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Individual chapters may be referenced in this fashion:

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Introduction

Introductory neuroscience course offerings continue to grow among both natural science and psychology programs (Cleland, 2002). Some scholars have suggested that these courses in particular require accurate and up-to-date supplementation by instructors, along with thoughtful design alignment with learning objectives (Cleland, 2002). Cleland (2002) advocates for the importance of interesting (or, engaging) content that reinforces previously learned concepts (often from textbooks) when both teachers and students have sufficient and appropriate resources (such as this ebook). A growing body of literature demonstrates the effectiveness of engaging, interactive pedagogies in teaching neuroscience (Birkett, 2009; Keen-Rhinehart et al., 2009; Schneider et al., 2013).

Purpose of the Book
The purpose of this book is to provide support for implementing activities to complement topics commonly found in undergraduate neuroscience, biopsychology or physiological psychology courses and texts. Our goal is to provide a practical guide of engaging, field-tested activities, lessons, and resources for teachers of these courses, along with rationale for importance of active and engaging learning activities from the scholarship of teaching and learning literature.

Organization of the Book
Each chapter consists of:

• An abstract of the activity written by a faculty member who has successfully used the activity in class.
• Step-by-step instructions for implementing the activity.
• Suggestions for learning objectives and assessment.
• Alignments to the most resent APA Guidelines for the Undergraduate Psychology Major. The full Guidelines (v.2.0) can be accessed at: http://www.apa.org/ed/precollege/about/psymajor-guidelines.pdf
• Information from the scholarship of teaching and learning literature (where applicable).
• Additional resources, including references, instructions, and student handouts.

In an overall introduction, Stephanie Simon-Dack opens the book by briefly addressing the scientific evidence regarding the benefits of active learning in the classroom and discusses her own experiences as a new professor that led her to embrace active learning strategies as a critical component of her teaching doctrine.

Section 1: Neuroanatomy
As an alternative to lecture, Amanda Maynard and Sarah Uzelac begin this section with their description of the use of the Jigsaw Classroom technique to teach neuroanatomy. Use of the Jigsaw Classroom technique actively engages students in their own learning,
provides students with the opportunity to practice oral presentation skills, and creates a positive learning atmosphere. The authors describe the use of this approach to teach neuroanatomy, including advance preparation and classroom implementation procedures as well as how the approach might be adapted for use in a variety of classroom contexts.

Next, Jeffrey Sable shares an activity that includes the use of hypothesis testing in the context of the neuroanatomy of language processing. This lesson explores the brain regions involved in language processing beyond Broca’s and Wernicke’s areas and challenges students to consider the sometimes messy process of research. The activity includes ways to integrate important neuroimaging techniques into the lesson and links to video and primary literature resources used.

To demonstrate ionic movement to a diverse population of students, Patricia K. Prunty provides a layman analogy to facilitate understanding of ionic concentrations and movements that contribute to the resting membrane potential. By focusing on the night club analogy, even the most biology-phobic student can understand these terms and apply them to the generation of action potentials. By envisioning ions as motivated entities, students are better able to predict and determine movements based on concentration gradients and electrostatic pressures.

In the final chapter of this section, Linda Walsh describes a flexible game activity and associated homework assignment that she has used successfully for over 20 years in both biopsychology and large and small introductory psychology courses. Students compete in teams and are responsible for completing assigned neuroanatomy readings and a detailed homework assignment, which may make the often dry neuroanatomy lecture optional. The origin of this activity is uncertain, but Linda began using the Brain Game before the advent of PowerPoint and smart classrooms!

**Section 2: The Neuron**

In the opening chapter of this section, Jeffrey Sable takes students outside to the campus quadrangle to imagine themselves inside a functioning neuron. He shares an activity that asks students to use the physical characteristics of a familiar location to enhance rehearsal and retention of information about post-synaptic potentials.

Next, to demonstrate the amygdala's role in fear and aggression, Patricia K. Prunty provides an activity that allows students to feel the constraints of their own "personal bubbles." Students will experience personal space violation and explore the accompanying emotional component.

For an engaging lesson on synaptic transmission, Brady Nichols shares an activity he developed using an unconventional apparatus: a Chinese Checkerboard. The demonstration provides a basic overview of neurotransmission fundamentals and can be adapted to facilitate understanding of more detailed and complex processes of
neurotransmission. Figures and directions for additional variations provide a wealth of possibilities for using this activity in class.

Section 3: Reproductive Behavior and Neuroendocrinology
Inspired by a “Case Studies in Science” workshop, Linda Walsh created mini-cases for teams of students in her biopsychology course to work on after they had completed lessons devoted to sexual differentiation and sexual development. The cases are set in a sexuality clinic of the future, which allows the class to take some liberties with the diagnostic tests necessary to provide the genetic, hormonal, and/or anatomical details of the “client” as well as family background. Teams later present their “diagnosis” and a description of how they arrived at their conclusions.

A longtime fan of the NPR show “This American Life”, Linda Walsh uses a fascinating episode for this activity. The Testosterone Show seems tailor-made for class discussions of organizational versus activational effects sex hormones, as well as how these actions may relate to sexual orientation and sex differences in behavior. This activity can be used as a strictly out-of-class assignment or can include a class discussion.

Section 4: Nervous System Phenomena
In an activity opening this section of the book, Echo Leaver helps students wrap their heads around the psychological underpinnings of Spatial Neglect with a mini-experiment. The goal of this particular assignment is to recreate the psychological parameters involved in spatial neglect by having students attempt to induce a made-up disorder (“Freezer Neglect”) in a friend or family member. Students are required to think critically about their strategy, to consider ethical implications involved, record their observations, and debrief the individuals they observe. Students share their methods and results in a classroom discussion focused on gleaning further insight into the phenomenon of Spatial Neglect.

The concept of Change Blindness is explored in this chapter. Echo Leaver describes a mini-experiment that helps convince skeptical students of the legitimacy of this phenomenon. This activity takes place across several days and requires observing friends and/or family responses to planned changes in appearance. The goal is to see how large of a change in their appearance students can enact without being noticed. Specifics of who notices what and when are recorded and students are encouraged to debrief their “participants” at the end of the mini-experiment. Through sharing the results in formal write-up or in-class discussions, students gain understanding of the subtleties of the Change Blindness phenomenon.

Despite a long history of research, the placebo effect is often misunderstood and under-appreciated by students. This chapter describes a demonstration of the placebo effect that requires few resources. Student confederates request volunteers to test a “newly synthesized drug” and collect data on their self-reported experience. The results of this
exercise provide an opportunity for students to discuss the implications of the placebo effect and engage in the research process.

**Section 5: Skill Development**

In this chapter, Merry Sleigh describes a brief oral presentation for use as a classroom activity. The activity allows students to examine current scientific sources, bring their personal interests into the classroom, and practice communication skills. The short presentations expose students and teachers to up-to-date information on a breadth of topics that might be too extensive to address in other ways. This chapter provides instructions on how to implement the activity with possible modifications. The benefits, as well as research on outcomes, are included.

In this collaborative journal article review activity designed by Leighann Chaffee, students in a small group are assigned a scholarly journal article on a topic central to the course. Students read the article and write a summary and response paper outside of class. In class, the small groups meet and each present the key findings from their journal article. Using a modified jigsaw approach, each student of the group is exposed to the findings from all journal articles. The instructor may provide discussion questions to stimulate group dialog and reinforce reading the primary literature in an area of neuroscience research.

Concluding the book, Shane Mueller describes an approach for using open source software to facilitate testing novel hypotheses. This detailed chapter includes directions for promoting experiential learning through demonstrating Hick’s Law, collecting, and analyzing data, along with information for accessing and using the software.

**Acknowledgements**

I would like to thank the authors for their enthusiasm and dedication to improving education in biopsychology and neuroscience. They have first hand knowledge of the unique challenges and rewards of teaching in this area. They have made their classrooms better places for students through their commitment to active and engaged learning. Thank you too to Division 2 for continuing to support projects like this with the goals of continuous improvement in psychology education and fostering productive collaborations among colleagues.

**References**


neuroscience postdoctoral fellows in the fellowships in research and science teaching (FIRST) program. *Journal of Undergraduate Neuroscience Education, 7*(2), A74.

Thoughts from an Active Neuroscience Classroom

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The contributors to this project are educators and scholars who generously share their wealth of knowledge with this community of teachers. The following commentary by Dr. Stephanie Simon-Dack reflects the experiences of many in our field and highlights the benefits of an engaged classroom.

When I started as an assistant professor teaching introductory neuroscience at a large state university, I had very little teaching experience. A class of 40 students is not particularly large, but as a new professor teaching what might be considered quite dry material to a social sciences class, I was intimidated. I was more so intimidated by the blank expressions on my students’ faces. Within several weeks of my first semester, I realized my oh-so-strategic technique of slamming out slides into Powerpoint every night and then regurgitating information the next morning wasn’t going to work. They weren’t engaged and because of this they weren’t learning.

There is a body of literature available that demonstrates the effectiveness of games and activities (so named “active” learning strategies) particularly for strongly scientific areas of study including physics, engineering, and biology (e.g., Ebert-May, Brewer, & Allred, 1997; Prince 2004). Furthermore, it is well known that games, interactive activities, and simulations in the classroom promote student retention and learning by involving students through personal engagement and increasing student motivation (Kumar & Lightner, 2007; de Frietas, 2005; Yoder & Hochevar, 2005). However I didn’t know any of this when I started introducing activities and active learning strategies into my classroom. It wasn’t about pedagogy at that point, it was a matter of personal survival.

The first activity I implemented into my classroom is still one of my most used and favorite. I have my entire class stand up and “act out” the action potential of a neuron. Students play the role of sodium ions, potassium ions and anions (with pre-prepared labels), as well as portions of axon, ion-selective permeable channels, and sodium-potassium pumps. By getting students out of their seat and up to the front of the class, they become “deputy instructors,” teaching themselves and one another through demonstration. Students are at first hesitant and than increasingly enthusiastic about the activity, which we run through several times. I have since collected data on the activity and demonstrated its effectiveness on enhancing student self-efficacy regarding the topic and increased learning of the stages of the action potential (Simon-Dack, 2014). The activity is also described in my instructional resource booklet of interactive teaching activities for the biopsychology classroom published on the Office of Teaching Resources
What I noticed when implementing this activity for the first time, however, was that it was fun. The students, although sheepish at first, were having fun. I was having fun. Furthermore, they were engaged: raising hands and asking questions. I also noted that getting up and moving was good for their engagement and that the physiological arousal of actual movement seemed to be translating into increased physiological arousal to the material. This is when I realized the importance not only of implementing activities into the classroom, but the importance of implementing activities that engage students through recruiting their own body and movement into the learning of the material.

I now try to implement an activity for every new section of material during the semester. And while not every activity can require students to use their hands, feet, or body movements, I consciously try to emphasize movement and physical representations of the concepts when appropriate. When I teach saltatory conduction, the students come up, form lines, and through simple hand-squeezing demonstrate that more students closer together (unmyelinated axon) take longer to “conduct” their signal than fewer students standing farther apart (myelinated axon). To demonstrate population coding, I have (when available) a student play the guitar. When I teach synchronized oscillation of neural activity, students march in rhythm. The activities take next to no time to implement and few to no resources, all of which fit well into my time and budget management requirements. Students enjoy them and as a whole classroom community seems to become enhanced, the space for asking questions seems to become safer, and the students enjoy the course much more than when I was solely lecturing. While teaching from an “active” learning perspective may have begun as self-defense, it is now an enjoyable and consistent part of my teaching approach that the students and myself rely on in the classroom.

References

Section 1: Neuroanatomy

1. Using Active Learning to Teach Neuroanatomy: The Jigsaw Classroom

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This activity was created as a way to improve upon the standard class session on neuroanatomy that might include identifying the structures, locating them on a PowerPoint slide/model, and defining their function. The standard approach is more passive and less exciting for both the students and the faculty! The jigsaw approach provides an opportunity for students to engage with the material actively as they identify the structures, function, and location. The activity also allows for students to discuss what they have read actively with the goal of improved retention of the material.

Lesson Abstract
Students in general psychology, biological psychology, and neuroscience courses are required to learn about the structures and the functions of the central nervous system (CNS) and may be intimidated by the technical nature of this material. Traditionally, structures and functions of the CNS are disseminated via lecture. This activity introduces the application of a collaborative learning technique, the jigsaw classroom, to teach about the CNS. In this activity, small groups of students are assigned to expert groups to learn about a specific area of the CNS in depth. Once mastery of the material has been achieved, one student from each expert group will join an informational exchange team to share his/her knowledge with other group members who have expertise in other areas of the CNS. All group members have the opportunity to practice their oral presentation skills within the informational exchange teams. The materials provided to students allow for active note taking on the content areas as explained by each informational exchange team member. Benefits of this activity include the practice of oral presentation skills to promote greater confidence among students who might otherwise be hesitant to participate during lecture, and the possible creation of a more positive classroom atmosphere as students have an opportunity to work with several classmates during this activity. The activity also provides the instructor with an opportunity to learn about the students in the class by creating teams that could extend beyond this activity in the classroom.
APA Guidelines

This lesson meets the following APA Guidelines for the Undergraduate Psychology Major:

• 1.1 Describe key concepts, principles, and overarching themes in psychology
• 1.2 Develop a working knowledge of psychology's content domains
• 3.2 Build and enhance interpersonal relationships
• 4.2 Exhibit effective presentation skills for different purposes
• 4.3 Interact effectively with others
• 5.4 Enhance teamwork capacity

Learning Objectives

After completing this activity, the student will be able to:

1. Identify and locate the structures of the central nervous system (e.g., brainstem, hippocampus, parietal lobe).

2. Articulate the function of central nervous system structures in behavior, cognition, and/or emotion.

Assessment recommendations

Learning Objective 1: Identifying and locating the structures in the areas of the CNS can be assessed by exams either in multiple choice or essay format in which the student is provided with a blank diagram and is asked to identify structures on the diagram. Alternatively, instructors could use a practical exam whereby students locate the structures on a model instead.

Learning Objective 2: Articulating the function of the CNS structure in behavior, cognition, or emotion could be assessed via examination (e.g., multiple choice or essay questions) as well as through an assignment. Multiple choice items might provide the function in the item stem requiring the student to select the correct structure from the options (or the reverse having the structure in the question stem and the function among the options). An essay question might ask students to describe the role of the CNS in a particular behavior (e.g., walking), thought process (e.g., memory) or emotion (e.g., fear). The student would then be required to illustrate his/her understanding of the structure and function by accurately identifying the structure in the CNS involved with an aspect of behavior, cognition, and/or emotion.

An assignment approach could provide students with a mini-case study of a person who is either engaged in a behavior (e.g., looking out the window and painting a landscape that is being observed) or experiencing some disruption in function (e.g., having difficulty walking and remembering following a car accident). The student then would need to explain the role of the CNS in the behaviors being observed.
Course and level recommendations
Undergraduate: Introductory and intermediate levels
General Psychology, Biological Psychology

Characteristics for success
Moveable classroom desks or individual small tables to facilitate teamwork are helpful. While not necessary in introductory classes, it is recommended that instructors proactively form the expert groups in intermediate level classes such that there is a range of experience and comfort with the subject matter within each expert group. A tool to facilitate gathering information for group formation can be found in the Additional Materials section. This tool can be distributed electronically for students to complete outside of class time. Expert groups ranging of four to five students are ideal. For large classes, create multiple expert groups for each area of the nervous system.

Lesson Preparation: 20-60 minutes
1. Create teams before class meets (at random or using team based learning questionnaire).
2. Select structures of the nervous system and customize handouts.

Lesson Background
The Association of American Colleges and Universities (AAC&U, 2002) reported that many more students than ever before are pursuing a college education, with approximately “75% of high school graduates getting some postsecondary education within two years of receiving their diplomas” (AAC&U, 2002, viii). This increase in the proportion of high school graduates now attending college increases the diversity of students and their learning needs in college classrooms. In addition, AAC&U reports that employers are looking for students who can successfully communicate in both oral and written forms, and work in teams (AAC&U, 2002). The traditional lecture format does not encourage the development of these skills.

Aronson (1978; 1996; 2000) reported a collaborative learning technique, the jigsaw classroom, which was designed to teach students content while encouraging a more cooperative learning environment in the classroom. The purpose of the jigsaw classroom was to teach students that each person in the classroom has something to contribute to the learning environment by structuring the classroom learning so that students must rely on each other for their own learning and success. One result of using this technique is that students from diverse backgrounds were given the opportunity to work with each other and see the contributions of diverse others, reducing stereotyping and prejudice in the classroom (Aronson, 1978; 1996; 2000).

While Aronson’s work (1978; 1996; 2000) involved elementary and high schools, the jigsaw classroom technique has the potential to provide benefits to students in the college classroom. First, the use of the jigsaw classroom provides a more active learning experience than lecture, as it requires student engagement during class sessions. Past
research in a statistics class reported that a majority of students indicated that the jigsaw classroom technique was useful in helping them understand the course material (Perkins & Saris, 2001). Miyake and Shirouzu (2006) reported that students involved in their jigsaw experience demonstrated retention of information related to cognitive science six months later. Finally, Doymus (2008) reported significantly better exam performance in a general chemistry course for those students in a jigsaw classroom as compared to a traditional classroom. Taken together, these studies suggested that the jigsaw classroom technique has been used in a diverse set of academic disciplines with significant benefits.

