# Activities for a Neuroscience Course

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In our experience, many psychology students resist neuroscience-oriented courses. Some students fear that they will not perform well in a course that incorporates material from the natural sciences. Others fail to see the relevance of such a course, especially because their career aspirations are geared toward an applied area of psychology. The self-fulfilling prophecy that ensues is all too familiar to psychology instructors, regardless of the subdiscipline or level of students they teach. Our approach to engaging students in neuroscience courses is twofold. First, we know that active, conceptually oriented involvement is key to learning. We also understand, however, that students need to learn specific content and that this needs to be emphasized, integrated, and made explicitly relevant to students. In the paragraphs that follow, we provide an annotated bibliography of several activities that provide integrative, hands-on learning experiences in the classroom or the classroom laboratory. In addition, we discuss two novel approaches to actively engaging students in a neuroscience course: (a) a set of out-of-class exercises, in-class discussions, and a neuroanatomy laboratory adaptable to any neuroscience course; and (b) a novel, process-oriented, neuropsychopharmacology experimental design appropriate for a laboratory neuroscience course.

1. A set of 10 exercises for classroom engagement, developed as an Instructional Resource for the Society for the Teaching of Psychology, which is located at: http://teachpsych.org/otrp/resources/lloyd08physio.pdf

The first exercise is an expandable, guided neuroanatomy tutorial, which reinforces a structure-function and systems approach to learning brain anatomy using sheep brain dissection and histologically stained microscopic tissue sections. For this (and every) exercise, we provide student instructions and instructor answer keys. The neuroanatomy lab prompts student engagement and understanding through a question-answer format. For example, instead of simply asking students to locate and memorize the name of the infundibulum, they must locate it; describe its connection to the hypothalamus and the pituitary gland; report a few major neuro-endocrine hormones released through this system along with their systemic functions; and describe the function of the vascular plexus that surrounds these structures, which are readily observable during dissection. The addition of case studies and other pedagogical tools reinforces structure-function relations, actively engages students, and highlights the importance and relevance of the content and approach. Importantly, concepts that are discussed in further detail throughout a typical semester course are emphasized.

The remaining exercises take a conceptual approach to learning difficult core material. For example, students develop a written explanation of the pharmacokinetics and pharmacodynamics of alcohol on the CNS, but only after learning the neurophysiology of the action potential as well as the organization and function of the major neurotransmitters and neurotransmitter receptors. Students must describe why alcohol is a CNS depressant and why it produces dose-dependent biphasic effects. The written assignments serve several functions: They allow students to apply the information they are learning to topics that are interesting and relevant to them, but they also provide ample opportunity for classroom discussion of these and related (and sometimes non-related) topics. Some of the topics addressed through these exercises include:

a) Neurophysiology and mechanisms of action of common neurotoxins
b) Neurophysiology and neuropharmacology of alcohol and other CNS depressants
c) Developmental neuroendocrinology, sexual dimorphism, and sexual orientation
d) Adult neurogenesis and homeostatic functions
e) Visual perception and visual agnosias
f) Learning theory, plasticity, and substance abuse
g) Mirror neurons, social learning, theory of mind and autism

2. A novel neuropsychopharmacology laboratory exercise modeling the actions of over-the-counter

supplements or drugs on the CNS, which is located at: http://northgeorgia.edu/STPebook.

We have developed a novel, active-learning laboratory experience in an underrepresented area of investigation, neuropsychopharmacology, intended for undergraduate upper- and lower-division psychology courses. This exercise incorporates an engaging, process-oriented approach to the instruction of the scientific method without the use of animal models or scheduled compounds commonly used in neuropsychopharmacology. Furthermore, this exercise focuses on *in vitro* models as a viable alternative to *in vivo* studies. Participants test the effects of an over-the-counter drug or dietary supplement on a microglia cell line. They measure rates of phagocytosis, cell morphology, and cellular proliferation as functional readouts for drug-induced changes. Over two or three laboratory sessions, students in small, collaborative groups engage in the following: (a) develop a novel hypothesis and experimental design; (b) collect and analyze primary data; (c) develop scientific and APA-style writing skills; and (d) learn key neurophysiology, neuropharmacology, and neuroimmunology concepts and techniques. Background information, protocols and possible student assignments can be obtained at: http://northgeorgia.edu/STPebook.

