratory experiences that exemplify neuroscientific techniques from anatomy, computational models, electrophysiological recordings and behavioral analysis. Students will have the opportunity to capture their own data, analyze it, describe their results and interpret them within the context of their experience and the knowledge acquired during the course.

The budget incorporates a stipend for a Trinity student to work on a summer research project, which will be related to these course revisions. This student is expected to have an interest in both Neuroscience and Computer Science. His/her research will involve development, testing, and implementation of simulation programs, some or all of which could be incorporated into the new courses. Based on my experience and considering the background/experience of the student, I predict that each simulation will take a full week to develop. I will work closely with the student throughout the summer, in order to ensure the quality and direction of the research, as well as the pedagogy of the simulations.

**Prior Activities:** As mentioned above, during the last few semesters, I have been selecting teaching materials that will help me put together the revised courses. Also, last summer I produced a set of computer simulations that exemplify 6 different neural processes, from the action potential to the control of eye movement by the brain stem (see appendix).

**Projected Timetable:** I will be devoting at least 7 weeks of full-time work during the 2007 summer period to the selection and re-writing of course materials for implementation in the fall of 2007 and the creation of new reading materials. A student will spend 10 weeks of full-time work implementing the computer simulations in NetLogo following my designs and under my supervision.

**Requested Budget: \$6,500.00**

Faculty stipend, summer 2007	\$3,000.00
Student stipend, summer 2007	\$3,500.00

**Context of the course in the curriculum / Impact on the institution:** There is a real need for non-major science courses for the fulfillment of the Common Curriculum requirements at Trinity. Three section of the Introduction to Neuroscience course will be taught every year (75 students) and two sections of the Laboratory will be taught each spring semester (32 students).

**Institutional support:** In the summer of 2005, a large area in the fourth floor of the Life Sciences building was remodeled as a teaching lab to be shared by Vertebrate Physiology (Fall) and Neuroscience (Spring). The lab was furnished with four laboratory tables each of which has a computer and an electrophysiological signal capture system (iWorx). The systems come with a tool kit that permits the recording of diverse biological signals from

humans and other animal species as well as dedicated software for a number of experiences. We also purchased 4 dissection microscopes and two large fume hoods. The total investment in equipment was close to 40 K.

Student participation in this project during the summer of 2007 will be supported by Trinity in the form of free housing (contingent on the provision of a stipend through external support).

#### **4. Evaluation, Dissemination, and Continued Support**

At present, there are no graphical computer simulations of neural processes. During my discussions with other neuroscience professors at Faculty for Undergraduate Neuroscience (FUN) meetings, I have often heard comments to the effect that there is a need for such a teaching tool. I intend to make the simulations available to Neuroscience professors by 1) presenting an education poster at the 2007 Society for Neuroscience conference in San Diego, 2) publishing an article describing the package in the *Journal for Undergraduate Neuroscience Education (JUNE)*, 3) making the actual programs available for download from my Trinity webpage and the *NetLogo* community webpage. *NetLogo* has the capability to encode the simulations as JAVA applets, which would allow me to have examples run directly on a web browser without the need for the *NetLogo* executable.

Evaluation of the students' understanding of the concepts and issues involved in the neuroscience courses is carried out by various means. The assignments derived from the students' experiences with the computer simulations provide 'snapshots' of the development of the students' understanding of the processes under discussion. I have found that if a student does not understand the basic concepts, their assignments clearly

show this deficiency. In that case I generally ask them to come to office hours to clarify the issue. During the semester, students in the introductory course read two journal papers and describe them in a short “report”. This helps me gauge their critical thinking skills, as they are required to discuss the results and opine on them. Finally, 10% of their grade is based on a final project that tests their understanding of the whole nervous system. For the project, they are asked to choose a short activity (that can be captured in about 5 minutes) and describe its neural substrates in writing. In the past I have had students explore the neural bases of different sports (baseball, hunting, horse-riding), interactions (meeting someone, kissing, playing with their pet), creative work (painting, playing music) and cognition (choosing what to have for dinner). I have found that most students greatly enjoy doing their projects and find it amazing at times to realize how much they have learned by the end of the semester. Next summer I will be designing a rubric to obtain a more consistent assessment of the final projects. It is important to note that all of the above is done in addition to three exams.

The laboratory course is also a highly monitored experience. After data capture, students have to produce brief laboratory reports describing their experiments and their results. At the end of the course they have to present (as groups) an experimental design on a topic of their choice, complete with the selection of the appropriate analysis and predicted results. The redesign creates 6 integrated lab experiences and the introduction of 4 out-of-lab group exercises designed to develop the students’ understanding of the scientific process. These exercises will also involve data capture and analysis but do not require a laboratory setting to take place.

Trinity employs a standard faculty evaluation forms to obtain information regarding the students' opinions of each course. While there is not a consensus on the value of the forms and their design, students' comments on their individual experience can be quite valuable as a means of feedback to instructors.