When group work is used in the classroom, students may be more likely to form groups based on already existing relationships when the instructor does not create the groups. The jigsaw classroom provides the opportunity for students to get to know other students in class with whom they may not associate, potentially creating a classroom environment where students feel more comfortable (Aronson, 2000) and potentially more willing to ask questions. Perkins and Saris (2001) reported that just over half of their participants reported the jigsaw classroom was useful in helping students to work with others and give help to others. In addition, the use of this technique addresses the learning needs of students in the 21st century (AAC&U, 2002), providing them with more opportunities to present information orally and work within teams.

**Detailed Explanation of Lesson**

**Preparation**

Instructors seeking to use the activity will first need to consider forming expert teams within their course. Expert teams may be created randomly or an instructor may take a more proactive approach to group formation to create more diverse teams with respect to certain criteria. If a random approach is desired, then each student is placed in an expert group with a number (see Table 1). To create the informational exchange teams, then the groups are reshuffled so that each informational exchange team has one person from each of the expert groups (see Table 2).

If however, a more proactive approach to group formation is desired, then the instructor might collect some information from the class and use that data to form the groups. For example, we have administered an electronic questionnaire to students outside of class as means of getting to know the students and to form diverse groups with respect to perceptions of the course, challenge of the material, and academic skill as indicated by GPA and previous coursework. Survey responses from this instrument (see Additional Materials) are examined and kept confidential. Heterogeneous groups can be created based on student interests and experiences.

**Implementation**

We have used this activity in both general psychology and biological psychology courses. Prior to engagement in the group activity, the purpose and general format of the jigsaw activity were briefly explained to the students. Students were then divided by the
instructor into ‘expert groups’ responsible for mastering a certain task/content. The areas of the CNS were divided into sections according to the level of detail required for the course. For example, in general psychology, the areas were divided into hindbrain, limbic system, language areas, and the cortex. Instructors of intermediate classes could tailor the assignment to reflect the greater level of detail present in these courses. Students were then responsible for a) identifying the structures of the brain relevant to their assigned section and b) identifying the role of this structure in human behavior, cognition, and/or emotion.

To aid in these tasks, worksheets for organizing and recording information were provided by the instructor (see Additional Materials). The textbook was used by the students as a reference during the expert group meeting. In addition, figures from the course text were provided to students to illustrate location of these structures. In both general and biological classes, the expert groups were asked to submit a summary of their assigned section of the brain to the instructor for review to ensure accuracy of information before presentation to the informational exchange teams. This review process was done in-class while the students were still in their expert groups. This review was conducted to minimize the possibility of misinformation being provided to peers and the subsequent possible negative impact on class performance. Alternatively, a quiz could be given at the end of the expert group experience to ensure students’ mastery of the material.

After each expert group had instructor approval, the groups were restructured into ‘informational exchange teams’. The resulting teams included one person from each expert group. The task of these newly formed teams was for each expert to teach the other members of the team his/her area of expertise. A sample group distribution using the jigsaw classroom technique is shown in Table 2. All students were asked to keep a list of questions for clarification at the end of informational exchange team discussion. These questions were addressed by the instructor before the end of the class.

The jigsaw classroom is a flexible technique that can be utilized in classes of various sizes and levels. With respect to class size, it is recommended that the expert groups not exceed four to five people in order to decrease chances of social loafing (i.e., some students performing the work for others). If an instructor had a large section of the course, multiple expert groups could be created for each area and informational exchange teams adjusted accordingly.

It is possible to adapt the jigsaw classroom to meet instructor’s course goals depending on the level of the course. For example, if an instructor was interested in having students learn to locate the structures of the brain, unlabeled diagrams from the students’ text could be provided as part of the expert group task. For upper level classes, more “realistic” images of the brain could be provided for diagramming or model brains used to locate structures physically. One potential concern identified in our experience was the possibility for incorrect pronunciation of CNS structures. We recommend that
the instructor complete the jigsaw classroom session with questions from students on pronunciation to address this issue. In both courses in which this technique has been utilized, the students were exposed to these areas repeatedly in subsequent chapters and the pronunciation was reinforced throughout the course.

Diverse student learners in today’s college classrooms are likely to benefit from a variety of teaching pedagogies including lecture and cooperative learning (e.g., jigsaw classroom). This technique provides an opportunity for students to become active learners early in the semester. The instructor may then elect to continue the jigsaw classroom for future class activities or assignments to reinforce not only the mastery of material but also the development of oral communication and teamwork skills needed in future employment or graduate study.

References
### Table 1: Example of Original Expert Group Designations:

<table>
<thead>
<tr>
<th>Hindbrain</th>
<th>Midbrain</th>
<th>Forebrain - Telencephalon</th>
<th>Forebrain - Diencephalon</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Jose</td>
<td>2. Sam</td>
<td>2. Larry</td>
<td>2. Maria</td>
</tr>
</tbody>
</table>

### Table 2: Example of Informational Exchange Team Re-groupings:

<table>
<thead>
<tr>
<th>Team A</th>
<th>Team B</th>
<th>Team C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Paul</td>
<td>2. Larry</td>
<td>3. Margaret</td>
</tr>
</tbody>
</table>
Team Based Learning Questionnaire

1. What is your name? ________________________________

2. Do you consider yourself to be a leader in group situations?  Yes  No

3. How much would you say you like or enjoy science-based courses? Choose all that describe you from the statements below.
   - I LOVE science courses.
   - I typically perform well in science courses.
   - I like science classes.
   - Science classes are a struggle for me.
   - I really dislike science classes.
   - I typically perform poorly in science classes.

5. How responsible and dependable would you rate yourself?
   - Extremely responsible/dependable
   - Usually responsible/dependable
   - Occasionally responsible/dependable
   - Hey, I don’t like to pinned down

6. How much experience do you have writing APA style papers?
   - I have written more than 5 APA style papers.
   - I have written 3-5 APA papers.
   - I have written 1-2 APA papers.
   - I have not written any APA papers.

7. What is your current approximate GPA?
   - Below 2.0
   - 2.0-2.4
   - 2.5-2.9
   - 3.0-3.4
   - 3.5-4.0

8. Have you completed any of the following courses?
   - Experimental Psychology/Research Methods  Yes  No
   - Anatomy & Physiology  Yes  No

9. How comfortable do you feel with the subject matter of this course?
   - Extremely comfortable
   - Somewhat comfortable
   - Neutral
   - Somewhat uncomfortable
   - Extremely uncomfortable

10. What is your major? ________________________________

11. Have you had trouble with a groupwork project?
    - Yes (Please explain below.)
    - Usually not, but I have had a bad experience or two (Please explain if you wish.)
Learning the Structures of the Central Nervous System

Name: __________________________________________

Purpose
The purpose of this activity is to help you to begin to develop a basic understanding of
the major areas of the brain and their role in human behavior.

Tasks
You will first be assigned to an expert group and subsequently to an informational
exchange team. The tasks to be accomplished in each group context are described
below.

1. **Expert Group:** Identify the major structures within your assigned portion of the
central nervous system and list the name of the structure and its role in human
behavior, thought, or emotion on the handout attached. Using the figures
attached, label any structures from your region of the brain. Identify the role
that each structure plays human functioning. When your expert group has
finished the task, consult your instructor for questions and to review the
accuracy of your notes.

2. **Informational Exchange Team Assignment:** Each person in the team is now an
expert in one of the areas of the brain. Each person should explain the major
areas within his/her area of the brain, where the structures are located, and the
role that each plays in human functioning. Do not simply pass your handouts
around to other team members. Your task is to EXPLAIN your section of the brain
to your team members. Be sure to take note as your team members explain their
sections of the brain.

*Note: Group members should keep a list of questions that need clarification from the
instructor.*

Expert Group Assignment: __________________________________________

Informational Exchange Team Assignment: ______________________________

Questions:
## Structure and Function of the Central Nervous System Note-Taking Guide

Name: ____________________________________________________________

<table>
<thead>
<tr>
<th>Location</th>
<th>Structure</th>
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<td>Lover Level</td>
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<td>Limbic System</td>
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<td>Cortex</td>
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<td>Language Areas</td>
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2. Hypothesis Testing Using a Video of Language Neuroimaging

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I developed this activity initially as an engaging way to examine language function in the brain - transitioning from older, lesion-based theories to more modern, neuroimaging based understanding. It is also great for reinforcing concepts related to research methods and hypothesis testing. I initially used it in a Biopsychology course, but I have used the basic exercise in various ways in other courses - even General Psychology.

Lesson Abstract
Engaging students directly in the process of hypothesis testing can be a valuable exercise in many different classes. This activity provides the opportunity for students to develop hypotheses based on early models of language processing in the brain, and then to see those hypotheses tested in a neuroimaging video. In addition to providing an introduction to the functional neuroanatomy of language (including the network properties of neural function), the activity can be used to illustrate the scientific method, assumptions often applied in cognitive psychology and cognitive neuroscience studies, and early hemodynamic neuroimaging research.

APA Guidelines
This lesson meets the following APA Guidelines for the Undergraduate Psychology Major:
• 1.1 Describe key concepts, principles, and overarching themes in psychology
• 2.1 Use scientific reasoning to interpret psychological phenomena
• 2.3 Engage in innovative and integrative thinking and problem solving
• 2.4 Interpret, design, and conduct basic psychological research

Learning Objectives
After completing this activity, the student will be able to:
1. Describe the basic functional neuroanatomy of language.
2. Explain the subtractive process of inferring mental processes that is used in cognitive psychology and neuroimaging.
3. Explain how using multiple methods can enhance our understanding of the brain.
Assessment recommendations

Learning Objective 1: Test items, written responses, and discussion can be used to assess students’ description of the functional neuroanatomy of language.

Learning Objective 2: Test items, written responses, and discussion can be used to assess students’ ability to explain subtractive processes in cognitive psychology and neuroimaging.

Learning Objective 3: Discussion and original research design assignments can be used to assess students’ ability to explain how using multiple methods can enhance understanding of the brain.

Course and level recommendations
Undergraduate: Introductory though advanced levels

Characteristics for success
The exercise is most engaging (but also more time consuming) if—before seeing the video (or before reading Raichle, 1996, if applicable)—students make predictions about what parts of the brain will be active in each condition, based on the “old school”, lesion-based, Wernicke-Geschwind Model of language function. Finding that they were wrong—sort of—sets the stage for the various discussion points. Different discussion points may be selected as appropriate for the course. For more advanced courses, more discussion points and more extensive discussion of each may be appropriate.

Lesson Preparation: 15-30 minutes
2. Prepare information (e.g., slides) on the Wernicke-Geschwind Model of language function.

Lesson Background
Note: This activity was presented as a poster at the annual meeting of the Society for Neuroscience: Sable, J. J. (2002). Using brain imaging of language processing as a hands-on example of hypothesis testing in neuroscience. [Program No. 22.59]. 2002 Neuroscience Meeting Planner. Orlando, FL: Society for Neuroscience. Online. Prior research has suggested that topics in biological psychology are among the most challenging for many introductory psychology students. Enhancing engagement and motivation for this area may facilitate increased student success in this important area of psychology (Peck, Ali, Levine, & Matchock, 2006).
Previous research further suggests that lessons incorporating primary literature and encouraging students to consider contradictory data and revised hypotheses emphasize the research process and help to dispel student misperceptions. This approach to teaching demonstrates the changing nature of scientific understanding and the value of the scientific process (Hoskins, 2008).

The functional neuroanatomy of language is a topic that is covered, at least at a basic level (e.g., Broca’s and Wernicke’s areas, typically in the left hemisphere), in many psychology and neuroscience textbooks. By taking into consideration its historical context, however, this topic can be used to illustrate many different concepts in both cognitive neuroscience and cognitive psychology. It also provides a useful demonstration of the progressive nature of scientific research.

The activity is based on research described in Raichle (1996). This provides excellent background for the instructor, and it may be appropriate reading for students.

**Detailed Explanation of Lesson**

**Procedure**

1. The instructor will describe lesion studies indicating the functions of Wernicke’s area (language comprehension) and Broca’s area (language production) and how damage to these areas produces specific aphasias.

2. Based on the findings of lesions studies (i.e., the Wernicke-Geschwind Model of language), ask students to make predictions about the results of brain imaging studies of language. Specifically, what parts of the brain will be active in each of the following conditions:
   a. See a blank screen
   b. See words
   c. Read words out loud
   d. Generate nouns based on words seen

   Students should predict:
   a. Visual cortex
   b. Visual cortex + Wernicke’s area
   c. Visual cortex + Wernicke’s area + Broca’s area + facial area of primary motor cortex
   d. Visual cortex + Wernicke’s area + Broca’s area + facial area of primary motor cortex + ?? (maybe additional prefrontal activity)

3. Show the video (6 1/2 minutes), “Language Processing in the Brain”, which depicts the early use of positron emission tomography (PET) to study cognitive
function in the human brain. Collection of PET data during the four conditions described above is shown in the video, followed by the results.

4. After the video, review the results with the students:
   a. Seeing a blank screen activated the visual cortex.
   b. Seeing words activated additional areas of visual cortex, but NOT Wernicke’s area.
   c. Reading the words aloud activated the above areas (a and b), as well as facial areas of the motor cortex—BUT NEITHER WERNICKE’S AREA NOR BROCA’S AREA!
   d. Generating nouns based on the words seen activated the above areas (a-c), as well as Wernicke’s and Broca’s areas.

5. Facilitate a student discussion about these findings and how they compare to their predictions.

Potential Discussion Points

- Raichle (1996) points out that viewing and repeating words (conditions b and c) also activated the insular cortex (in the Sylvian fissure) in both hemispheres, but this activity was absent when generating verbs (condition d). He goes on to explain that, if participants repeatedly performed the verb generation task with the same set of words, activity decreased in Broca’s area and shifted to the insular cortex, suggesting that Broca’s area was essential for more effortful language production. As a language task became more automated, however, it required less from Broca’s area. It may be useful for students at this point to reiterate a general pattern in the brain, in which the outer cortex is very active during effortful tasks (e.g., learning to drive a car). As these tasks become more automated, the associated brain activity shifts from the outer cortex to deeper structures (e.g., basal ganglia for motor programs, striatum for habits).

- This exercise can be used to illustrate the assumption of additivity and how it is used in cognitive psychology and cognitive neuroscience: Brain activity in one condition (e.g., eyes open rest) is subtracted from brain activity during a different condition (e.g., viewing words).

- This exercise provides some history of hemodynamic neuroimaging and its application to cognitive psychology. It can also provide a background for a discussion of the evolution of hemodynamic neuroimaging methods and comparing and contrasting different techniques (e.g., PET vs. fMRI).

- As is briefly mentioned in the video, and as Raichle (1996) explains in more detail, these early neuroimaging studies of language confirmed the role of the cerebellum in human cognition—a role often overlooked in basic neuroscience courses.
• This exercise provides an engaging example of the scientific process: Starting with previous research and existing theory (i.e., the Wernicke-Geschwind Model), using that information to make specific predictions (hypotheses) about the outcome of your study, collecting data and producing results, and comparing your findings to previous research and existing theory—supporting and/or modifying it. A scientific journal article reflects these steps.

• As Raichle (1996) states near the end of the article: “By combining studies of normal functional anatomy with studies of patients with lesions, we shall certainly enrich our understanding of human brain function more rapidly than when either approach is used in isolation” (p. 13). This exercise illustrates the practical value of such practices as the use of converging methods, being thorough in literature reviews, and interdisciplinary efforts.

Resources

http://www.learner.org/vod/vod_window.html?pid=1615

This 6 1/2 minute video is the core of the exercise. Early use of positron emission tomography (PET) to study cognitive function in the human brain is depicted. Collection of PET data during the four conditions described above is shown in the video, followed by the results.


This article provides a brief (but thorough) overview of research related to that shown in the video, including theoretical background and subsequent research.
3. Get Out of My Face! Amygdala Activation During Personal Space Violation

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This activity provides a quick demonstration of emotional reactions during personal space violations, illustrating the role of the amygdala.

Lesson Abstract
This lesson presents a real world demonstration of the influence of the amygdala on our sense of personal space. The lesson involves pairing students up to explore their individual space boundaries to demonstrate the variety of personal “bubbles” had by each person.

APA Guidelines
This lesson meets the following APA Guidelines for the Undergraduate Psychology Major:
• 1.1 Describe key concepts, principles, and overarching themes in psychology
• 1.2 Develop a working knowledge of psychology’s content domains
• 1.3 Describe applications of psychology
• 2.1 Use scientific reasoning to interpret psychological phenomena
• 2.3 Engage in innovative and integrative thinking and problem solving

Learning Objectives
After completing this activity, the student will be able to:
1. Explain the role of the amygdala in our sense of personal space and why we feel agitated when our personal space is violated

Assessment recommendations
Learning Objective 1: Discussion, written assignments or test items can be used to assess students’ ability to explain the role of the amygdala in emotional response to personal space violations.