## Annotated Bibliography

***Glial Response to Neurotrauma***

Barnes and colleagues describe a 5-week laboratory experience involving student-developed hypotheses to test the effects of experimental ablation on astrocyte activity in the rat brain. Several weeks focus on the instruction and development of the surgeries, histology, and subsequent image analysis. The instructor served as an "expert consultant" through the process, allowing students to develop hands-on, problem-solving, and critical-thinking skills. Students learned how to perform experimental ablations, tissue fixation and processing, cryostat tissue sectioning, histological staining, and computerized image analysis; they also performed statistical analyses and interpreted the data. Pretest-posttest scores revealed a significant impact of the course on student-learning outcomes. This activity provides a valuable set of experiences for a semester-long laboratory course because there are many opportunities for hands-on learning.


- Barnes, C. L., Sierra, M., & Delay, E. R. (2003). Integrated undergraduate research experience for the study of brain injury. *The Journal of Undergraduate Neuroscience Education, 1*(3), A47-A52. Retrieved from: http://www.funjournal.org/


***Gustation + Olfaction = Flavor.***

Beins describes an activity that demonstrates the combination of two or more senses to distinguish stimuli, in this case gustation and olfaction. Discerning a single stimulus often requires multiple senses. In these situations, multiple sensory signals combine to create one single perception (e.g., flavor). In this experiment, students who were blindfolded ate jellybeans and guessed the flavor. Some students also smelled the jellybean before eating it. Students who had olfactory cues outperformed students who relied solely on gustatory cues. This experiment highlights the importance of combined gustatory and olfactory sensory information in the formation of a new sense (i.e., flavor) using a simple design suitable for an in-class demonstration.


- Beins, B. C. (1999). The interaction of taste and smell to create flavor. In L.Benjamin, B. Nodine, R. Ernst, & C. Broeker (Eds.), *Activities Handbook for the Teaching of Psychology* (Vol. 4, pp. 154-156). Washington, DC: American Psychological Association.


***Quantification of Serotinergic Cells in the Raphe Nucleus.***

This activity utilizes inquiry-based instruction, which is described as student designed and driven, but does not have a prescribed outcome. Students received a set of immunohistochemically stained slides with sections through the dorsal raphe nucleus of the gerbil brain. The students estimated the number of serotonergic cells in this nucleus by developing their own counting technique. The activity includes instruction of microscopy and immunohistochemistry as well as microscopy tutorials and activities. The author provides several suggestions for how to expand or apply this activity in various ways (e.g., making it a semester-long activity in which students prepare the slides and apply the technique to answer an experimental question). This activity demonstrates a particularly creative way to stimulate critical thinking, especially in the context of primary literature involving cell counting.


- Birkett, M. A. (2009). Every cell counts: an inquiry-based approach to address a novel research question in an undergraduate neuroscience lab. *The Journal of Undergraduate Neuroscience Education, 7*(2), A53-A64. Retrieved from: http://www.funjournal.org/


***Motor Programs and their Circuitry***

Instruction on the control of movement is complicated by the complex interactions of the cerebral cortex with the central pattern generator.

Buford proposes a demonstration involving a task to consume spare attention while also monitoring performance on a concurrent motor task. Performance on a math task declines when cerebral cortical attention networks are taxed by cortical motor demands. Participants performed a simple math quiz while sitting, walking, or navigating a simple obstacle course while walking. Participants who were sitting or walking performed similarly on the math quiz. But participants who navigated an obstacle course made more errors. This activity demonstrates the lack of involvement of the cerebral cortex in normal, over ground walking, but highlights its involvement when visual control of foot placement is required. Posttesting showed that participants and classmates retained these concepts for up to 14 months. This is a simple experiment to demonstrate complex control of motor programs and the limited circumstances by which it involves the cortex, especially when coupled with instruction on motor programs and the central pattern generator.

- Buford, J. A. (2005). A laboratory exercise demonstrating the limited circumstances in which the cerebral cortex is engaged in over ground locomotion. *The Journal of Undergraduate Neuroscience Education, 3*(2), A53-58.

***Sexual Dimorphism in the Olfactory System***

This activity provides a good demonstration of sexual dimorphism in the olfactory system. It requires a few fashion magazines that have perfume ads containing small amounts of perfume or perfume samples that comprise a panel of about 20 different fragrances (both perfume and cologne) with numbered codings. Participants identified each fragrance. Average accuracy for men was 30-40%, whereas the average accuracy for women was 50-60%. Consistently, women performed better in both olfactory sensitivity and discrimination ability, which may generate a discussion about anatomical differences between men and women (dimorphism), theoretical reasons for these differences, and the practical implications. This activity uses a very simple design suitable for an introductory course in-class demonstration. This activity also demonstrates that olfaction is one of the weaker senses.