## **5. Literature cited**

Av-Ron, E & Baxter, D. A. (2006) Teaching Basic Principles of Neuroscience with Computer Simulations. *Journal of Undergraduate Neuroscience Education* 4, (2) pp. A40-A52.

Molitor, S. C., Tong, M & Vora, D. (2006) MATLAB-based Simulation of Whole-Cell and Single-Channel Currents. *Journal of Undergraduate Neuroscience Education* 4, (2) pp. A74-A82.

Resnick, M. (1994) *Turtles, termites, and traffic jams. Explorations in massively parallel microworlds.* MIT press. Cambridge, MA.

Wilensky, U. (1999). NetLogo. <http://ccl.northwestern.edu/netlogo>. *Center for Connected Learning and Computer-Based Modeling.* Northwestern University, Evanston, IL.

## 6. Curriculum Vitae

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                  Trinity University  
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#### EDUCATION

1987	Universidad Autonoma Metropolitana Iztapalapa, Mexico City, Mexico	B. S. Experimental Biology Minor: Molecular Biology
1998	Rutgers University, New Brunswick, New Jersey	M. S. Psychobiology
2002	Rutgers University, Newark, New Jersey	Ph. D. Behavioral and Neural Sciences.

#### PROFESSIONAL EXPERIENCE

1996	Lecturer, Psychobiology. Summer session, Rutgers University, New Brunswick, NJ.
1997	Lecturer, Psychobiology. Summer session, Rutgers University, New Brunswick, NJ.
2002-2004	Essel Posdoctoral Fellow, Williams College, Williamstown, MA. Research: <i>Spatial and temporal characteristics of cortical motor representations.</i> Instructor, neuroscience laboratory. Adjunct instructor, Winter Study Period.
Present	Assistant Professor, Psychology Department Trinity University, San Antonio, TX

## PUBLICATIONS

Jacobo Grinberg-Zylberbaum, Ruth Cerezo, Lea Bella Attie, Manuel Delaflor, Carrie Banda, Miguel Angel Guevara, Luis Schettino, Natalia Montaña, María Esther Sánchez y Manuel González (1992) Interhemispheric Correlation in Humans. *Revista Mexicana de Psicología* 9, 77-84.

Schettino, L. F. and Otto, T (2001). Patterns of Fos Expression in Amygdala and Ventral Perirhinal Cortex Following Olfactory-guided Fear Conditioning. *Behavioral Neuroscience* 115, 1257-72.

Schettino, L. F., Adamovich, S. V. and Poizner, H. (2003). The Role of Visual Feedback and Object Shape during Grasping. *Experimental Brain Research* 151, 158-66.

Schettino, L. F., Rajaraman, V., Jack, D., Adamovich, S. V., Sage, J. and Poizner, H. (2004). Deficits in Hand Preshaping in Parkinson's Disease. *Neuropsychologia* 42, 82-94.

Schettino, L. F., Adamovich, S. V., Tunik, G., Hening, W., Sage, J., & Poizner, H. Hand Preshaping in Parkinson's Disease: Effects of Visual Feedback and Medication State. (2006) *Experimental Brain Research* **168** (1-2), 186-202.

## CONFERENCE ABSTRACTS

Luis F. Schettino, Sergei Adamovich and Howard Poizner. Effect of Object Shape and Visual Feedback on Hand Configuration During Grasping. *International symposium on Progress in Motor Control III: Form Basic Research to Applications*, Montreal, Canada, 2001.

Howard Poizner, Wayne Henning, Luis Schettino, Julie Messier, Sergei Adamovich, Michail Berkinblit. New Strategies for Investigating higher-level motor disorders. *International Symposium on Progress in Motor Control III: From Basic Research to Applications*. Montreal, Canada, 2001.

Luis Schettino, Sergei Adamovich and Howard Poizner. The Role of the Transport Phase in hand preshaping during grasping. *Society for Neuroscience Abstracts*, 27. San Diego, 2001.

Sergei Adamovich, Alma Merians, Luis Schettino, Rares Boian, Grigore Burdea, Marilyn Tremaine, Michael Recce, Howard Poizner. Virtual reality rehabilitation of hand use after stroke: transfer to function. *Proceedings 3d World Congress in Neurological Rehabilitation*, Venice, Italy, 2002.