Course and level recommendations
Undergraduate: All levels  
Behavioral Neuroscience, Physiological Psychology
Characteristics for success
This activity works best in a smaller classroom setting (no more than 30 students) if all students participate. However, it can be tailored to a larger group by asking for volunteers to demonstrate.

Lesson Preparation: 10 minutes
1. Obtain tape measures that can be lain upon the floor to demonstrate the size of individual student’s "bubbles". Printable tape measures can be found online to a cheap and easy remedy.
2. Obtain the Kennedy et al. (2009) article (see Reference section below).

Lesson Background
This demonstration fits nicely after discussing the role of the amygdala in emotional reaction. It can serve as a segue into the role of the amygdala in aggression as many aggressive responses are often related to fear responses.

This activity provides a real world application of the amygdala related to something we are all very familiar with - our personal space. After participating in an activity, students are introduced to a case study of an individual with amygdala damage resulting in dramatic changes to their comfort with personal space (Kennedy et al., 2009).

Detailed Explanation of Lesson
Before the activity, the students should be introduced to the role of the amygdala in emotion. After thorough discussion of the amygdala’s role in species typical reactions, introduce the activity.

Ask students to stand and create pairs of students. Create pairings that are not very familiar with each other. Then ask the students to stand a “comfortable distance apart” as if they were about to engage in a conversation. Once they have settled in their spot, set a measuring tape between each group to determine the distance. Usually there are groups that are closer and groups that are very far apart. Ask the students to initiate a conversation using a prompt such as “What did you do over summer break?”

After students finish their conversations, discuss why certain groups are standing closer than others. Most students share information about their personal space “bubbles” and how some are more open with their “bubbles” than others.

Next, ask each student to take a step toward their partner. Once settled, provide a new conversation prompt. The levels of discomfort grow as they talk and the students are less likely to engage in a full discussion. After the discussion trails off, ask if this conversation was more difficult.
Finally, ask the students to take another step toward their partner (often students will now try to take the smallest step possible) and discuss another conversation prompt. (After this point, I typically allow them off the hook!)

Finally, allow students to sit down and ask them to discuss why our personal space is defined as it is. (I usually investigate with more depth the students that claim the least discomfort and the most discomfort, trying to ascertain why their respective bubbles are the size that they are.)

After the students sit down, introduce the story of a patient who has bilateral lesions of the amygdala who no longer has a sense of personal space. She can stand “nose-to-nose with direct eye contact” with no discomfort (Kennedy, Gläscher, Tyszka, & Adolphs, 2009). Ask students to explain, in writing, why it makes sense that the amygdala governs our sense of personal space. This activity provides a real world application of the amygdala related to something we are all very familiar with - our personal space.

Reference
4. The Brain Game and Neuroanatomy Notes

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The combination of the neuroanatomy notes to reinforce reading of the chapter plus the active problem-solving of the in-class game has been an engaging, fun and learning-enhancing activity.

Note: This activity is of uncertain origin. I have been using it for at least 20 years and have gathered "cases" from a variety of sources, including a variation of an activity that can also be found in Moulton, P., Barnett, S., Cecchini, V., Hansen, C. & Deka, T. (2002). Instructor’s Resource Guide for Plotnik’s Introduction to Psychology (6e). Pacific Grove, CA: Wadsworth.

Lesson Abstract
Students complete a neuroanatomy notes assignment based on assigned reading and web resources, then use these notes to compete (either in groups or as individuals) for points in a "Brain Game" by correctly identifying the likely nervous system damage based on case symptoms or the likely behavioral symptoms based on a particular site of nervous system damage. If desired, students can also earn points by locating the related brain components on large unlabeled brain diagrams.

APA Guidelines
This lesson meets the following APA Guidelines for the Undergraduate Psychology Major:
• 1.2 Develop a working knowledge of psychology's content domains
• 1.3 Describe applications of psychology
• 2.1 Use scientific reasoning to interpret psychological phenomena
• 2.2 Demonstrate psychology information literacy
• 2.3 Engage in innovative and integrative thinking and problem solving
• 4.3 Interact effectively with others
• 5.2 Exhibit self-efficacy and self-regulation
• 5.4 Enhance teamwork capacity

Learning Objectives
After completing this activity, the student will be able to:
1. Provide multiple examples of the relationship between the normal functions of a part of the nervous system and the dysfunction likely if that region is damaged or altered.
2. Explain some of the practical applications of understanding the basic anatomy and function of the nervous system.
3. Demonstrate skills such as participation in groups and effective reading for understanding.
4. Demonstrate knowledge of the basic physical anatomy of the brain.

Assessment recommendations
Learning Objective 1: Assessment of this learning objective can be determined by completion of the neuroanatomy notes assignment.

Learning Objective 2: Assessment of this learning objective can be determined by students’ ability to identify the most likely location of nervous system damage when given patient symptoms resembles (somewhat) the clinical diagnoses neurologists might do, even before getting neural imaging results. Recognizing the changes in functioning that might result from specific areas of damage allows students to better understand functional deficits they might encounter in those with neurological problems as well as the occupational, physical, and/or communication therapies that might then follow.

Learning Objective 3: Earning points during the game requires that team members exchange information from their notes, discuss possible responses, and defend various options, and decide which answer the team will put forth.

Learning Objective 4: Completion of the neuroanatomy notes assignment.

Course and level recommendations
Undergraduate: All levels
Introductory Psychology, Biological Psychology

Characteristics for success
This activity will generate participation in the most passive of classes. It can be done as a group activity as described here, but in a large introductory psychology class of 150 students with fixed seating I have students compete individually rather than in groups.

Lesson Preparation: 10 minutes
1. Review the anatomy chapter and websites you assign to make sure the content fits the cases you include in your game and the terms you include in the neuroanatomy notes assignment since texts vary in their anatomy coverage.
2. Decide how you will form teams. I form teams of convenience (2-4 students sitting close together), but some instructors prefer other methods. Distribute an index card to each team to list their team members and team number.
3. List the team numbers on the board for keeping score.
4. I use PowerPoint to present the Brain Game cases and would be happy to share my PowerPoint file. PowerPoint files can be obtained by emailing the author at: walsh@uni.edu
Lesson Background
In my experience, using lecture to give a “guided tour” of nervous system anatomy was never very successful. Student attention would wane, eyes would glaze over, and little of the tour would be recalled. I decided to make the students responsible for taking the tour on their own (by reading the anatomy chapter and related websites), actively recording, in a neuroanatomy notes assignment, where each structure is located, what functions it is related to, and what might happen if the structure were damaged. I also encouraged drawing little anatomy diagrams as memory aids and reminded the class that the more complete the assignment, the greater the likelihood of earning extra credit points during the Brain Game (not to mention points on later exams!). This assignment encouraged timely completion of the reading assignment, active engagement with the material, and resulted in a product that was also a useful study aid. While students may not love the assignment, they do seem to enjoy the later competitive game and remember it long after the semester ends.

Detailed Explanation of Lesson
First, assign the Neuroanatomy Notes, due at the beginning of the Brain Game class period, to encourage students to read and take notes on the required neuroanatomy. Check for completed notes at the start of class if you care to create a "No-notes" team. The teacher should be comfortable with the functional neuroanatomy of the questions selected and might consider possible follow-up questions for at least some of the cases. For teachers who also would like students to have some familiarity with the most basic components of brain diagrams, additional preparation might include enlarging unlabeled diagrams of a lateral view of the brain and a mid- sagittal section of the brain. After emphasizing some of the "landmarks" or "dividing lines" in the diagrams with marker (to make it a bit easier on my students), I went to a copy shop and enlarged them to poster board size, mounted them to posters and then laminated each poster to protect them. I use tiny sticky "post-its" tabs to make anatomy labels to match the correct answers for the first ten "cases" in my brain game PowerPoint. The first ten cases relate to major cortical regions, lobes or major divisions of the brainstem visible in my poster diagrams. During the first round of the game, when a team answers their question correctly I offer an additional point if they can use a post-it to label that brain area on one of the posters. During each round each team, in turn, gets the chance to answer a question.

References
Additional Material

Brain Game Student Directions

Read class notes and the anatomy modules of the text as well as the following websites providing information on the functions of different regions: Explore the NS (click on Divisions of the Nervous System, Functional Divisions of the Cortex, Right Down the Middle, and Split Brain Experiments), Lobes, and Areas of Cerebral Cortex

Complete the neuroanatomy notes handout noting the location and, whenever possible, the function of all the parts of the brain and nervous system listed on the handout. You might also want to make yourself some diagrams and include any additional brain regions we have already discussed in class. You’ll use your assignment to help your team earn points in the Brain Game.

Rules for the Brain Game

1. Bring your completed notes handout to class. No completed handout, no game points, no exceptions. Your handout will be very important to you and your group because you cannot use your textbook or the internet to answer questions. You may however supplement your handout with additional diagrams that you think may help you during the game.

2. We will divide into small groups. You will share notes and work together with others in your group to answer questions and win points.

3. During the game each group will use their knowledge of brain anatomy and the functions of different parts of the nervous system to either locate the region of brain involved in a particular case or "diagnose" what area of the brain is damaged on the basis of behavioral symptoms. I’ll give your group a set of symptoms – e.g. a person who has a brain tumor that causes blindness – and your group will identify which brain area may be involved.

4. Correct Answer: If your group answers correctly, your group receives a point. If your group answers incorrectly, you receive no point and the next group can steal the question as well as get their own new question.
Brain Game Notes

For each of the structures below, address the following items:

- **Where is the structure located?**
- **What function(s) is/are affected if the structure is damaged?**

<table>
<thead>
<tr>
<th>Structure</th>
<th>Function(s) Affected if Damaged</th>
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<tbody>
<tr>
<td>1. Central nervous system (CNS)</td>
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<td>2. Peripheral nervous system (PNS)</td>
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<td>3. Somatic nervous system</td>
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<tr>
<td>4. Autonomic nervous system</td>
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<tr>
<td>5. Sympathetic division</td>
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<td>6. Parasympathetic division</td>
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<td>7. Spinal cord</td>
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<td>8. Dorsal roots and ganglia</td>
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<tr>
<td>9. Ventral roots</td>
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<tr>
<td>10. Spinal cord white/gray matter</td>
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<td>11. Brainstem</td>
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<td>12. Hindbrain</td>
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<td>13. Medulla</td>
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<td>14. Pons</td>
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<td>15. Reticular formation</td>
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<td>16. Cerebellum</td>
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<td>17. Midbrain</td>
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<td>18. Tectum</td>
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<td>19. Superior colliculi</td>
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<td>20. Inferior colliculi</td>
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<td>21. Tegmentum</td>
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<td>22. Substantia nigra</td>
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<td>23. Periaqueductal gray</td>
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<td>24. Forebrain</td>
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<td>25. Diencephalon</td>
<td></td>
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<tr>
<td>26. Thalamus</td>
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<td>27. Sensory relay nuclei</td>
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<tr>
<td>28. Hypothalamus</td>
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<td>29. Pituitary gland</td>
<td></td>
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<tr>
<td>30. Basal ganglia (caudate, putamen, globus pallidus)</td>
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<tr>
<td>31. Limbic system</td>
<td></td>
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<td>32. Hippocampus</td>
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<td>33. Amygdala</td>
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<td>34. Basal forebrain</td>
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<tr>
<td>35. Nucleus basalis</td>
<td></td>
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<tr>
<td>36. Nucleus accumbens</td>
<td></td>
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<tr>
<td>37. Cerebral hemispheres</td>
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<td>38. Corpus callosum</td>
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<tr>
<td>39. Cerebral cortex</td>
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<td>40. Frontal lobe:</td>
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<tr>
<td>41. Primary motor cortex (precentral gyrus)</td>
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<td>42. Broca's area</td>
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<td>43. Prefrontal cortex</td>
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<td>44. Parietal lobe:</td>
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<td>45. Primary somatosensory cortex (postcentral gyrus)</td>
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<tr>
<td>46. Temporal lobe</td>
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<tr>
<td>47. Primary auditory cortex (superior temporal gyrus)</td>
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<tr>
<td>48. Wernicke's area</td>
<td></td>
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<tr>
<td>49. Occipital lobe</td>
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<tr>
<td>50. Primary visual cortex</td>
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<td>51. Ventricles</td>
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<td>52. Hydrocephalus</td>
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<td>53. Meninges</td>
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<td>54. Meningitis</td>
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<td>55. Encephalitis</td>
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</table>
Brain Game – Questions and Answers

1. Uncle Ed suffered a stroke that damaged a portion of his cortex. He shows some weakness and partial paralysis of his right leg. What area of his cortex was affected by the stroke?
   **The Precentral Gyrus or Primary Motor Area.** Ed’s stroke must have deprived the blood flow to the strip of primary motor cortex.

2. John was having surgery to remove a brain tumor. Before removing the tumor the surgeon used electrical stimulation to test the function of regions of John’s cortex. When one region of his cortex was stimulated John perceived flashes of light. What region was being stimulated?
   **Visual Cortex of the Occipital Lobe**

3. A person is accidentally shown in the head behind the ear. The bullet enters the brain. Breathing and heart beat stop almost immediately. Where is the bullet?
   **The Medulla.** The medulla oblongata contains life-sustaining reflex centers for breathing, heart rate and blood pressure regulation.

4. A child was extremely short for his age. His doctors concluded the brain was not stimulating the proper release of pituitary hormones necessary for growth. What area of brain are they probably focusing on?
   **The hypothalamus.** Insufficient growth hormone is being released.

5. On Justin’s 21st birthday he and his buddies celebrated a bit too much. When the police stopped his car, Justin’s speech was slurred; he couldn’t walk a straight line or balance on foot. He had lost his ability to precisely control movement (he nearly missed his face altogether when asked to touch his nose with eyes closed). The impaired functioning of what part of Justin's brain is responsible for these difficulties with motor coordination and balance?
   **The Cerebellum.** The cerebellum functions like a motor computer taking care of the underlying details of our movements (coordination, timing, targeting, balance).

6. Leon’s car was broadsided by a truck, causing him to his head against the windshield. Although his ear was undamaged, bruising of his cortex impaired his hearing. What region was damaged?
   **Temporal Lobe Auditory Cortex.** The part of the cortex devoted to making sense of was we hear is in the temporal lobe.

7. All his life Jose had been a good sleeper. Playing football this fall however he received an exceptionally hard blow to the back of his head and neck. Now he suffers insomnia regularly. Even sleeping pills don't seem to work. What part of the brain related to sleep may have been damaged?
**The Pons.** The pons contains key sleep areas of the brain.

8. Karen is blind and depends on Braille to read. A tragic head injury has made it much more difficult for her to distinguish the feel of the Braille symbols. What part of her brain was probably damaged?  
**Somatosensory Cortex.** Gives us conscious appreciation of body sensations.

9. Gwen's brain has a congenital anomaly (a difference in brain anatomy that she was born with) - it lacks the main connection between the right and left hemispheres. What was Gwen born without?  
**Corpus Callosum.** The corpus callosum is a large bundle of axons connecting the corresponding parts of the right and left hemisphere.

10. Brett was a superior student and had a full scholarship, but following a head injury he can no longer plan, organize or follow through with tasks. He no longer behaves appropriately in class and was eventually asked to leave school after several emotional outbursts. Where was his injury?  
**Prefrontal cortex (frontal lobe).** The front-most portion of the frontal lobe is involved in planning, judgment, developing strategies, and inhibiting incorrect or inappropriate responses.

11. Saturday night, Mark decided to dive from his second floor balcony into the pool below. He dove, struck his head on the bottom and broke his neck. Through the quick action of others he was rescued and survived. He is paralyzed and without sensation from his shoulders down. What was damaged?  
**The Spinal Cord.** The spinal cord carries messages from the brain to the body and from the body to the brain.

12. After falling through ice on a local pond Maya was trapped under the icy water for 10 minutes before rescuers got her out. They were able to resuscitate her pulse and breathing but she did not regain consciousness for days. Disturbance of what specific part of Maya's brain might have resulted in an inability of the brain to regulate normal alertness?  
**The reticular formation (or “ascending reticular activating system”) of the brainstem.**

13. Paul suffered a case of encephalitis (a brain infection) while in college & the infection damaged parts of his brain. He has been unable to store new long-term memories since his illness. What part of the brain did the encephalitis damage?  
**Hippocampus.** Part of the limbic system called the hippocampus seems essential for our ability to store memories in their permanent, long-term form.
14. Tom was moving furniture when he felt something “go” in his lower back. Suddenly his right leg seemed much weaker and he was unable to climb the stairs. His doctor said he had a herniated spinal disk that was pressing on the part of a spinal nerve root carrying efferent messages out to the muscles of his leg. This particular root of a spinal nerve would be called: **A Ventral Root.** Motor commands leaving the cord to go to body muscles exit the cord via the ventral roots.

15. Stephanie has a brain tumor. The primary changes in her behavior are a decrease in her primitive auditory reflexes (she doesn’t react when a car’s horn startles her) and a decrease in her primitive visual reflexes (her eyes move more slowly to new visual stimuli). Where is her tumor probably located? **The Midbrain.** The midbrain contains reflex centers that automatically direct eye movements (superior colliculi) and as well as trigger orientation towards an auditory stimulus (inferior colliculi).