- Charlton, S (1999). Testing sense of smell with scratch and sniff. In L. Benjamin, B. Nodine, R. Ernst, & C. Broeker (Eds.), *Activities handbook for the teaching of psychology* (Vol. 4, pp. 157-160). Washington, DC: American Psychological Association.

***Plasticity and the Somatosensory Cortex***

In this activity, Chute and Schatz demonstrate the probabilistic nature of neural networks in the context of learning, neural plasticity, and rehabilitation. The authors used a stylus to touch the second, third, and fourth toes of a blindfolded participant's bare foot. The participant reported which digit was touched. The activity can proceed in a number of ways allowing students to collect various types of data. The use of an independent-samples design demonstrates improved accuracy when the stimulus is applied to the digits of the hand instead of the foot. The use of a repeated-measures design exemplified how participants' accuracy improved with training and declines as time passes without training. The various experiments demonstrated principles of somatosensory organization and plasticity resulting from experience, especially in respect to rehabilitation. This simple activity necessitates few resources but is capable of demonstrating complex neural phenomena. Another merit of this activity is its ability to expand to fit the particular pedagological needs and levels of a particular course.

- Chute, D. L., Schatz, P. (1999). Observing neural networking *in vivo*. In L. Benjamin, B. Nodine, R. Ernst, & C. Broeker (Eds.), *Activities handbook for the teaching of psychology* (Vol. 4, pp. 97-102). Washington, DC: American Psychological Association.

***Gustatory Morphology and Individual Differences***

This activity provides a visual demonstration of fungiform papillae on the tongue using food coloring, a flashlight, and a magnifying glass to distinguish between filliform (i.e., stained; no taste function) and fungiform (i.e., non-stained; contain taste pores) pappillae. The activity also allows students to correlate fungiform papillae density (i.e., taste pore density) with individual differences and individual taste differences using a 6-n-propylthiouacil (PROP) assay to identify "supertasters," "tasters," and "nontasters." This activity focuses on gustatory transduction, gustatory anatomy, and anatomical variations among people using a cost-effective and simple, yet effective design. This be would a suitable experience for an introductory class discussing sensation and perception.

- Davidson, M. (1999). How blue are you?: The world of taste variations. In L. Benjamin, B. Nodine, R. Ernst, & C. Broeker (Eds.), *Activities handbook for the teaching of psychology* (Vol. 4, pp. 148-153). Washington, DC: American Psychological Association.

***Memory for Affective Stimuli.***

Flint describes three studies designed to uncover the connection between emotional arousal and circulating glucose levels in relation to recall, hypermnesia, and reminiscence memories. These studies use varying emotionally arousing stimuli (words or pictures). The first study involved affectively rated words with three subsequent free recall tests to measure hypermnesia in relation to emotional arousal (and suspected glucose release). The second used affectively rated pictures with concomitant blood glucose sampling using a glucometer to measure more directly the relation between recall and glucose levels. The third involved the use of beverages of varying glucose levels to measure recall of affectively rated pictures. Collectively, these studies provide a simple demonstration of the importance of the valence of stimuli and their relation to memory with implications for both the advantages and disadvantages (e.g., psychopathology) that might result. Importantly, this activity also necessitates an underlying discussion of the neural mechanisms of memory formation. Given the breadth of this exercise, it is adaptable to numerous classes and class levels in institutions with varying facilities.

- Flint, R. W. (2004). Emotional arousal, blood glucose levels, and memory modulation: three laboratory exercises in cognitive neuroscience. *The Journal of Undergraduate Neuroscience Education, 3*(1), A16-A23. Retrieved from: http://www.funjournal.org/

***A Structure-Function Approach to Memory Development***

This activity uses a rodent non-match-to-sample assay to assess rat pup performance on a working/spatial memory task known to involve the hippocampus. The ability to perform this task typically develops in rats by postnatal Day 18. The authors provide instructions for how to construct and use the necessary Y-maze and how to run this behavioral paradigm. Eighteen-day-old pups but not 15-day-old pups acquired the alternation habit (NMTS behavior). Several discussion questions prompt students to explore the structural, functional and developmental components of the behavior. This activity provides students the opportunity to use a behavioral assay to test complex neural structure and function in a developmental context and is particularly relevant to an upper-level neuroscience, development, behavior or learning course.