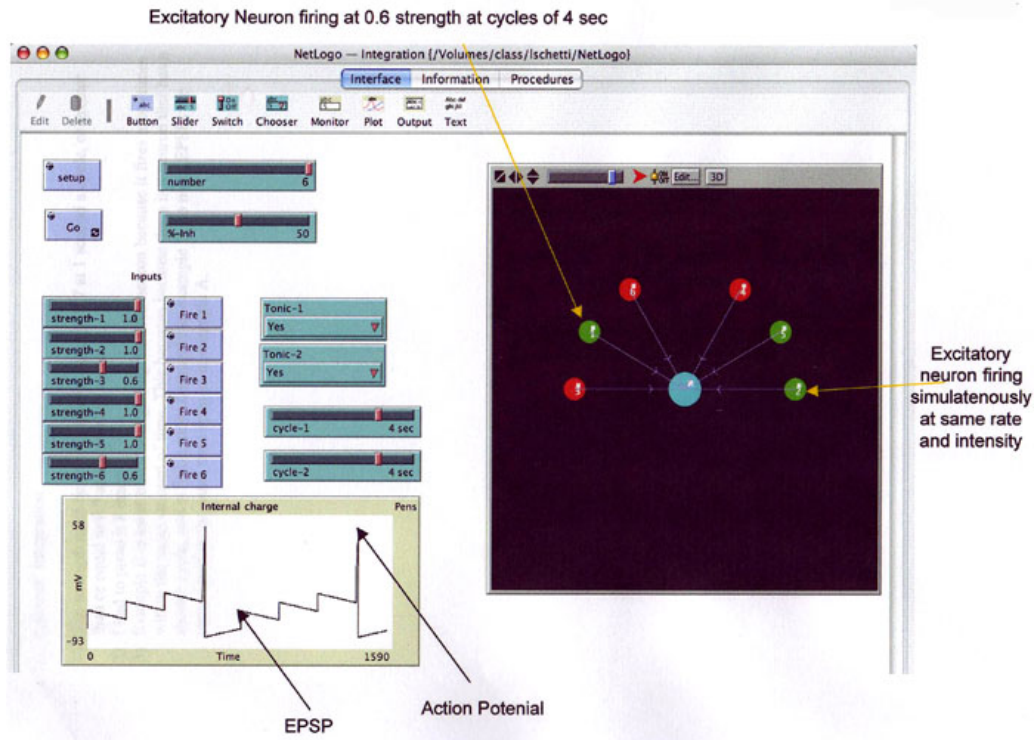
L. F. Schettino, E. van Erp, W. Henning, S. Lessig, D. Song, D. Barba & H. Poizner The Influence of Subthalamic Nucleus Stimulation on Grasping Variability in Parkinson's Disease . *Society for Neuroscience Abstracts*, 32. Atlanta, 2006.

## **7. Disclosure statement**

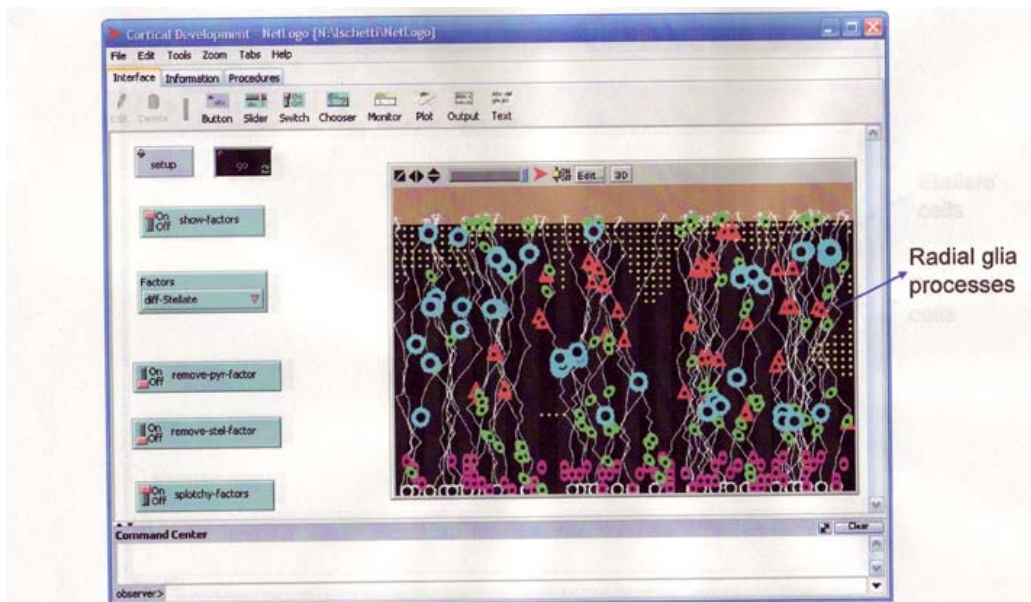
Next summer I will be taking part in a collaborative ACS funded project: Interdisciplinary Research with Multi-Agent Simulations in Virtual Environments, whose P. I. is Dante Suárez, Ph. D. of Trinity's Business Administration Department. The total amount I will be receiving from that project is \$800.00. I don't expect that project to interfere with the present proposal in any significant fashion.



## Impulse summation.



## Cortical development



By having the show-factors button on, the concentration of factors at each layer of the cortex can be seen. By having the splotchy-factor button on, random expression of factors leads to differentiated cells in unintended regions of the cortex. The cells do not know where they are to end up so they simply fix themselves in a random region of space.