16. You’re in a parking lot at 2 AM when someone jumps out from behind a car and scares you. What system of nerves would arouse your body to action? **The Sympathetic Division.** The sympathetic division of the autonomic nervous system is in our “fight or flight” system, arousing the body for action when necessary.

17. After Jaime’s cerebrovascular accident (stroke) he had difficulty understanding what others were saying to him. He could speak but what he said made little sense. Where is Martin’s brain damage? **Wernicke’s area.** Located in the left temporal lobe; Critical to language comprehension.

18. Folksinger Woodie Guthrie suffered from a genetic disorder that caused deterioration of large portions of the basal ganglia. What aspect of his behavior is likely to have been impaired by this damage? **Movement.** The basal ganglia are part of the “extrapyramidal motor system” and, with other brain areas, help to control movement.

19. You’re taking a short cut through a back yard to get to your car and encounter two dogs that begin to chase you. You run faster than you have ever run before and dive into your car just in time. It takes ten minutes for your pulse and breathing to slow down to normal. What part of the nervous system slows heart rate and breathing down after a stressful experience? **The Parasympathetic Division.** The parasympathetic half of the autonomic nervous system takes care of normal body maintenance functions including slow normal breathing & heart rate.

20. Since suffering brain damage, Dr. House’s new patient speaks with great difficulty, only getting out a word or two at a time. Where is the damage likely to be located? **Broca’s Area in the Frontal Lobe of the Left Hemisphere**
21. Scot is required to take a polygraph test (“lie detector test”) as part of a job application process. The electrodes of the polygraph are recording bodily responses (like increases and decreases in breathing, heart rate, and blood pressure). These responses are regulated by the nerves of the ____________

**Autonomic Nervous System**

22. Jacqueline has a high fever, stiff neck, and a terrible headache. Bright light only makes her feel worse. Her doctor said she has an infection of the protective coverings of the brain known as the ____________.  

**Meninges.** Jacqueline has meningitis.

23. Michael J. Fox suffers from Parkinson’s disease. This disease involves the loss of cells located in the ____________.

**Substantia Nigra of the Midbrain**

24. Lisette suffers intractable pain from nerve damage due to diabetes. After trying every medication and physical treatment available for pain relief, she finally decides to have surgery cutting the nerve rootlets that carry sensory input into her spinal cord. Incoming (afferent) sensory messages enter the cord via the ________.

**Dorsal roots**

25. Your grandmother is beginning to show symptoms of Alzheimer’s Disease. Her doctor explains that a group of neurons which usually send activating acetylcholine messages to the entire cortex are becoming damaged. The area that is deteriorating is known as:  

**The Basal Forebrain.** Specifically the nucleus basalis or basal nucleus

26. Jeanette suffers from focal epilepsy (seizures localized in one part of brain). Her seizures are triggered by extreme emotions. What part of the brain is being affected?  

**The Limbic System.** The limbic system structures, hidden under the cortex of our right and left hemispheres, are best known for their control of emotion. Parts of this system also play a role in memory. One part of the limbic system - the **amygdala** - seems particularly important for emotional reactions and memories.

27. Jan suffered a concussion in a car accident. Since that day she has noticed a dramatic decrease in her sexual libido, a lack of appetite and an absence of thirst. She never thinks of having a drink until her lips actually dry and crack. What part of her brain might have been affected by the car accident?  

**The Hypothalamus.** The hypothalamus is critical for basic behaviors/motivations like hunger, thirst, and sex.
28. Since your grandfather’s stroke he no longer pays attention to the left side of his world. He ignores people and objects on his left as well as the left side of his body. He doesn’t comb the left half of his hair, shave the left side of his face, or put his left arm in the sleeve of his shirt until the nurse’s did it for him. This is probably due to damage to the__________

Right parietal lobe

30. Marcia has suffered from back pain for years. She gets no relief from commonly used pain reduction techniques. She finally decides to try an experimental treatment - implantation of a stimulating electrode into the part of the brain related to analgesia/pain suppression known as the:

Periaqueductal gray
Section 2: The Neuron

5. The Quad Is A Neuron: An Outdoor Demonstration of PSP Properties

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First, this activity gets students up and active. Next, it encourages students to imagine themselves inside a functioning neuron and to be a part of it. It relates what may seem like confusing concepts to intuitive concepts with which they are already familiar (e.g., sound volume degrades with distance). Finally, using the physical characteristics of a location familiar to them may enhance rehearsal and retention of information about post-synaptic potentials.

Lesson Abstract
To understand intracellular communication, it is important to understand the basic characteristics of post-synaptic potentials (PSPs). This simple activity uses student shouts of “yes” and “no” to demonstrate some of these characteristics, including summation at the axon hillock (a role played by the instructor). It uses the layout of a physical space (such as the campus quad) to give students an engaging, inside-a-neuron perspective of PSP characteristics, such their graded nature, their spatial and temporal summation, and how the location (i.e., source) of a PSP is critical to its influence on the neuron’s behavior. The activity reinforces text and lecture material on PSPs and can be used as a foundation for learning about action potentials.

APA Guidelines
This lesson meets the following APA Guidelines for the Undergraduate Psychology Major:

• 1.1 Describe key concepts, principles, and overarching themes in psychology
• 1.2 Develop a working knowledge of psychology’s content domains

Learning Objectives
After completing this activity, the student will be able to:
1. Articulate the characteristics of post-synaptic potentials.

Assessment recommendations
Learning Objective 1: The learning objective for this activity can be assessed using various types of exam questions, including multiple choice or true/false, or more open-
ended items. The learning objective may also be assessed by asking students to verbally explain characteristics of post-synaptic potentials to the instructor or to each other.

**Course and level recommendations**
Undergraduate: Introductory levels
Neuroscience, Biopsychology, Physiological Psychology, Cognitive Neuroscience

**Characteristics for success**
The activity would work with most classes, although it may require modification for very large classes.

**Lesson Preparation: 0-5 minutes**
1. Determine a location for the activity (outdoor area or other large open space, ideally with a neuron-like shape—see Figure 1).
2. Become familiar with the activity and decide where the axon hillock will be.

**Lesson Background**
A recent meta-analysis revealed that active learning increases student learning and performance across a variety of scientific disciplines. The authors of the meta-analysis concluded that using active learning approaches results in improved course performance, reduced failure rates and enhanced student retention, making active learning approaches a valuable addition to science courses (Freeman et al., 2014).

At least in my experience, the subtleties of neuronal electrophysiology are often both difficult and boring topics for students—especially psychology students (who may resent the idea that the brain has anything to do with psychology). In this exercise, each student takes on the role of an excitatory or inhibitory PSP, actively trying to influence the instructor’s decision whether or not to initiate an action potential.

**Detailed Explanation of Lesson**

**Preparation**
A schematic of a sample location for the activity is shown in Figure 1. On our campus, this is a small quadrangle, surrounded on all four sides by buildings. The gray area represents sidewalk. In the middle is a raised, circular area that is surrounded by a low wall (for this exercise, this is a convenient representation of the neuron’s nucleus). The face represents the instructor. No other materials are needed.

In general, this activity works well after presenting the basics of PSPs in class. I begin the next class period with this exercise, so I have students meet at this location at the beginning of class. The exercise reinforces and builds on the basic concepts of neural communication.
**Procedure**
Assemble the class near the middle of the outdoor area. Tell them they are standing inside the cell body of a large neuron. Several processes extend from the cell body in various directions: Most of these are dendrites. Select one process and stand at the point where it branches from the cell body (e.g., the face in Figure 1—which is at the foot of the steps of a building on our campus). This process is the neuron’s axon and the instructor represents the axon hillock. As such, the instructor integrates PSPs from throughout the neuron and, if the summation meets or exceeds a certain excitatory threshold, an action potential is initiated in the axon.

Each student is an ionotropic receptor. When activated, some students produce excitatory PSPs (EPSPs) by shouting “yes”. Other students produce inhibitory PSPs (IPSPs) by shouting “no”. Each student should decide in advance (or be assigned) which PSP she or he will be. Students should then disperse throughout the cell body and the dendrites. Make sure there is at least one student close to the instructor (preferably an IPSP) and that some students are some distance down the dendrites. Once students are in their places, instruct them to start communicating (i.e., shouting “yes” or “no” according to their chosen or assigned identity), and to continue to communicate for at least 30 seconds. Additional coaching may be necessary to most effectively demonstrate particular concepts.

**Discussion Points**
- All PSPs degrade with distance (i.e., they are graded potentials). The spatial degradation of PSPs is demonstrated by the decrease in the volume of the shouts with distance. It is more difficult for the instructor to hear student shouts if they are farther away. This is analogous to the greater degradation of PSPs that are farther away from the axon hillock. Emphasize how great this effect would be for a single PSP far down a dendrite.

- PSPs generated closer to the axon hillock have a greater impact on the likelihood of an action potential being initiated. Because the PSPs degrade with distance, location of the receptor is important. The instructor will hear closer students more clearly, having a greater effect on her or his “decision”. Likewise, closer PSPs are more influential in action potential generation. A single receptor adjacent to the axon hillock may override many receptors at greater distances. This means that the input from a single well-placed neuron may be much more “persuasive” than many placed farther away.

- PSPs from multiple receptors may spatially summate. If several students shout “yes” or “no” at the same time, this will make them much more noticeable than if they yell at separate times. This is analogous to multiple receptors producing PSPs at the same time—they will summate from their individual locations and have a relatively great impact on the likelihood of an action potential being generated.
• Multiple PSPs from one or more receptors may temporally summate. If one student shouts “yesyesyesyesyes” or “nononononono”, it is more likely to get the instructor’s attention than if the shouts are more spread out in time. Similarly, if a receptor produces multiple PSPs in rapid succession, it will have more of an influence on the likelihood of an action potential being generated. Note that spatial and temporal summation may work together, with multiple receptors producing the same PSP in rapid succession.

Review
• PSPs degrade with distance, so their location relative to the axon hillock is critical to their influence on the neuron. Different patterns of PSPs may spatially and temporally summate to create a stronger influence on whether or not an action potential is initiated at the axon hillock. Axo-somatic synapses have a greater influence than axo-dendritic synapses. Axo-axonal synapses can be even more influential, essentially slamming on the brakes at the last minute (after an action potential has already been generated).

• These concepts can be extended to action potentials: An action potential is continuously regenerated along the axon. This slows the rate of transmission, but it also maintains the full strength of the potential. Myelination speeds the transmission of the action potential by providing areas where the potential “jumps” greater distances between ion channels (i.e., the distance that is wrapped in myelin). If the myelin breaks down, however, the action potential may not make the “jump”, and the potential may degrade to the point that it does not complete its journey down the axon. This happens, for example, in the case of multiple sclerosis.

Finally, it is worth mentioning that all the neural work that is reflected in the activity ultimately may result in a single PSP at the next neuron!
References
6. Night Club and Bouncer Analogy for Teaching About Ionic Movements

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This analogy presents the ionic movements involved in resting membrane potentials and action potentials to a lay audience. It allows students with minimal biological background to gain an understanding of how ions move across a semi-permeable membrane.

Lesson Abstract  
This lesson is an alternative method to explaining ionic movements involved in the resting membrane potential and action potentials. Students are often confused by terminology related to this phenomenon and repeated classes have benefited from the lecture being presented in terms of attendance to a nightclub. Students are exposed to "motivations" of ions in terms that are more familiar and easier to remember, making the lesson a more understandable one overall. Students often report that the Night Club Lecture is one of the more memorable of the first few weeks of class.

APA Guidelines  
This lesson meets the following APA Guidelines for the Undergraduate Psychology Major:  
• 1.1 Describe key concepts, principles, and overarching themes in psychology  
• 1.3 Describe applications of psychology  
• 2.2 Demonstrate psychology information literacy  
• 2.3 Engage in innovative and integrative thinking and problem solving

Learning Objectives  
After completing this activity, the student will be able to:  
1. Describe how ions move to create the resting membrane potential and action potentials.

Assessment recommendations  
Learning Objective 1: Students can be asked to write a response paper after the lesson to indicate that they understand the analogy and, in related terms, movement of ions. They can also be asked to replicate the movement of ions by coming to the board and indicating directions of ionic movement and verbally stating the rationale behind such movements.
Course and level recommendations
Undergraduate: Advanced levels
Behavioral Neuroscience, Psychobiology, Physiological Psychology

Characteristics for success
Given the complexity of the discussion, it is suited to smaller classes, but the analogy can be used with larger classes as well.

Lesson Preparation: 0 minutes
1. No specific preparation needed.

Lesson Background
Students often struggle with the biological concepts related to ionic movements and how these movements create the resting membrane potential and later facilitate the action potential. By using layman’s terms and providing an analogy for how these ions move, students are better able to grasp the ideas.

Detailed Explanation of Lesson

Teaching Resting Membrane Potential
The lesson begins with an instructor’s brief explanation of ionic movement. First, introduce students to the pertinent ions of sodium, potassium, and chloride. Next, indicate where each ion is found in greatest concentration during the resting membrane potential. Finally, explain the ideas of diffusion and electrostatic pressure.

Diffusion
Diffusion can be equated to how students space themselves out in the classroom setting. Students typically cite various reasons including liking to spread out their things over an entire table.

Electrostatic Pressure
With respect to electrostatic pressure, refer to magnet polarities and how opposites attract yet like charges repel. Introduce students to the idea that sodium ions are being pushed towards the inside of the cell due to both diffusion and electrostatic pressure. However, these ions are unable to enter the cell as they wish to because the cell membrane is not permeable for sodium ions at this juncture (no passive channels for sodium). At this point, the first mention of the nightclub occurs.

Introduce the concept of cell as nightclub using a metaphor:

“Imagine, if you would, that the cell itself is like a night club. Not just an average night club that anyone can enter, but instead an exclusive nightclub, complete with a list of prominent guests that would be allowed entry. Potassium and chloride are on the list. Chloride comes and goes as it pleases, often resulting in
relatively equal numbers both inside and outside of the club (i.e., no net movement of Cl\(^{-}\)). Potassium, also on the list, can also come and go as it pleases but the electrostatic charge results in more potassium inside the cell rather than outside. As a result, there are many potassium ions at the party. This situation suits the potassium ions wonderfully because there are so many sodium ions (also positively charged) outside of the cell that the atmosphere is simply “too positive” outside of the club. Potassium ions would rather stay in the negative environment.

Sodium, however, wants to dance and party! Sodium ions can’t wait to get in to the club. Several of them sneak in via passive channels designated for potassium and chloride but only a few sodium ions manage to get in this way due to their size. This phenomenon is the equivalent of sodium ions sneaking into the club via bathroom windows. Only a few will be able to do so because the windows are simply too small.

For those sodium ions that do manage to sneak into the club, the bouncers (i.e., sodium potassium pump) promptly find them and kick them out, allowing potassium ions to come back in to maintain the delicate potassium to sodium balance. This balance results in the -70mV resting membrane potential and the status quo of club attendees.”

At this point, do a knowledge check. Draw a cell on the board and ask students to indicate where to can find potassium, sodium, and chloride in greatest concentrations.

Ask students to define diffusion and indicate which way each ion will move based on diffusive pressures.

Ask students to define electrostatic pressure and indicate the directions of movement for each ion based on electrostatic pressure.

Finally, point out that sodium ions are being acted on by both diffusive and electrostatic pressure to move into the cell. Ask why there is so little sodium in the cell. Students will often yell out “The bouncers!” which can then be identified as sodium potassium pump, which allow two potassium ions in for every three sodium ions that are kicked out.

**Teaching Action Potential**

When discussing the action potential, return to the nightclub analogy:

“So what happens with these ions during an action potential? The internal voltage of the cells changes from a -70mV to a highly positive number. What is accounting for this drastic change? That’s right, it’s sodium! When stimulation occurs, doors open that are specifically for the sodium ions (i.e., voltage gated sodium channels). When those doors open, what will sodium ions, who so
desperately want to attend, do? Let me remind you that sodium is so desperate it will crawl through tiny windows to get inside. So what will sodium do? Those doors open and sodium ions are going to RUSH into the cell. As sodium comes flooding into the club, what are the potassium ions going to do?

The potassium ions’ party is being crashed by a major influx of sodium. Potassium is going to start leaving (via voltage-gated channels) because the atmosphere is becoming too positive, which is being driven by the sodium ion influx. The sodium ions are whooping and hollering and having a good time. Yet the party is short-lived. The doors allowing the sodium ions to enter are closed, so now we have a situation that our club is overrun with sodium ions but no more can enter. Who is going to step in and clean house? That’s right, the bouncers! The sodium-potassium pump starts redistributing the ions to the appropriate places, kicking out three sodium ions for every two potassium ions it lets back in.”

Assess student understanding with another knowledge check after this point. Ask students to predict the movement of potassium and sodium ions in the action potential scenario. Ask students to predict the movement of ions if the bouncers are busy with other tasks (i.e., sodium potassium pumps are inactivated) or what would happen if the sodium doors are locked (i.e., sodium channels are blocked, as with some local anesthetics).

The nightclub analogy sticks with students and they are often able to work through questions about diffusive and electrostatic pressures the next class period because the material has become more salient rather than a boring lecture on ions.

References
7. Addressing A Misconception: A Model To Teach Synaptic Transmission

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The demonstration provides a simple but accurate model of synaptic transmission using an unconventional and whimsical apparatus. The demonstration can provide a basic overview of neurotransmission fundamentals or can easily be elaborated upon to facilitate understanding of more detailed and complex processes.