- Gitts, A. G. (2002). The emergence of non-match-to-sample behavior in the developing rat pup. *The Journal of Undergraduate Neuroscience Education, 1*(1), A1-A3. Retrieved from: http://www.funjournal.org/

***Sexual Dimorphism in the Spinal Cord and Androgrens***

This activity investigates the organizational effects of androgens on the development of sexually dimorphic nuclei in the spinal cord using image analysis. The spinal nucleus bulbocavernosus (SNB) innervates the muscles of the penis, which are absent or vestigial in adult females. The SNB is larger in adult males than adult females. The retrodorsal lateral nucleus (RDLN) innervates the flexor digitorm brevis muscle and is not as dramatically sexually dimorphic. This activity uses digitized micrographs of spinal cord segments through the RDLN and SNB of adult male and female rats, some of which were treated developmentally with Flutamide, an antiandrogen. Students counted the number and size of neurons in each nucleus in each condition using blinded analysis. Statistical analysis revealed an effect of Flutamide on male rats, but only in the SNB. There was also a gender effect on the SNB and RDLN of control animals. This is a self-contained activity. The authors provide all digitized images needed as supplements as well as instructions for how to perform image analysis using the free NIH Image J software. This is an excellent activity to demonstrate the use of image analysis in an experimental design.

- Grisham, W., Jones, H. B., & Park, S. H. (2003). Sex differences and organizational effects of androgen in spinal cord nuclei. *The Journal of Undergraduate Neuroscience Education, 2*(1), A28-A35. Retrieved from: http://www.funjournal.org/

***A Primer on Functional Brain Imaging***

This activity involves students in functional magnetic resonance imaging (fMRI) analysis. It requires access to primary fMRI data sets, preferably through an arrangement with a local medical center and ideally through a collaboration that would allow students to observe the data collection. In the event that primary data are not available, the authors report hyperlinks for free datasets compatible with various software packages. A preassignment overview is available for instructors as PowerPoint slides available through a hyperlink, and the authors discuss several key issues concerning the acquisition and use of freeware for fMRI analyses. Key to the exercise is the opportunity for instruction on the development of activation maps produced during fMRI post processing. The activity culminates in an APA-format report and is suitable for an upper-level course on neuropsychophysiology or cognitive neuroscience.

- Hurd, W. M., & Vincent, D. J. (2006). Functional magnetic resonance imaging (fMRI): a brief exercise for an undergraduate laboratory course. *The Journal of Undergraduate Neuroscience Education, 5*(1), A22-A27. Retrieved from: http://www.funjournal.org/

***Learning Neuroanatomy Using the Allen Brain Atlas***

The Allen Brian Atlas is a free, on-line tool that functions as an atlas, a gene expression map, and a 3-D model of the mouse brain. This activity details a self-guided tutorial meant to supplement the Allen Brian Atlas and to teach neuroanatomy and structure/function concepts. The tutorial guides the user through several exercises that require active use of the Atlas, including constructing an image and a 3-D model using the Allen Brain Explorer; retrieving gene expression data to reinforce anatomical and functional concepts; and a closer look at several key brain areas such as the olfactory system, the limbic system, and the hypothalamus. This activity is a work in progress with pleas for it to be collaboratively expanded. Although extremely valuable in its own right, expansion of this free resource will serve to enhance further neuroanatomy educational experiences. This activity adapts to any class that teaches neuroanatomy, particularly for institutions that cannot implement brain dissection laboratories.

- Jenks, B. G. (2009). A self-study tutorial using the Allen Brian Explorer and Brain Atlas to teach concepts of mammalian neuroanatomy and brain function. *The Journal of Undergraduate Neuroscience Education, 8*(1), A21-A25. Retrieved from: http://www.funjournal.org/

***The Evolution of the Action Potential***

This experiment gives students the opportunity to witness and measure the electrophysiological properties of an action potential in the Chara giant alga. Using intracellular recording and mechanical stimulation, the sustained and large amplitude action potentials from the large Chara cells demonstrated the properties of the resting membrane and action potentials and the likely ions involved. This lab stresses Nernst calculations and waveform analysis. This activity also promotes a discussion of the evolution of the nervous system in general and ion channels specifically, but it provides a more technically simple means of performing electrophysiological measurements than if using animal cells. It also reinforces difficult concepts related to neuronal excitability. It is suitable for an upper-level course in neuroscience or neurophysiology.