Lesson Abstract
Even students who excel in their introductory neurophysiology course may carry away crucial misconceptions. One such misconception concerns synaptic transmission. This demonstration is meant to introduce a highly accessible visual and dynamic model of the neurotransmission process. Instructors can use a Chinese checkers board or similarly arranged apparatus to demonstrate the physical process of neurotransmitter diffusion across the synapse as well as postsynaptic neurotransmitter reception. Beyond these fundamentals, instructors can adapt or elaborate upon the analogy to accommodate varying degrees of content depth. Some examples of this include demonstration of agonist, antagonist and SSRI function as well as postsynaptic summation.

APA Guidelines
This lesson meets the following APA Guidelines for the Undergraduate Psychology Major:

• 1.1 Describe key concepts, principles, and overarching themes in psychology
• 1.3 Describe applications of psychology
• 2.1 Use scientific reasoning to interpret psychological phenomena
• 2.3 Engage in innovative and integrative thinking and problem solving

Learning Objectives
After completing this activity, the student will be able to:

1. Accurately explain the process of neurotransmission.
2. Generalize an accurate understanding of neurotransmission to more complicated topics in neurophysiology such as neurophysiological complexity and the basics of psychopharmacology.

Assessment recommendations
Learning Objective 1: Accuracy of neurotransmission explanations can be assessed with written assignments or test items.
Learning Objective 2: Generalization can be assessed via written assignments, test items and student demonstrations.

Course and level recommendations
Undergraduate: All levels
Biological Psychology, Introductory Neurophysiology

Characteristics for success
The demonstration is effective in lecture sessions of all sizes given adequate visibility from all points within the room.

Lesson Preparation: 5-20 minutes
The demonstration requires no preparation other than access to a Chinese checkers board or similar board. Instructors could easily arrange a similar apparatus out of classroom/office supplies.

Lesson Background
Even those students who excel in their introductory neurophysiology course may carry away critical misconceptions (Guy, 2012). One important misconception concerns the synaptic transmission process (Montagna, Azevedo, Romano & Ranvaud, 2010). For example, it’s not uncommon for students to conceptualize the nervous system as an electrical circuit. While this analogy has its uses, it also has its limitations and fails to recognize the variable diffusion of neurotransmitters across the synaptic gap. The ability to accurately conceptualize this process is a critical step in fully understanding neurophysiology and could lead to the development of a more complete understanding of such concepts as protein-receptor lock and key mechanism, postsynaptic inhibitory or excitatory potentials and basic principles of neuropharmacology. This demonstration is meant to provide a basic visual model of the neurotransmission process and facilitate a general understanding of what occurs during synaptic transmission. By providing students with a simple visual framework onto which they can map more complicated concepts, an accurate and more complete understanding of synaptic transmission and neurophysiology in general, should follow.

Detailed Explanation of Lesson
Preparation
Instructors should plan for the demonstration to take anywhere from 5 to 20 minutes depending on level of detail addressed and student inquiry.

Although the full demonstration may be more effective, the following could also be verbally presented as an analogy and worked into a lecture. If this approach is taken, preparation is minimal and may only include addressing the possibility of unfamiliarity with Chinese checkers.
If the demonstration is presented in full, preparation includes access to a Chinese checkers board. Even without a specific board, the activity might be adapted various ways using available objects and supplies. Additionally, instructors should take a moment for a few “practice rounds” as different boards can react differently to falling marbles (i.e. you want only some marbles to settle on the board).

**Implementation**

For optimal efficacy it is important the demonstration follows the presentation of fundamental concepts. Instructors should first present topics in basic neuron anatomy and physiology. These include structure and function of the dendrites, soma, axon and presynaptic terminal. Students should also be familiar with the basic idea of action potential propagation as well as understand that neurons are cells that form networks and communicate via chemical exchange.

**Performing the Demonstration**

1. Present the Chinese checkers board on a surface that is visually accessible to the entire class. In a lecture hall, the demonstration could be conducted under a camera and projected on a screen.
2. Retrieve a handful of marbles and hold them in a closed hand just above the board.
3. Take a moment to describe the analogy:
   a. Explain that the board is some active surface on the post-synaptic neuron and that the depressions on the board are individual receptor sites.
   b. Identify your arm as the “axon” of the presynaptic neuron
   c. Explain that the marbles in your hand can be thought of as neurotransmitters and demonstrate how a given neurotransmitter “fits” into a depression on the board.
   d. Point out that you have various colors of marbles and explain how those colors represent different neurotransmitters, which can exert either an excitatory or inhibitory effect on the post-synaptic receptor.
4. Inform the class that an action potential is propagating down your arm (“the axon”) and that synaptic transmission is about to occur.
5. From just above the board, release the marbles. Some will settle in place and others will roll off the board.
6. While you use your other hand to slowly retrieve the marbles that did not settle onto the board, take another moment to further describe the analogy.
   a. Relate your hand to the presynaptic vesicles
   b. Explain how, in the nervous system, not all neurotransmitters find a postsynaptic receptor. Some remain in the synaptic gap.
   c. Relate your second hand (the one that is retrieving non-settled marbles) to the process of reuptake.
7. Remove the settled marbles, add a few more marbles from a nearby bag to those you’ve picked back up and repeat as necessary.
This is the basis of the demonstration. The analogy can be referred to throughout the course to clarify confusion or misconceptions. In addition, the analogy can be further elaborated upon and adapted to accommodate more in depth concepts.

**Additional Variations**

**Summation**

Put a few marbles in each of your hands (one color per hand) and explain that each hand represents a different pre-synaptic neuron. Explain that the activity of a given neuron depends on the excitatory or inhibitory input of many surrounding neurons and that some neurotransmitters will pair with their respective receptors to initiate excitatory impulses while other neurotransmitter/receptor couplings will initiate inhibitory effects. Set a threshold ratio of excitatory to inhibitory marble reception (*i.e.* for the neuron to fire there must be 2 (excitatory) blue marbles for every 1 (inhibitory) red marble). Allow the class to determine the functional “sum” of the synaptic transmission. Allow the class to determine if the postsynaptic neuron will fire.

**Selective Reuptake Inhibitors**

Return to the basic demonstration where one hand acts as the presynaptic terminal and the other acts as the reuptake mechanism, busy retrieving the non-settled marbles for reuse (neurotransmitters). Explain how you are a neuron in a patient with depression and how an increase in a neurotransmitter called serotonin can ease depression symptoms. Now introduce the class to the concept of “Selective Serotonin Reuptake Inhibitors” and competitive substrate inhibition (*i.e.* the reuptake mechanism binds to the SSRI protein instead of the neurotransmitter). Re-run the basic demonstration but instead of picking up marbles with your re-uptake hand grasp something desirable (*i.e.* coffee cup, snack, book, etc.). Explain how you’d much rather be using your hand to sip a coffee or read a book than to hold a bunch of marbles, so the marbles stay where they are and over time crowd the synapse, increasing the probability the serotonin will find its receptor in following transmissions.

**References**


**Additional Material**

**Figure 1**

A step-by-step depiction of the demonstration
Section 3: Reproductive Behavior and Neuroendocrinology

8. Cases at the Sexuality Clinic: Advising New Parents

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Attending a “Case Studies in Science” workshop inspired me to include some “mini-case” activities in my class. Atypical cases of sexual differentiation always seem to interest students. One note of caution: Students are sometimes so engaged that it’s impossible to make it through all groups’ cases in one class meeting.

Lesson Abstract
During this in-class activity, each small group of students analyzes one of five cases of atypical sexual differentiation. Based on case details concerning development of brain, genetics, gonads, sexual ducts, and genitalia, the groups identify the sexual development condition and make predictions about the future gender identity and behavior of the individual. The cases are factional and include examples of tests or measurements that may not be practical or feasible, but are included to provide students the opportunity to consider various aspects of the case. Groups prepare short written responses and present and defend their conclusions to the class. Although each team only works on a single case during the class activity, they hear presentations on all cases and review all cases for the next exam.

APA Guidelines
This lesson meets the following APA Guidelines for the Undergraduate Psychology Major:
• 1.1 Describe key concepts, principles, and overarching themes in psychology
• 1.2 Develop a working knowledge of psychology’s content domains
• 1.3 Describe applications of psychology
• 2.1 Use scientific reasoning to interpret psychological phenomena
• 3.2 Build and enhance interpersonal relationships
• 3.3 Adopt values that build community at local, national, and global levels
• 4.1 Demonstrate effective writing for different purposes
• 4.2 Exhibit effective presentation skills for different purposes
• 4.3 Interact effectively with others
Learning Objectives

After completing this activity, the student will be able to:

1. Describe several examples of how genes are involved in typical and atypical sexual differentiation.
2. Provide real life examples of how variations in the *in utero* hormone environment or ability to respond to that hormone environment result in atypical patterns of sexual differentiation that may impact later gender identity and gender related behaviors.
3. Identify multilevel factors influencing sexual differentiation and gender identity.
4. Describe the diversity of human sex development and gender identity.
5. Describe an example of how theories change in the face of new research evidence.

Assessment recommendations

Each group prepares both written responses to the questions about their case and an oral presentation of their conclusions and their reasoning. They also may defend their conclusions in response to questions from other groups. Assessment of these outcomes also comes from student responses on a test that includes this content.

**Learning Objective 1:** To assess this learning outcome, students identify the role of genetics in each of the cases through the group response worksheet or through follow up assessment activities.

**Learning Objective 2:** Students describe the in utero hormone environment and its impact on physical development in each case and make predictions about the likely effect on future behaviors and gender identity through the group response worksheet or through follow up assessment activities.

**Learning Objective 3:** Students explain which of multiple factors involved in the pattern of sexual development (genetic, hormonal, developmental stage, environmental) are key to understanding each case through the group response worksheet or through follow up assessment activities.

**Learning Objective 4:** Students describe factors beyond sex chromosome makeup that may lead to variations in the sexual development of body and brain and later behavior and gender identity through the group response worksheet or through follow up assessment activities.

**Learning Objective 5:** Students give examples of research findings supporting the role of nature (biology) rather than just nurture (upbringing) in the development of gender identity and human sexuality through the group response worksheet or through follow up assessment activities.
Course and level recommendations
Undergraduate: All levels
Biological Psychology, Psychology of Gender

Characteristics for success
A class with previous experience working in small groups

Lesson Preparation: 0-60 minutes
1. Assign and encourage reading of the sexual differentiation portions of your text so that students have some background for the activity.
2. Remind students to bring their textbooks to class on the day of the activity.
3. Prepare the case and group response handouts.
4. Collecting any additional references you choose to provide for students (optional)

Lesson Background
As a strong believer in the value of active learning, especially problem-based learning, and the role of student interaction in the learning process, I wanted to do something more than lecture about the biological basis of sexual behavior and gender identity. I also recognize the importance of changing things up in class to maintain attention and engagement. These mini-cases seemed to fill the bill.

Detailed Explanation of Lesson
This activity typically follows two or three class periods spent on the basics of the neuroendocrine system and the role of genetics and early hormone environment in sexual differentiation and development of gonads, ducts, genitals and brain. In preparation for this activity, the importance of completing the reading of the portions of the textbook addressing sexual differentiation (both typical and atypical) should be stressed and students are reminded to bring their texts to use as reference books during the activity.

Students are divided into small teams of two to four. Each team receives a group response sheet on which to record their names and their responses. This sheet also assigns each team a number (1 to 4 if you are using 4 different cases). Every student receives a handout describing the details of all 4 cases, but during the activity they only work on the particular case number that matches their group number.

Students work with their teams to answer the questions concerning their assigned case. The instructor should move around the class, answering questions, giving encouragement and sometimes a hint or bit of direction if necessary. Since we do several of these team-based activities during the semester, I encourage the teams to rotate the various tasks (who writes down their responses, who presents their answers to the class, who searches for information in the text, etc.) from activity to activity.
When most teams have completed their responses (usually 30-35 minutes into the class), the teams should start to present their cases. Since there may be multiple teams for each case, the teams can alternate in responding to the questions and also add to the responses of the other teams, or sometimes offer alternative responses. While the teams are responding, I usually display a PowerPoint slide listing the essential features of the case (e.g.: XY individual, testes, normal levels of testosterone, lacks enzyme 5-alpha-reductase etc.).

At the end of class teams turn in their group response sheets but keep their case handout so they can study and work on the other cases in preparation for the next exam.

References
Refer to Reproductive Behaviors chapter of biological psychology texts for content information.

Example online resources with additional detail on the atypical patterns of differentiation related to most of the these cases:

5-alpha-reductase deficiency: Two medical resources and one popular press article
http://emedicine.medscape.com/article/924291-overview

Androgen insensitivity syndrome: Two medical resources and one short description from the Intersex Society of North America (ISNA), a website that might be of general interest to students
http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(12)60071-3/fulltext
http://www.isna.org/faq/conditions/ais

Congenital Adrenal Hyperplasia: Two medical resources and another description from the ISNA website
http://www.aafp.org/afp/1999/0301/p1190.html
http://www.isna.org/faq/conditions/cah

SRY Gene Displacement: Three genetics/embryology websites providing information on the SRY gene and its loss from the Y or its addition to the X chromosome
http://embryo.asu.edu/pages/sex-determining-region-y-mammals
http://www.embryology.ch/anglais/ugenital/molec03.html
**Additional Material**

**Handout for Cases at the Sexuality Clinic: Advising New Parents**

**Instructions:** You and your group are responsible for the case that matches your group number. After introducing yourselves you should divide up the tasks at hand (rotate responsibilities if you have worked together before). Some members should be “researchers”, checking texts and class notes for information that might help in your analysis. Another member will serve as the recorder, writing down your group’s responses on your group response sheet. Another member will serve as your group’s main spokesperson when you present your conclusions to the class.

**Situation:**
You are working in a medical center of the future, counseling expectant parents and new parents. You are given the cases where there is some variation in sexual development of the child. Your job is share information with the parents about the sexual development of their child. This might involve predictions about the physical and likely psychological and behavioral development of their babies, based on the results of your genetic and hormonal tests. While not all of these tests currently exist, imagine that they can be conducted to provide you with the needed information.

**Group 1**
Baby Alex is two weeks old. A body MRI scan reveals an absence of Mullerian as well as Wolffian ducts/structures. Blood hormonal assays show high levels of androgens. Chromosome testing indicates an XY genotype with a mutation on the X chromosome in the region of the androgen-receptor gene.

1. What is the name of the condition shown by Baby Alex?
2. What kind of gonads does Alex have?
3. Will Alex menstruate and be able to become pregnant when mature?
4. Would you recommend any treatment or change in the way the parents raise Alex? If so, what would you recommend?

**Group 2**
The Martins' new baby Chris was born six days ago. The Martins have four older sons. They are meeting with you because Chris has an empty scrotum and somewhat smaller penis than their other children. A body MRI scan does not show any undescended testicles. It does reveal an enlarged adrenal gland and well-developed Mullerian ducts/structures as well as ovaries. Hormonal tests show abnormally low levels of an adrenal hormone called cortisol and high levels of androstendione.

1. What is the name of the condition shown by Chris?
2. What is Chris’s genetic sex?
3. What has caused Chris’s genitals to develop as they have?
4. What effect might this have on Chris’s behavior?
5. What information would you give to the parents concerning Chris’s development?
**Group 3**

Mrs. Santino just gave birth last night. You are asked to visit the Santinos during Mrs. Santino's hospital stay to talk to them about Baby Santino (they haven't picked a name yet). Here is the information available on the infant: Baby Santino has an XY genotype. Hormone assays reveal normal levels of testosterone, but an absence of dihydrotestosterone (DHT) due a genetically based deficiency of the enzyme (5-alpha-reductase) that produces DHT. A body MRI shows normal development of Wolffian ducts and undescended testes. Baby Santino has female external genitalia with a somewhat enlarged clitoris.

1. What is Baby Santino's biological sex at birth?
2. Does Baby Santino have female ducts?
3. What is the function of DHT?
4. Would you expect Baby Santino's brain to show a male- or female-typical pattern of development?

**Group 4**

Baby J went through typical prenatal sexual differentiation and development, but misfortune struck during the second week of the baby's life when a physician accidentally burned off the baby's penis during what should have been a routine circumcision. Acting on the recommendations of their physician, the parents agreed to reconstruction of the genital area to resemble female genitalia, removal of the testes, and then consistent rearing of the baby as a female.

1. Without any hormone supplements would Baby J be likely to have a cyclic or noncyclic hypothalamus?
2. With hormone supplements later in life, to what extend can Baby J be feminized and function as a female?
3. Can you offer a biopsychological explanation of why Baby J may not agree to or be able to assume a female gender identity?
4. After removal of the testes, why might Baby J show masculine tendencies?

**Group 5**

The McGuire's are older than average expectant parents (45 and 48). At their obstetrician's recommendation they went through early genetic testing to check for Down Syndrome (Trisomy 21) and a variety of other genetic disorders. They were relieved that there was no trisomy - the fetus had 23 pairs of chromosomes. They were happy to learn that the baby was a girl. Gene mapping revealed that there apparently had been crossover of the SRY from the father's Y chromosome to his X chromosome.

1. What will the baby's reproductive anatomy be like (gonads, ducts, genitalia)?
2. What is likely to be the baby's assigned sex at birth?
3. If the crossover is typical of all the father's Y-chromosomes, what would happen if he fathered an XY child (i.e. what would that child's reproductive anatomy be?)
Sample Group Response Worksheet

Introduce yourselves, then list all group members below, along with your group responses to your questions.

<table>
<thead>
<tr>
<th>Group Members:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group Responses:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>
9. The Testosterone Show

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Students seem to find this radio segment fascinating and it provokes good discussion and writing related to the biological basis of gender identity, gender differences and sexual orientation. I originally developed this assignment to create some assignments with an auditory rather than visual modality. An ulterior motive was to get my students to listen to a great National Public Radio program!

Lesson Abstract
Students find this assignment contains an engaging set of examples of biological (hormonal) influences on psychological functioning. Students are challenged to distinguish between early, organizational influences and later, activational effects of sex hormones. This assignment also promotes better understanding of gender differences, gender identity, stereotypes and misinformation concerning gender and sexual orientation. This three-part assignment requires the following outside-of-class preparation. In this lesson, students: a.) Carefully listen to a 45-minute radio segment, b.) respond thoughtfully in writing to a series of related questions, applying concepts from class and assigned reading, and then, and c.) come prepared to discuss and defend their conclusions during an in-class discussion.

APA Guidelines
This lesson meets the following APA Guidelines for the Undergraduate Psychology Major:
• 1.1 Describe key concepts, principles, and overarching themes in psychology
• 1.3 Describe applications of psychology
• 3.2 Build and enhance interpersonal relationships
• 4.1 Demonstrate effective writing for different purposes

Learning Objectives
After completing this activity, the student will be able to:
1. Distinguish early, "organizational", developmental influences on gender identity from later, adult, "activational" effects on behavior and mental processes.
2. Provide examples of how changes in biological functioning can have effects on behavior and mental processes.
3. Provide an example of how science-based understanding of biological influences on psychological functioning can lead to practical applications (e.g. hormone supplements to treat a deficiency).
4. Identify misconceptions or knowledge limitations (e.g. "sex hormones only influence sex and aggression" or "homosexual men have low hormone levels").
5. Reflect upon and critically evaluate examples of biological influences on behavior.

Assessment recommendations
Learning Objective 1: The written assignment in this lesson allows assessment of APA goals (1.1c & e, 1.2 d, 1.3a & d, 2.1c, 3.2 c, 3.3a, 4.1a, 4.3 a). The in-class discussion enhances presentation skills and recognition of different points of view.

Learning Objective 2: In the written assignment for this lesson, students list the changes in behavior, emotion and cognition that follow the loss of testosterone (case 1) or the addition of testosterone supplements (case 2).

Learning Objective 3: Case 1 specifically concerns a hormonal deficiency so naturally leads into a discussion of whether the deficiency could be reversed. Case 2 involves the effects of hormone supplements used during and after the transitioning of transgender individuals and might also be used to better understand the behavioral effects of more extreme doses in cases of hormone abuse (anabolic steroids).

Learning Objective 4: As the students list the changes that follow hormone loss or hormone supplementation in the included assignment, the students discuss diverse aspects of behavior and cognition, many nonssexual in nature.

Learning Objective 5: Students reflect on the response to changes in hormone levels. They also discuss whether any of the hormone-behavior correlations are different from what they expected. Class discussion should include the problems of single cases and what data would be necessary to know if these cases are representative. Discussion should also address the organizational versus activational effects of hormones and how adult hormones activate motivation rather than sexual orientation.

Course and level recommendations
Undergraduate: All levels
General Psychology, Biological Psychology

Characteristics for success
This assignment could stimulate discussion in almost any type of course. Because this assignment begins with an out-of-class experience, followed by in-class discussion, it may be appropriate for a flipped classroom. I originally developed this assignment when a student with a visual impairment enrolled in biopsychology, a course with primarily visually oriented assignments. This challenged me to re evaluate my approach to the course and I developed an assignment with an auditory rather than visual focus.

Lesson Preparation: 5-10 minutes
1. Students must be familiar with the organizational and activational effects of hormones and in utero sexual differentiation.
2. Check online links and make changes in assignment questions as desired. Prepare the out-of-class assignment ahead of time and be ready to facilitate discussion the next class period.

Lesson Background
Clinical cases related to sexuality always seem to engage students. When I first heard the *This American Life* segment, *Testosterone*, I immediately thought it would have great appeal to students, but knew it was too long to listen to in class. Having a visually impaired student enrolled in the course encouraged me to develop an assignment that students *listened* to rather than looked at.

Examining half-dozen different biological psychology texts revealed that all of them contained a chapter including sexual differentiation, organizational and activational effects of sex hormones, biological basis of sexual orientation and possible variations in the sexual differentiation process. This assignment allows students to work with the concepts of organizational and activational effects as well as reflect on what individuals might experience in response to hormone fluctuations.

Detailed Explanation of Lesson

Preparation
This is the final activity related to the sex chapter, and students have (presumably) already read the assigned chapter but are asked to re-read the sections concerning the difference between the organizational and the activational effects of hormones, as well as the section on biological influences on sexual orientation. I demonstrate the link to the audio segment in our online syllabus and promote the Testosterone show as one of the most interesting radio segments that they will ever listen to.

Implementation
The written assignment related to the audio segment is completed out on class. On the day that it is turned in we hold a class discussion on the segment and how students answered the questions. Depending on the general level of participation in a particular class, I sometimes use sticky notes to reinforce meaningful contributions to discussion, with each sticky earning a student a point. (I use sticky note rewards for daily review questions and other activities during the semester.)
Additional Material
Student Directions: Testosterone Show Assignment

1) Complete the assigned reading in our text’s chapter on the biological psychology of reproductive behaviors. Pay particular attention to the sections on the “Organizing Effects of Sex Hormones,” “Activating Effects of Sex Hormones,” and “Gender Identity and Gender-Differentiated Behaviors.”

2) Listen to Acts One, Two and Three of the Testosterone episode from the National Public Radio show This American Life at: http://www.thisamericanlife.org/radio-archives/episode/220/testosterone

3) Take notes to help you reply to the questions below. Interpret or explain these segments in terms of the biological mechanisms discussed in class and described in Reproductive Behaviors chapter.
# Questions to Students

## Case 1 – A Male Who Has Lost All Testosterone

How does this person’s **psychological functioning** appear to be influenced by the loss of testosterone? What things decrease? What things increase?

Is this change more likely to be related to the organizational or the activational effects of hormones? (Explain your answer.)

Although we would never draw conclusions from single cases, do you think the experienced changes in visual appreciation may reflect a basic difference in the way that high testosterone-stimulated versus low testosterone-stimulated individuals (*i.e.* males vs females) experience the world?

## Case 2 – A Female Who Sought a Sex Change and Received High Doses of Testosterone

How does this person’s **psychological and behavioral functioning** appear to be influenced by the high doses of testosterone? What things decrease? What things increase?

Is this change more likely to be related to the organizational or the activational effects of hormones? (Explain your answer.)
Are this person’s original gender dissatisfaction and their need to seek a sex change more likely to be related to the organizational or the activational effects of hormones? (Explain your answer.)

Do you think you would change cognitively, emotionally, and behaviorally if you went through a large change in testosterone levels (either up or down)?

Case 3 – Nine adults have their daily blood level of testosterone measured.
Within each gender, what are the characteristics of the individual(s) with the highest level? The lowest level?

Did high or low testosterone levels relate to behavior in the ways you expected? What was expected and what surprised you?
Section 4: Nervous System Phenomena

10. Freezer Neglect

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This is a fun activity that students, at first, think it is outrageous. It is such a strange thing to have them do and, often, their “targets” respond just as strangely. When it works, it drives home the concepts really well. A side benefit is the incorporation of ethical issues in research.

Lesson Abstract
This activity is an individual homework assignment designed to help students better understand the psychological underpinnings of Spatial Neglect. Students really struggle with wrapping their heads around why a person cannot just be reminded to "look left". In this mini-experiment, the goal is to recreate the psychological parameters involved in spatial neglect. Toward this goal, students attempt to induce "Freezer Neglect" in a friend or family member. They do this by repeatedly hiding the target's belongings in the freezer. The point of the exercise is to see how people respond to repeatedly losing their items and finding them in the freezer. Half of the time people end up refusing (almost belligerently) to look in the freezer even after repeated lost-found episodes suggesting that the best strategy would be to check the freezer. Students are required to think critically about their strategy, to consider ethical implications involved (they are hiding people's belongings!), record their observations, and debrief their targets. After students complete the assignment, we discuss the results in class. This is imperative, because only half of the students will have succeeded in inducing the Freezer Neglect syndrome. During the class discussion, we relate the target’s unwillingness to look in the freezer for their lost items with a Spatial Neglect patient’s intense reactions when forced to attend to the neglected side of space.

APA Guidelines
This lesson meets the following APA Guidelines for the Undergraduate Psychology Major:
- 1.1 Describe key concepts, principles, and overarching themes in psychology
- 1.2 Develop a working knowledge of psychology's content domains
- 2.1 Use scientific reasoning to interpret psychological phenomena
- 2.3 Engage in innovative and integrative thinking and problem solving
- 3.1 Apply ethical standards to evaluate psychological science and practice
- 4.1 Demonstrate effective writing for different purposes
Learning Objectives

After completing this activity, the student will be able to:
1. Explain the phenomenon of Spatial Neglect and how it occurs
2. Critique research design strategies
3. Describe the psychological components of Spatial Neglect
4. Differentiate neurological versus psychological contributions to behavior
5. Identify ethical issues in research

Assessment recommendations

Learning Objective 1: In their write up, or in class discussions, students should be able to describe the key symptoms of Spatial Neglect as well as the brain regions involved.

Learning Objective 2: Successful students will be able to describe details of their experimental design choices, explain why they made certain choices, and why they avoided other options. Students should be able to explain how their choices fit the context of their social and physical environment. Thoughtful students will be able to reflect on the efficacy of their choices and note potential improvements for future designs.

Learning Objective 3: Students should be able to differentiate the neurological symptoms from the psychological effects of the disorder. This can be particularly difficult for many students to grasp so the minimum expectation should be the identification of a psychological component of the disorder. Some students will be able to engage in more nuanced discussions of the relationship between psychology and neurology as it relates to Spatial Neglect.

Learning Objective 4: Successful students will be able to describe the contribution of psychology to behavior and provide some general examples (these may or may not be related to Spatial Neglect). They will also be able describe the contribution of neurology to behavior and provide some general examples.

Learning Objective 5: Students should be able to identify variables (gender, personality, targeted item(s), hiding space of choice, how long items were left hidden, etc.) that impacted the experimental outcome. Specifically, they should be able to discuss how these variables contributed to the final outcome.

Course and level recommendations

Undergraduate: Introductory and intermediate levels
General Psychology, Biological Psychology, Introductory Neuroscience, Sensation and Perception, Cognitive Psychology, Neuropsychology
**Characteristics for success**
This is an individual assignment, so it tends to be unaffected by class dynamics. Sometimes I have the students discuss the results in class and this can lead to an engaged classroom activity. For larger classes, I adjust the grading to a check/check+ process. For smaller classes, I grade on a 5 or 10-point scale.

**Lesson Preparation:** 0-5 minutes
1. Instructor will explain the assignment and why it is relevant to class/lecture/textbook material.
2. No special materials are needed, however, it will help immensely to spend some time in class discussing the nuances of the psychological versus neurological aspects of spatial neglect. I use this time to remind students that we are attempting to re-create the psychological aspects of the syndrome.

**Lesson Background**
Students have a difficult time comprehending just why Spatial Neglect patients can’t be reminded to pay attention to the left side of space. Even after discussing aspects of attention and how the brain creates a spatial map, students still struggle. This lesson can be helpful in helping them understand why patients will so vehemently neglect one side of space. The caveat, however, is that students must understand the difference between psychological and neurological contributions to behavior. If you weave this theme throughout your course, like I do, then you will only need to spend some time discussing examples of how it applies to Spatial Neglect. Otherwise, you might want devote to some extra class time to this concept before assigning this lesson.

**Detailed Explanation of Lesson**

**Preparation**
A week before handing out the assignment I spend time in class teaching about Spatial Neglect. We cover the basics of the brain regions affected and the various symptoms. We watch videos of patients and read some case studies. Throughout this process the class inevitably erupts into strings of questions such as “why won’t they just look left?” or “why can’t you just tell them to look left whenever they are hungry?” Once the students start asking these questions, I begin the discussion of the psychological effects of Spatial Neglect. I often refer to one of the case studies that was read by the class previously to illustrate the patient’s fearful response to being forced to attend to their left side of space.

**Implementation**
The day I hand out this assignment, I begin class by opening up discussion on the more interesting/confusing aspects of Spatial Neglect. After 15-20 minutes of conversation I introduce my analogy of Freezer Neglect as a possible answer to the question of “why can’t they just remember to look left?”. I have students imagine repeatedly losing an item of importance (wallet, keys, glasses, etc..) and ask them where they might look for the item. I then have them imagine that every time they lose this item it can be found
only by looking in the freezer. I use the freezer, I explain, because it is a ridiculous place for these items to end up. Yet, I remind the students, there are times when lost items really do end up in the freezer (a few students usually have some fun examples to share with the class). Finally, I have students think about repeatedly losing items only to find them in the freezer over and over again. I have them guess how soon they might start looking in the freezer before looking elsewhere for the item? I then make the link between checking the freezer in this made up scenario with the behavior of Spatial Neglect patients attending to the left side of space. I also explain that this is not a perfect analogy, but might represent the psychological contributions to the disorder.

Once students understand the analogy, I hand out the assignment and explain the logistics to them. I emphasize the ethical aspects of the experiment since it calls for them to repeatedly hide a family member or friend’s belongings in the freezer several days in a row. Students are given 1-2 weeks to complete their experiment and write-up. Their instructions are to plan a series of hidden events to observe the reactions of their target. In the fall I tend to assign this project around Fall Break and it works extremely well as it gives many students plenty of opportunities and a variety of potential targets. The students keep a daily journal or logbook to record the item stolen and how long it took before the item was found in the freezer. Students are also encouraged to debrief their target and interview them upon completion of the experiment. Finally, I have students write up their experience in a 2-3 page report and share their experiences in groups or with the whole class. Every time I assign this, half the students witness their targets refusing to ever look in the freezer for their lost items. We discuss the responses of individuals and the various strategies that students used. There are usually one or two particularly interesting stories that can be linked back to the psychological behavior of the Spatial Neglect patients.

References
Additional Material

Student Assignment Directions: Hemi Neglect

This assignment is voluntary. If you choose to participate you will be awarded up to 10 points. These points will be added to your overall class points earned. Maximum points will be awarded to a well-designed strategy and clear, effective communication in the write-up.

Your task:
You are an experimenter trying to induce “freezer-neglect” in one of your “participants” by repeatedly hiding their possessions in the freezer (or any other ridiculous locale). You are to relocate items randomly throughout the observation period and place them in the freezer. You may also have to “magically find” the items for your participant after their initial search starts. As the experimenter, you will need to think of what items to choose and how often you want to hide them. Additionally, you will need to decide how soon after their search you should “happen upon” their item in the freezer.

Choose your participant and the hidden items carefully, as this person will be inconvenienced repeatedly throughout the observation period. Thus, you should avoid individuals who would be distressed by the observation and avoid choosing items that will impair their ability to get to work or care for their children, etc.

Think carefully about informed consent. It is important in psychology experiments that participants agree to the experiment, are allowed to stop at any time, and are debriefed on the purpose of the experiment.

Consider the following:
1. How will you inform potential participants about your study?
2. How will you determine if an experiment needs to be ended? How will participants know that they can stop at any time?
3. How will you debrief your participant?

How are you going to establish this without letting your participant know what you are up to? I highly suggest announcing to your family members that you are engaging in an “observational” psychology study for one of your classes and that they should let you know if they do NOT want to be part of the study. That way, you can eliminate them as potential subjects. Additionally, if problems arise as a result of your repeatedly hiding items from your subject, you should stop the experiment immediately. Finally, once you have collected your data be sure to inform your subject of the experiment. You may even interview them about their experience (assuming they are still talking to you!)
Collecting Data:
Keep a data log throughout the observation period. Each time you hide an item, note how long it takes for the participant to look for it in the freezer (if at all), if you had to “happen upon it” yourself, how many other places they look for it, and their emotional response to the process. Also note if you use any confederates each time. Note, too, if you had to end the experiment prematurely due to ethical considerations. At the end, debrief your participant and interview them to find out what they were thinking and feeling during each “lost” episode. For repeated trials where they did not immediately seek out the freezer, ask them why they avoided the freezer?

Writing it up:
If you can, keep a journal for the two days or more that you collect data. Note what items you took, how soon they were found, and how the items were found. Note the emotional response to the items missing and being found in the freezer. Keep tabs on your own thought processes as a scientist—what was your initial strategy and how does it change throughout data collection. Your measure of interest is how soon/frequent they check the freezer as a function of how many items have been placed there. One theory is that as more items are placed in the freezer over the observation period, the more likely the participant should begin to search there. An alternative hypothesis is that they will act like a hemi-neglect patient, and finding items in the freezer will confuse/irritate them to the point of avoiding looking there since things really shouldn’t end up there! Finally, if you can interview your subject, include information about their responses and thought processes as the experiment proceeded. If you find it useful to interview other friends or family members, please do so. Good luck, and have fun!