- Johnson, B., R. Wyttenback, R. A., Wayne, R., & Hoy, R. R. (2002). Action potentials in a giant algal cell: a comparative approach to mechanisms and evolution of excitability. *The Journal of Undergraduate Neuroscience Education, 1*(1), A23-A27. Retrieved from: http://www.funjournal.org/

***Social Neuroscience and Cortisol***

In this activity, Kalman and Grahn use an enzyme immunoassay to detect salivary cortisol levels. Cortisol is released from the adrenal cortex in response to stress, which is regulated upstream by hypothalamic corticotrophin hormone release. Thus, circulating cortisol levels are indicative of a neuroendocrine response, which is sensitive to environmental perturbations. This resource proposes numerous between-groups and within-groups studies demonstrating natural or stress-induced variations in salivary cortisol (e.g., circadian rhythms, exercise, sociability, and risk-taking behaviors) and provides a simple psychophysiological approach to understanding social neuroscience. It also provides a forum for discussion of correlative vs. causative analyses and other oft-debated topics in behavioral neuroendocrinology. This activity is suitable for a mid- to upper-level course in neuroscience, endocrinology, behavioral neuroscience, or social neuroscience.

- Kalman, B. A., Grahn, R. E. (2004). Measuring salivary cortisol in the behavioral neuroscience laboratory. *The Journal of Undergraduate Neuroscience Education, 2*(2), A41-A49. Retrieved from: http://www.funjournal.org/

***Prism Goggles and Visuo-Motor Plasticity***

Neural plasticity is an important concept in neuroscience, yet it is difficult to model in a classroom environment. This activity is simple, inexpensive, and runs well within the constraints of the typical classroom. The authors describe how to construct prism goggles that laterally shift the visual field along with a set of exercises that test cerebellar-dependent visuo-motor coordination. Student testing occurred at baseline (no goggles), during preadaptation (goggles on, but training not yet performed), after adaptation (goggles on and training performed), and post adaptation (adaptation complete with goggle on, but tasks now performed with goggles off). Coding of the performance of participants on graph paper during an open-loop pointing task allows for the quantification of the degree and direction of visuo-motor errors. The authors suggest the use of additional conditions to show the importance of active versus passive training on visuo-motor adaptation while wearing goggles.

This demonstration allows the instructor to teach students about neuroplasticity in a relatively short period of time. A number of thought questions for students to ponder encourage further student engagement.

- Li, A. (2008). Experiencing visuo-motor plasticity by prism adaptation in a classroom setting. *The Journal of Undergraduate Neuroscience Education,* 7(1), A13-A18. Retrieved from: http://www.funjournal.org/

***Neuroscience Course Supplements***

This resource contains a set of 10 exercises meant to supplement a traditional neuroscience course. The first activity includes a structured set of sheep brain dissection labs designed to provide a structure/function approach to neuroanatomy, covering sections in the coronal and sagittal planes as well as special dissections and microscopic anatomy. An interactive set of lab questions and an instructor key are included for each as well as basic information about how to construct the neuroanatomy labs, what materials are needed, and where to purchase them. The remaining exercises, distributed to students as supplemental assignments, cover a range of topics including neurophysiology, drug addiction, sexual orientation, adult neurogenesis, and prosopagnosia. An instructor key comes with each assignment. This set of activities, in part or in full, is appropriate for an upper-level course as a supplement to lecture material.

- Lloyd, S. A. (2008). Enhancing the physiological psychology course through the development of neuroanatomy laboratory experiences and integrative exercises. Retrieved from http://www.apadiv2.org/otrp/resources/resources.php?category=Physiological

***Simple Neural Network Demonstrations***

Discussions of neural networks are underrepresented in the undergraduate curriculum, despite the importance of understanding algorithmic analyses in determining the output of neural circuitry. The major goal of this set of activities is to explain how complex processes (outputs) can emerge (i.e., the whole is greater than the sum of the parts) from the interaction of simple elements (inputs). The authors describe three demonstrations whereby participants must tap a neighboring person and raise a sign if they are tapped on the shoulder. Thus, through a simple, three-person circuit, an emergent "inclusive-or" or "and" network is demonstrated. The addition of more participants with expanded instructions (e.g., if you are tapped and not if you have a hand resting on your shoulder, tap the person in front of you and hold your hand on the shoulder of the person diagonal to you) yields the opportunity to demonstrate inhibitory connections and "hidden" layers to produce "exclusive-or" networks. The authors provide additional background information pertaining to the non-linear outputs of neuronal interactions. This activity is suitable for an upper-level cognitive neuroscience or neuroscience course and provides a theoretical viewpoint to supplement commonly used texts, which often neglect these important concepts.

- May, C. J. (2010). Demonstrations of neural network computations involving students. *The Journal of Undergraduate Neuroscience Education, 8*(2), A116-121. Retrieved from: http://www.funjournal.org/

***Learning Neuroscience One Case at a Time***

In this article, Meil details three exercises that teachers can use to incorporate case studies in a neuroscience course. Exercise 1 requires a literature review of the salient features of the case study and the development of a hypothetical experiment to test a novel question concerning the condition. Exercise 2 entails a supervised case study of a patient with a brain disorder. Exercise 3 requires students to evaluate an existing interpretation of a case study or treatment strategy on the condition of interest. The article contains a chart detailing many classic case studies, which are useful as a starting point for discussion or as a stand-alone resource. Finally, the author highlights the advantages and disadvantages of the case-study approach as well as the value of its incorporation. The nature of these exercises allows teachers to incorporate them into a number of courses in neuroscience, including those dealing with psychopathology themes.

- Meil, W. M. (2007). The use of case studies in teaching undergraduate neuroscience. *The Journal of Undergraduate Neuroscience Education, 5*(2), A53-A62. Retrieved from: http://www.funjournal.org/

***Environmental Enrichment, Neural Plasticity, and Neurogenesis in Crayfish***

This activity uses fluorescent immunohistochemistry directed at a synthetic S-phase marker (BrdU) and confocal microscopy to analyze adult neurogenesis in the brains of adult crayfish as a function of environmental enrichment. Students performed all aspects of the experimental design from which they demonstrated that an enriched environment results in increased neurogenesis in cluster 10 of the crayfish brain. Participants gain experience in brain tissue processing, immunohistochemistry, and confocal microscopy as well as image and statistical analyses. This activity also provides an opportunity to instruct on the practical and theoretical importance of adult neurogenesis, which is a key concept in neuroscience.

- Paul, C. A., Goergen, E. M., & Beltz, B. S. (2002). Exploring neurogenesis in crustaceans. *The Journal of Undergraduate Neuroscience Education, 1*(1), A18-A22. Retrieved from: http://www.funjournal.org/

***Learning Neuropsychopharmacology Through the use of Behavioral Techniques and Animal Modeling***

This activity uses a rodent model and behavioral neuroscience assays to assess the effects of social isolation or an enriched environment on anxiety and drug-induced sensitivity. The authors operationalized anxiety through the use of an elevated plus maze and an open field chamber. Using animals with or without amphetamine exposure, they assessed the amount of time spent in the open arms (elevated plus maze) or near the center of the chamber (i.e., thigmotaxis in the open field chamber) by animals reared singly or in an enriched environment. Students performed a prelab reading, ran the behavioral tests, collected and analyzed data, and wrote a formal report. The authors also describe how to build the behavioral testing apparatuses. The authors note several targeted outcomes including the development of an understanding of psychostimulants' mechanism of action, conceptual and operational definitions of thigmotaxis, the use of animal models, the ability to perform statistical analysis, and provide graphic displays of the data. This is a thorough activity, which runs students through the entire process of experimentation. It provides an ability to tailor the activity to the level of students as well as the ability to expand the involvement of students.

- Pritchard, L. M., Van Kempen, T. A., Williams, H., & Zimmerberg, B. (2008). A laboratory exercise for a college-level, introductory neuroscience course demonstrating effects of housing environment on anxiety and psychostimulant sensitivity. *The Journal of Undergraduate Neuroscience Education, 7*(1), A26-A32. Retrieved from: http://www.funjournal.org/