Recommended resources:
This provides the basics of what perceptual processes are affected in human spatial neglect cases. Read this article before beginning your assignment to learn about what spatial neglect entails.

This textbook has a section on spatial neglect and includes a discussion of lesion locations, factors affecting the severity of the syndrome, and how this relates to spatial neglect. Read this article before beginning your assignment to learn about what spatial neglect entails.

Sacks is a neurologist who describes a case that conveys personal, neurological symptoms, and psychological reaction to symptoms of spatial neglect. Read this article before beginning your assignment to understand the purpose of this assignment, as it is the psychological aspect of spatial neglect that we are attempting to re-create in this exercise.
11. Change Blindness

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This homework assignment taps into students' mischievous side while also helping overcome that "no way that really happens" attitude. I show them demos in class of change blindness, but for those who aren't duped by the demo, this activity helps them cement the concept as they watch it happen in their personal environment.

Lesson Abstract
This activity is an individual homework assignment designed to help students better understand the concept of Change Blindness. They perform a mini-experiment across several days, involving friends or family. The goal is to see how large of a change in their appearance they can enact without being noticed. Specifics of who notices what and when are recorded and students are encouraged to debrief their "participants" at the end of the mini-experiment. Finally, students submit a write-up of the results and discuss how and why things went they way they did. Students have a lot of fun "pulling a fast one" on their loved ones and are often shocked at how many of their change-attempts went unnoticed. A fun observation to discuss, too, is that many mothers are the first to pick up on the change-attempts.

APA Guidelines
This lesson meets the following APA Guidelines for the Undergraduate Psychology Major:
- 1.1 Describe key concepts, principles, and overarching themes in psychology
- 2.1 Use scientific reasoning to interpret psychological phenomena
- 2.3 Engage in innovative and integrative thinking and problem solving
- 4.1 Demonstrate effective writing for different purposes

Learning Objectives
After completing this activity, the student will be able to:
1. Describe the phenomenon of Change Blindness and how it occurs
2. Critique research strategies
3. Relate the phenomenon of Change Blindness to their own life
4. Describe variables that affect Change Blindness

Assessment recommendations
Learning Objective 1: In their write up, or in class discussions, students should be able to describe the key elements of a Change Blindness event. They should also be able to differentiate this phenomenon from other visual and attentional phenomenon.
Specifically, they should be able to identify Change Blindness as a relatively large change in a visual scene that does not merely reflect a change of attention or motivation.

**Learning Objective 2:** Successful students will be able to describe details of their experimental design choices, explain why they made certain choices, and why they avoided other options. Students should be able to explain how their choices fit the context of their social and physical environment. Thoughtful students will be able to reflect on the efficacy of their choices and note potential improvements for future designs.

**Learning Objective 3:** In their write up, or in class discussions, students should be able to identify aspects of the Change Blindness phenomenon that were unique to their setting. Thoughtful students will reflect upon their expectations while preparing the experiment and how they compare to the outcomes.

**Learning Objective 4:** Students should be able to identify variables (gender, personality, targeted item(s) for change, etc..) that impacted the experimental outcome. Specifically, they should be able to discuss how these variables contributed to the final outcome.

**Course and level recommendations**
Undergraduate: Introductory and intermediate levels
General Psychology, Biological Psychology, Introductory Neuroscience, Sensation and Perception, Cognitive Psychology, Neuropsychology

**Characteristics for success**
This is an individual assignment, so it tends to be unaffected by class dynamics. Sometimes I have the students discuss the results in class and this can lead to an engaged classroom activity. For larger classes, I tweak the grading to a check/check+ process. For smaller classes, I grade on a 5 or 10-point scale.

**Lesson Preparation:** 0-5 minutes
  1. Provide a brief explanation of the assignment and its relevance to course/lesson/textbook material.
  2. The assignment can be posted and/or graded online.

**Lesson Background**
Students are often in disbelief about the occurrence of the Change Blindness phenomenon. Additionally, they often assume that the effect results either small changes that occur while the individual is not looking. Lecture, discussion, and in-class demonstrations help reduce some of this misunderstanding. By following up with this assignment, students are able to spend time reflecting on the definition of Change Blindness and what situations lead to it. An added bonus is that they get to observe the effect as it occurs and to discuss the experience with the individuals involved. By observing the people in their lives succumb to this phenomenon, they gain an
appreciation for the significance of the effect and a greater understanding of the definition of the phenomenon.

**Detailed Explanation of Lesson**

**Preparation**
The class or two before handing out the assignment I lecture briefly on the concept of Change Blindness. We then discuss The Door Study and The Gorilla Study. I narrate the studies before showing video clips of the original experiment. At times I have used clips of replication studies. Once students are fairly well convinced that they would not fall for this effect themselves, I present them with video clips of images that slowly change over the span of a few minutes. Inevitably, a good portion of the class cannot identify the change as it is happening. Often I can get the students to perceive the change by playing the video super-fast so that the change ends up “popping” into or out of view. This activity and class discussion primes the students to start thinking about the types of situations where Change Blindness is likely to occur.

**Implementation**
Students are handed out the Student Instruction Sheet and approximately 15 minutes of class time is spent discussing the assignment’s goals and logistics. Students are given 1-2 weeks to complete their experiment and write-up. Their instructions are to plan a series of changes in their attire or hairstyle and to observe the reactions of roommates, friends, or family members. In the fall I tend to assign this project around Thanksgiving Break and it works extremely well as it gives many students plenty of opportunities try out a few changes. Sometimes I have the students get into groups to compare the strategy ideas. Sometimes I have the students keep a daily journal or logbook to record the item changed and who noticed. They always write up their experience in a 2-3 page report.

**References**


Class Experiment in Change Blindness

Your task:
You are an experimenter investigating change blindness. Throughout the observation period, you will change something about your appearance and observe a friend or family members’ reactions. Your goal will be to change the largest possible item without being detected. You will attempt this at least once per day. Things you can change are the following:

- Shirt
- Glasses/contacts
- Watch
- Tie
- Jewelry
- Shoes
- Pants
- Place setting at meal times
- Hairdo
- Anything else you can think of

Be sure that you are not obvious in your changing. It is best if you don’t just go in your room and come out with a different outfit. You should enter somewhere innocuously and then appear with the changed item. This may involve stashing clothes items in random, unexpected places.

Collecting Data:
Keep a data log for the two or more days that you collect data. For each item that you change, indicate whether it was successful and if so, who noticed the change and how long it took for them to notice. Note, as well, any vague comments from friends or family members that suggest they notice something different but can’t put their finger on what it is exactly.

Writing a Report:
You will submit a 2-3 page report summarizing the experience. Include in your report a description of the Change Blindness phenomenon, your particular experimental strategy (did you start out with subtle items and move gradually to large, more obvious items or did you start with the more obvious items?) and your personal reflections on the process. Consider, interviewing friends or family members after you complete your experiment to get their reactions. Good luck, and have fun!
Recommended resources:
This article discusses the ways in which Change Blindness may, or may not occur. Refer to this article before and/or after collecting your data. Reading it before may help you establish a better strategy. Reading (or re-reading) it afterward will help you discuss the ways in which your strategy succeeded/failed.

This article describes research on change blindness. This will help you understand the context for this type of research while giving you the details of actual study performed.

In this article, the authors describe real life applications of Change Blindness and other surprising (and counterintuitive) psychological concepts. Read this article after you complete this activity and use it to integrate your experience across other situations.
12. Demonstrating Susceptibility to the Placebo Effect

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This is a brief demonstration of the placebo effect. Informal discussions with students and others over the past few years has revealed a denigration of the placebo effect with the general sentiment being that it is “not real”, “small”, or only applies to others. Therefore, a brief exercise was implemented to demonstrate the placebo effect.

Lesson Abstract
Despite a long-history and widespread understanding of its importance (e.g. for research design), the placebo effect (PE) is often under-appreciated by students. This report describes a demonstration of the PE that requires minimal in-class time (≈10 min) and very few resources. Student confederates, purported to be research assistants with a local medicinal chemist, requested volunteers to test a newly synthesized drug that had never before been given to humans. A “consent form” included potential adverse events from a stimulant and a depressant. The majority (58.1%) of participants (N = 31) believed they were administered an active substance, typically a stimulant when, in reality, everyone received a vitamin. Subjective ratings (mood, energy, attention) were recorded via an online survey and reports were consistent with the drug participants thought they received. Comments to open-ended items regarding physiological changes included alterations in thermoregulation (e.g. “I felt hotter and more hyper/excited.”), respiration, and heart rate. Overall, these findings indicate that the PE is a robust phenomenon that could readily be incorporated into many different courses.

APA Guidelines
This lesson meets the following APA Guidelines for the Undergraduate Psychology Major:
• 1.1 Describe key concepts, principles, and overarching themes in psychology
• 2.1 Use scientific reasoning to interpret psychological phenomena
• 2.4 Interpret, design, and conduct basic psychological research
• 5.1 Apply psychological content and skills to career goals

Learning Objectives
After completing this activity, the student will be able to:
1. Demonstrate how the placebo effect can be studied quantitatively.
2. Record and analyze data (optional).
Assessment recommendations

Learning Objective 1: Students can demonstrate their understanding of how the placebo effect can be studied through completing a lab report or research paper, or by answering multiple choice questions.

Learning Objective 2: Students can demonstrate their ability to record and analyze data through incorporating these items into a lab report.

Course and level recommendations
Undergraduate: Introductory and intermediate levels
General Psychology, Biological Psychology, Physiological Psychology, Behavioral Neuroscience, Research Methods, Statistics, Psychopharmacology

Characteristics for success
This demonstration could be used with very small (minimum of 5 students) classes but larger groups provide more information for the data analysis.

Lesson Preparation: 30-60 minutes
1. Purchase placebo (vitamin)
2. Set-up a short online (or paper-based) survey for recording subjective and physiological responses.
3. Recruit one or more confederates
4. Get lab coat (optional)

Lesson Background
The psychobiological response to a placebo is a robust and important phenomenon in the psychological and biomedical sciences. A thorough understanding of the placebo effect is integral for a critical appreciation of various interventions for pain (Price, Ginniss, Benedetti, 2005), psychotherapy (Wampold, Minami, Tierney, Baskin, & Bhati, 2005), and many complementary and alternative medicines, particularly acupuncture (Cherkin, Sherman, Avins, Erro, Ichikawa, Barlow WE, et al. 2009), therapeutic touch (Rosa, Rosa, Sarner, & Barrett, 1998), and homeopathy (Jonas, Kaptchuk, & Linde, 2003). A recent report showed placebos produced equivalent pain relief to analgesics for partial meniscectomy and sham surgery (Sihvonen, Paavola, Malmivaara, Itälä, A., Joukainen, A., Nurmi, H., et al. 2013). However, a true placebo effect is only evident when a wait-list control group to quantify the natural progression of a disease or disorder is present (Price et al. 2005). Informal discussions with students and others over the past few years has revealed a denigration of the placebo effect with the general sentiment being that it is “not real”, “small”, or only applies to others. Therefore, a brief exercise was implemented to demonstrate the placebo effect.
Detailed Explanation of Lesson

Preparation
The procedures employed were based on modifications of an exercise originally designed for medical students (Blackwell, Saul, & Buncher, 1972). This demonstration was completed during two lectures in the neuroscience portion of RX 311 Medical Physiology and Pathophysiology I, a required course for first year (P1) pharmacy students during the fall, 2012 semester. This lesson was repeated with minor variation (described below) in the fall, 2013 semester.

On the first day, during the last ten minutes of class, a pair of confederates, dressed in white lab coats, made an announcement that they were research assistants with a local medicinal chemist and were looking for volunteers to test a newly synthesized drug. The drug had never before been given to humans so it was uncertain what effect the drug would produce. The “consent form” was made quasi-official by including the university letterhead and stated:

Thank you for agreeing to participate in this experiment. The goal of this study is to provide information about a new class of recently synthesized compounds. You will receive either a low dose of a stimulant or a low dose of a depressant.

Potential risks of a stimulant include exacerbation of symptoms of behavior disturbance and thought disorder in persons with a history of psychosis. Stimulants at higher doses than used here can cause treatment-emergent psychotic or manic symptoms (e.g., hallucinations, delusional thinking, mania) in individuals without a prior history of psychotic illness. Aggressive behavior or hostility have been reported in clinical trials in the post-marketing experience of some stimulant medications indicated for the treatment of Attention Deficit Hyperactivity Disorder (ADHD). These drugs may impair growth in children. Stimulants may lower the convulsive threshold and increase the likelihood of presence of seizures. Visual disturbances have been reported with stimulant treatment. Stimulants may also exacerbate Tourette’s syndrome and phonic or motor tics. Sudden death has occurred in children with structural cardiac abnormalities so please do not participate in this study if you have known structural cardiac abnormalities or other serious cardiac problems.

Potential risks of a depressant include worsening of insomnia and emergence of thinking or behavior abnormalities. Complex behaviors reported; strongly consider precautions if sleep-driving episode occurs. Other complex behaviors (e.g., preparing and eating food, making phone calls, or having sex) have been reported in individuals who are not fully awake after taking a sedative-hypnotic depressant. This drug may be habit-forming; tolerance, psychological and physical dependence may occur with continued use. Abrupt cessation after prolonged use may result in withdrawal symptoms. Use with caution if you
experience acute or chronic pain; this drug may cause paradoxical excitement or mask important symptoms. Caution is also warranted with depression, suicidal tendencies, history of drug abuse, and with hepatic damage. May cause fetal harm so do not take this drug if you are pregnant. Some individuals may experience excitement rather than depression. Exercise caution and do not participate in this study if you have hepatic damage. Depressants may impair mental/physical abilities.

By signing below, you agree that you are aware of the risks described above.

The information about risks associated with a stimulant was reworded slightly from the package insert from Adderall (amphetamine hydrochloride). The information about risks associated with a depressant was reworded somewhat from the package insert for Ambien (zolpidem tartrate). The intent of the consent form was, for those that read it, to introduce an expectation regarding drug effects. The order of drug types on the consent was reversed for the 2012 (stimulant/depressant) and 2013 (depressant/stimulant) courses. This manipulation had no appreciable effect and will not be discussed further.

Implementation

Next volunteers received the “drug”. In reality, all participants received a vitamin. Thiamine (B₁) was selected because the white 100 mg pills (Nature Made, Pharmavite LLC, Mission Hills) are non-descript and do not have a distinctive taste. A retail pharmacist also recommended them. Thiamine is an essential water-soluble nutrient contained in a variety of foods including pork, cereals, brown rice, potatoes, oranges, and eggs. The recommended daily allowance is 1.1 mg for women and 1.2 mg for men (age > 19). The “drug” was dispensed from one of two containers clearly labeled as “1” or “2”.

Immediately after class, a link to a seven question online survey (administered with Survey Monkey) was emailed by the confederates. The first item was intended to aid in the expectation: “What was your container #?” Participants were then asked “In the thirty-minutes after drug administration, how would you rate your mood (item #2), energy (item #3), or ability to maintain attention (item #4) with options ranging from substantially higher, slightly higher, no change, slightly lower, or substantially lower. Item #5 was open-ended and asked “Did you notice any physiological changes (heart rate, blood pressure, temperature, respiratory rate)? If so, please describe?” Item #6 queried “What drug do you think you received?” with options of the stimulant, the depressant, or not sure. The last item inquired “How certain are you in your response to the previous item?” with options ranging from 0% (not certain at all), to 100% (completely certain).

The findings were shared on the second day at the end of lecture on pain that included the neurobiology and measurement of pain, the limited efficacy of therapeutic touch
(Rosa et al. 1998), an example of methodologically rigorous research on acupuncture for lower back-pain (Cherkin et al. 2009), and the neural substrates of the placebo effect.

Data-analysis: Bivariate analyses were completed with Systat, version 13.1 (Chicago, IL) and figures were prepared using GraphPad Prism, version 6.03 (La Jolla, CA). The Likert-style items were coded as substantially higher = 5, slightly higher = 4, no change = 3, slightly lower = 2, or substantially lower = 1 point. Two-complementary analyses were then conducted. First, one-sample t-tests were run to determine if there were differences relative to an unchanged subjective effect (3 points). Second, independent sample t-tests were completed to compare subjective ratings (e.g. among participants that believed they received a stimulant with those that believed they received a depressant). The standard error of the mean was used to report variability. A p value of .05 was considered significant although statistics that met more conservative alphas were noted.

Results: Of the 31 students participating, the majority (58.1%) believed they were administered an active substance. Among this subset, three-quarters (77.8%) reported that they received a stimulant and only a minority (22.2%) a depressant. The certainty rating (0 to 100% certain) was moderately high for entire sample (65.8 ± 5.0%). Interestingly, participants that believed they received a stimulant were less certain (55.0 ± 6.1%) about this than those that were unsure of what drug they received (74.6 ± 8.7%), albeit non-significantly (t(25) = 1.87, p = .073).