***Using Neurovascular Unit Measurements to Teach Neuroscience.***

The neurovascular unit consists of several associated cell types including neurons, endothelial cells, astrocytes, and pericytes, which are affected by both exogenous and endogenous factors. In addition, the neurovascular unit regulates the function of the neuron, which is dependent on the delivery of oxygen and glucose from the blood. Thus, the neurovascular unit is an important anatomical construct that is implicated in numerous brain disorders, yet is underrepresented as a topic of instruction in undergraduate courses. The authors present several methodologies for visualizing the cerebral vasculature using unstained, Nissl-stained, DAB-stained, or imunocytochemically-stained brain tissue. Each method falls on a spectrum according to the amount of student involvement required, the facilities and resources needed, and the cost of performing such techniques as well as the value of the data collected. The authors present an additional activity involving searching for vascular markers on a free database of digitized images (GENESAT). The authors do not propose student projects in this resource, but the techniques they present are easily adapted to an experimental design (e.g., determining how environmental change can influence the neurovascular unit). In addition, these techniques provide expanded instruction opportunities focused on *in vivo* neurophysiology as well as techniques commonly used in the neuroscience lab.

- Ramos, R. L., Smith, P. T., Croll, S. D., & Brumberg, J. C. (2008). Demonstrating cerebral vascular networks: a comparison of methods for the teaching laboratory. *The Journal of Undergraduate Neuroscience Education, 6*(2), A53-A59. Retrieved from: http://www.funjournal.org/

***Observing and Measuring Biological Rhythms***

This activity focuses on circadian rhythms produced in the CNS, which affect the way the body works on a daily basis. The authors present an activity involving a simple means of observing biological rhythms (i.e., performing systematic body temperature measurements). For 3 days, students measured and recorded their body temperature during waking hours (i.e., every 2 hours). The students observed a daily change of about 1-2 degrees Fahrenheit in normal body temperature. Additionally, students observed that the temperature change followed a daily pattern. For most people, body temperature is lowest in the early morning upon waking and highest during the evening. This activity provides a simple method for demonstrating biological rhythms and the importance of systematic data collection and graphing. This activity is appropriate for an introductory class to demonstrate neuroendocrinology and scientific methodology.

- Renner, M. J. (1999). Circadian rhythms and body temperature. In L. Benjamin, B. Nodine, R. Ernst, & C. Broeker (Eds.), *Activities handbook for the teaching of psychology* (Vol. 4, pp. 109-

112). Washington, DC: American Psychological Association.

**Gustatory Perception Involves Receptor Interactions and Other Signaling Mechanisms**

This activity uses a simple pretest-posttest design to illustrate the importance of ligand-gated receptors for gustatory transduction. Students sampled salt, aspartame, sugar, M&Ms®, and Sweetarts® before and after ingesting a tea brewed from the leaves of the Indian herb Gymnema sylvestre (sold in health food stores), which binds to and blocks the sweet receptors for 30-60 mins. Participants described their subjective taste experience for each substance in relation to four primary tastes (sweet, sour, salt, and bitter). This activity highlights the importance of taste receptor mechanisms and interactions by demonstrating the taste of substances in the absence of a functional key receptor mechanism. Additional instruction opportunities arise from a realization that aspartame perception is not as dramatically altered as students might predict, hence allowing for a discussion of additional signaling mechanisms used in gustatory transduction. The key aspect of this activity comes from its ability to engage the students in a subjective reflection of their own sensory experience.

- Schroeder, J. A., & Flannery-Schroeder, E. (2005). Use of the herb *Gymnema sylvestre* to illustrate the principles of gustatory sensation: an undergraduate neuroscience laboratory exercise. *The Journal of Undergraduate Neuroscience Education, 3*(2), A59-A62. Retrieved from: http://www.funjournal.org/

**Using Movies to Teach Neuroscience**

This resource provides several examples of full-length movies that teachers can successfully incorporate into a neuroscience course. The article includes a thorough list of approximately 100 movies along with complete references, movie duration, specific neuroscience content covered, rating, reason for rating, and other useful information. It also includes several sample assignments and exercises to highlight the use of specific movies, film series, and film clips to supplement courses that cover neuroscience material. It is a useful resource for any class that involves neuroscience-related content.

- Wiertelak, E. P. (2002). And the winner is: Inviting Hollywood in to the neuroscience classroom. *The Journal of Undergraduate Neuroscience Education, 1*(1), A4-A17. Retrieved from: http://www.funjournal.org/

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Lloyd, S. A., Shanks, R. A., & Robertson, C. L. (2011). Using the BV-2 microglia cell line to model neuropsychopharmacological manipulations: a simple, student-centered, hypothesis-driven design. Retrieved from: http://northgeorgia. edu/STPebook