Figure 1 shows that the subjective ratings were consistent with the drug participants thought they received. The stimulant improved mood (one-sample p < .002) and increased energy (p < .0005) whereas the elevation in attention did not fulfill standard statistical criteria (p = .055). The depressant group (N = 4) showed indications (p = .092) of lower energy and attention. Between group comparisons revealed greater mood (p < .05) and energy (p < .005) in the stimulant relative to the uncertain groups. The depressant group rated their mood, energy, and attention (p < .05) lower than the stimulant condition.

An additional analysis was completed by evaluating the number of participants that indicated “no change” in energy, mood, and attention. Less than one-third (29.0%) were placebo non-responders when this more conservative criterion was applied. Table 1 shows selected qualitative responses. All responses were readily classified as stimulant or depressant-like. Six participants described effects on cardiac function.

Follow Up: There is an extensive history of the placebo having a negative connotation. This exercise demonstrated that the majority of students experienced the placebo effect. Other research has demonstrated that the placebo effect is biologically real with neurochemical, endocrine, and immunological substrates (Benedetti, 2008).
Some similarities and differences with a prior report (Blackwell et al. 1977) are noteworthy. Only a minority (29%) of second year medical students receiving a pink or blue capsule were unsure of whether they received a sedative (70%) or a stimulant (1%). This group inferred that there was a strong tendency to attribute sedative properties to the students in their sample because students spent the time following substance administration sitting through a lecture. The present dataset does not support this conjecture because these participants spent fifty minutes after receiving the “drug” in a pharmacology lecture.

Future Directions: Some caveats and future directions are noteworthy. First, the class met at 8 AM so it is likely that many students were already under the influence of caffeine. Repeating this exercise with courses that meet at different times might reveal a different pattern of qualitative and quantitative results. Second, there were some indications in the data that the second class was more suspicious than the first regarding the objective of this exercise. As the students at this small institution (3,500 students) are from a small community, it is quite possible that the more advanced students recounted their experience with subsequent classes. Third, this exercise was designed to place minimal time demands on both the instructor and the students. Some modifications could include more detailed information about student background (e.g. are students with less experience with legal stimulants more/less likely to interpret a placebo as a stimulant?), a visual-analogue scale to provide more nuanced assessment of subjective experiences, or inclusion of many more affective and physiological states. Fourth, this course was completed with first year pharmacy students in Maine as participants. This population is highly interested in the effects of medical drugs. However, as part of admission into the program, they complete a background check and therefore this group may be different in potentially interesting ways from the general undergraduate population. Also, only a subset (~25%) of students in each class volunteered. It is not known how the volunteers differ from non-volunteers in the magnitude of their expectancy effects.

In conclusion, this educational exercise could readily be utilized, with only minimal modifications, in a wide variety of courses. The students, rather than professor, in a research methods course, could complete the data collection, pre-processing, analysis, and construction of figures. The consent could be removed in a cognitive psychology class to see whether this manipulation would attenuate the attributions. Earlier reports documented improved motor learning among participants that expected to receive caffeine but instead received a placebo (Fillmore & Vogel-Sprott, 1992). Although the students that believed they received the depressant had lower attention, future explorations could be made as to whether this impairs subsequent learning and memory. A battery of open-source computerized measures for cognitive studies is available elsewhere (Mueller & Piper, 2013). Whether providing information about hallucinogenic effects (e.g. like dextromethorphan) in the consent could induce this type of subjective experience is currently unknown but could be explored as part of a psychopharmacology course. Health science students could gain experience obtaining
heart rate and blood pressure following the placebo. Similarly, if specialized equipment
were available, behavioral neuroscience students could record electroencephalograph
or functional near infrared spectroscopy measurements. Together, the PE
demonstration is congruent with the American Psychological Association (2013)
Guideline 2.4 to interpret, design, and conduct basic psychological research. Further,
this exercise provides a versatile assay of the sensitivity to individual differences and
robustness of the placebo effect.

Acknowledgements
Thanks to Whitney Jandreau, Colleen Le, and Scott Milton for assistance with data
collection.

References
Benedetti, F. Mechanisms of placebo and placebo-related effects across diseases and
treatments. Annual Review of Pharmacology and Toxicology, 48, 33-60.
[Recommended! This paper employs similar methodology]
(2009). A randomized trial comparing acupuncture, simulated acupuncture, and
usual care for chronic low back pain. Archives of Internal Medicine, 169, 858-66.
performance predicts the type of responses to placebo. Psychopharmacology,
of Internal Medicine, 138, 393-399.
and the PEBL battery. Journal of Neuroscience Methods, 222, 250-259.
placebo effect: Recent advances and current thought. Annual Review of
Psychology, 59, 565-590.
Journal of the American Medical Association, 279, 1005-1010.
is powerful: Estimating placebo effects in medicine and psychotherapy from
Additional Material

Figure 1. Subjective ratings (5 = substantially increased, 3 = no change, 1 = substantially decreased) among participants who were administered a placebo and believed they received a stimulant (N = 14), a depressant (N = 4), or were uncertain (N = 13). \(^a p < .05\) versus rating = 3; \(^b p < .05\) versus depressant, \(^c p < .05\) versus stimulant.

Table 1. Open-ended comments in response to “Did you notice any physiological changes? If so, please describe” among students that received a placebo.

<table>
<thead>
<tr>
<th>Stimulant Effects:</th>
</tr>
</thead>
<tbody>
<tr>
<td>“I felt hotter and more hyper/excited.”</td>
</tr>
<tr>
<td>“Light headedness that usually accompanies too much caffeine in the morning”</td>
</tr>
<tr>
<td>“heart rate increased a little bit”</td>
</tr>
<tr>
<td>“slightly higher respiratory rate”</td>
</tr>
<tr>
<td>“An overall increase of awareness regarding my surroundings.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Depressant Effects:</th>
</tr>
</thead>
<tbody>
<tr>
<td>“My heart rate seemed to decrease”</td>
</tr>
<tr>
<td>“I felt a little dizzy.”</td>
</tr>
<tr>
<td>“I was yawning a lot”</td>
</tr>
</tbody>
</table>
13. The Five-Minute Factoid: An Oral Presentation Activity

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I developed this activity because I needed to vary the way I was delivering material in Biopsychology to keep students engaged. Students were reluctant to speak and time for activities was limited. I also had difficulty making the material relevant to all students. This exercise addressed all of these issues. It is easy to implement and research suggests that students enjoy and benefit from it.

Lesson Abstract
This exercise is a low-stress opportunity for students to bring their interests into the classroom, demonstrate mastery of knowledge, and practice oral presentation skills. Students are asked to find a unique fact about the nervous system. The fact must be from a current and reliable source and cannot be covered in the course textbook or assigned readings. On the scheduled day, the student stands and shares his/her fact with the class. The sharing process takes about five minutes, with a bit of variability depending on the topic. The presentation should be conversational and accessible to a broad audience. Students also submit a brief typed statement that includes a summary of the fact and the resource(s) referenced in APA style. This exercise has the potential to benefit the presenter, audience, and instructor. For example, students have an opportunity to practice effective presentation skills. An assessment of this specific exercise revealed that students responded favorably. Participants expressed positive attitudes, demonstrated learning, and showed a stronger preference for oral presentations than did a comparison group (Sleigh, 2013). Students must research a topic, encouraging them to connect their own interests with the class, as well as evaluate the quality of scientific resources. Because students typically select topics that are meaningful to their peers, the presentations are an easy way to make the class relevant to a variety of students. The current nature of the information keeps the class updated and gives the instructor new knowledge to incorporate into the class in the future.

APA Guidelines
This lesson meets the following APA Guidelines for the Undergraduate Psychology Major:
• 1.1 Describe key concepts, principles, and overarching themes in psychology
• 2.2 Demonstrate psychology information literacy
• 4.2 Exhibit effective presentation skills for different purposes

Learning Objectives
After completing this activity, the student will be able to:
1. Describe a key finding in biopsychology to his/her peers
2. Identify a scientific resource and utilize it to gather information
3. Write an APA-style reference

Assessment recommendations
Learning Objective 1: Students will demonstrate description of a key finding through their presentation.

Learning Objective 2: Students will demonstrate their ability to identify a scientific resource through their reference.

Learning Objective 3: Assessment of the APA reference will indicate student’s mastery of this skill.

Course and level recommendations
Undergraduate: All levels
Biological Psychology, Neuroanatomy

Characteristics for success
A class size that does not exceed 60 students

Lesson Preparation: 0-10 minutes
1. Preparation for this assignment is minimal. The exercise needs to be described to students and a sign-up sheet distributed. Depending on the academic level of the students, instructors may need to spend time explaining parameters for ‘current’ and ‘reliable’ sources of information. A simple rubric for grading can be used.

Lesson Background
Biopsychology has some challenging characteristics that have to be considered when teaching the course. First, the field is rapidly advancing and unless it is their specific area of research, it may be difficult for instructors to keep up with the latest findings. Even when instructors are aware of the current research in the field, incorporating the information into class material necessitates preparation time. Second, the course covers a great deal of material and class time is valuable. Instructors have to figure out how to cover all of the material while finding activities that keep students engaged and participatory. Last, psychology majors tend to find biopsychology material to be more difficult to learn than other topics (e.g., Peck, Ali, Levine & Matchock, 2006; Sgoutus-Emch, Nagel & Flynn, 2007). Because students can be intimidated by the content of the class, they may dread the idea of speaking out loud. The exercise described here is intended to be a low-stress opportunity for students to bring their own interests into
the classroom, demonstrate mastery of biopsychology knowledge, and practice oral presentation skills. In addition, it supports the 2013 APA Guidelines for the Undergraduate Psychology Major by asking students to describe key concepts in psychology (1.1), demonstrate psychology information literacy (2.2), and exhibit effective presentation skills for different purposes (4.2).

**Detailed Explanation of Lesson**

**Preparation**
Preparation for this assignment is minimal. The exercise needs to be described to students and a sign-up sheet distributed. Depending on the academic level of the students, instructors may need to spend time explaining parameters for ‘current’ and ‘reliable’ sources of information. The grading is relatively simplistic and quick. Unless the instructor chooses to do so, students do not need lengthy feedback or grading explanations; the exercise is designed such that most students should easily be able to earn maximum points.

**Implementation**
Students are asked to find a unique fact about the nervous system; this fact can relate to any aspect of the nervous system, such as development, functioning, abnormality, injury, or cross-species comparisons. The fact can relate to humans or to other animals and must be from a current and reliable source. A key element is that the information cannot be covered in the course textbook, assigned readings, or class discussions. In other words, students must identify and research a novel topic using resources external to the class.

With the details dependent on class scheduling and size, one or two students give a presentation each day of class. Two exceptions might be days on which tests are given and the class period before the test when teaching time is often at a premium. At the beginning of class on the scheduled day, the student stands and shares his/her fact with the class. The sharing process takes about five minutes, with a bit of variability depending on the topic. The process is informal, with the main goal being to practice oral communication skills with interesting information that the average person would not know. Students can be instructed to talk to the class as if they were sharing this fact with a best friend; in other words, the presentation should be conversational and accessible to a broad audience.

Students also submit a brief typed statement that includes a short summary of the fact and the resource(s) referenced in APA style. These statements serve two purposes. First, they allow the instructor to confirm the presented fact if the accuracy is in question. Second, these presentations can alert the instructor to new advances or previously unexplored areas in the field, and the references provide an efficient way to gather additional information for future incorporation into the class.
Faculty can develop their own grading rubrics. One suggestion would be to assess the exercise with 40% of points for the accuracy and quality of the fact, 40% of points for clarity and brevity of the presentation, and the remaining 20% for the written statement with the APA-style reference. The contribution of the presentation to the student’s overall grade in the course should be weighty enough that students take it seriously but also appropriate for the time required for the assignment. The amount of time that students spend on this task can vary widely (Sleigh, 2013). A reasonable suggestion might be to make the assignment 9% of the overall grade in the course.

Sample Topics: Because students bring a range of interests and experiences into the classroom, their presentations are typically characterized by a great deal of diversity. Instructors would be wise to provide limited examples of what is expected in order to maximize students’ freedom, creativity, and originality. Following are sample topics:

- Why can’t humans tickle themselves?
- Does exercise help you think more clearly?
- Can eating dark chocolate reduce your stress level?
- Why do newborns often sneeze under bright lights?
- Why is laughter contagious?
- Why do people yawn?
- Have scientists ever been able to keep a fetus alive in an artificial womb?
- Can fetal movement predict a person’s later personality?

Benefits: This exercise has the potential to benefit the presenter, audience, and instructor.

1) Students have an opportunity to practice communication and effective presentation skills (APA goal 4.2). The brief and informal nature of the presentation helps minimize some of the public speaking anxiety. Previous research suggests that activities, such as information sharing, may be more effective in improving communication skills than instruction (Berkhof et al., 2011).

2) An assessment of this specific exercise revealed that students responded favorably. Participants expressed positive attitudes, demonstrated learning, and showed a stronger preference for oral presentations than did a comparison group (Sleigh, 2013).

3) Students must identify a presentation topic, encouraging them to connect their own interests with the class. Students must be familiar with what the class will cover in order to avoid overlap and to help them determine the relevance of the topics they are considering. The process also requires students to evaluate the quality of and understand their scientific resources (APA goal 2.2).

4) Students have an opportunity to focus on topics that are of interest to them. Athletes may focus on a sport-related publication, military personnel may select findings in sensation and perception, while parents may discuss developmental research. Students will often select topics that are meaningful to their peer
group. Thus, the brief presentations are an easy way to ensure that the class feels relevant to a variety of students.

5) Students find and present up-to-date information of which their peers and the instructor may not yet be aware. The brief presentation keeps the class current in real-time and gives the instructor new knowledge to incorporate into the class in the future.

6) As students describe key concepts in psychology (APA goal 1.1), they often create unique analogies or find new ways to explain concepts that are meaningful to their peers and useful to instructors who are wise enough to adopt them.

Optional Modification: Instructors may choose to assign topics for the brief presentations. This option may be particularly useful in a large class when numerous presentations cut into the limited time available to cover required material. Students still have the opportunity to develop research and oral communication skills; however, the instructor can use the presentations as an alternate strategy to deliver course material.

References

Note: Portions of this information were presented at the 2010 National Institute on the Teaching of Psychology conference and an assessment of this activity was published in *Psychology of Learning and Teaching* (Sleigh, 2013).
14. Collaborative Journal Article Review

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This collaborative journal article review technique allows a small group of students to review several research articles on an important course concept. Each student in a small group is assigned one journal article to summarize and share with their group. For example, in an introductory neuroscience or biopsychology course, the instructor could select five articles on the topic of ingestive behavior, and assign those articles to each student in a group of five. Outside of class, students read the article, and write a brief (2-3 page) summary and response paper. Then, in-class, they present the study to their group. Discussion questions may be provided to facilitate group interaction. As a group, students are able to form a cohesive understanding of a topic, without the individual burden of a literature review. This assignment can be completed several times in a term to expose students to important research on a variety of topics, and to allow students opportunities to improve their performance in response to instructor feedback.

Lesson Abstract
In the collaborative journal article review activity based on the jigsaw method, students in a small group are each assigned a (different) scholarly journal article on a topic central to the course (e.g., ingestive behavior). Outside of class, students read the article, and write a summary and response paper. On the due date of the assignment, the small groups meet in-class and each present the key findings from their journal article to their small group. Thus, each student of the group is exposed to the findings from all journal articles, without the burden of writing full literature reviews. The instructor may provide discussion questions to stimulate group dialog. Ideally, this assignment could be completed more than once during a course, allowing exposure to multiple topics and opportunity to respond to instructor feedback.

APA Guidelines
This lesson meets the following APA Guidelines for the Undergraduate Psychology Major:
- 1.2 Develop a working knowledge of psychology's content domains
- 2.2 Demonstrate psychology information literacy
- 2.4 Interpret, design, and conduct basic psychological research
- 4.1 Demonstrate effective writing for different purposes
- 4.2 Exhibit effective presentation skills for different purposes
- 4.3 Interact effectively with others
Learning Objectives

After completing this activity, the student will be able to:

1. Describe a key finding in biopsychology to his/her peers
2. Identify a scientific resource and utilize it to gather information
3. Write an APA-style reference

Assessment recommendations

Learning Objective 1: Description of key findings can be assessed through the writing quality of summary paper using a rubric (suggestion attached), small group presentation (by walking around class to take a snapshot of student performance), or through use of peer feedback.

Learning Objective 2: Students’ abilities to identify resources and use them can be assessed through their summary papers and group discussions.

Learning Objective 3: Ability to write an APA-style reference can be assessed through the summary paper.

Course and level recommendations

Undergraduate: Intermediate and advanced
Neuroscience, Physiological Psychology, Biological Psychology

Characteristics for success

Strong attendance and willingness to speak in front of small groups, ad ability to follow instructions and complete written assignments (knowledge of scientific writing and APA format) will all contribute to success in this lesson.

Lesson Preparation: 30-120 minutes

1. Approximately 30 minutes if using topics suggested; approximately 1-2 hours if preparing new topic
2. Prepare document or presentation to share assignment guidelines with the students (potentially including rubric, suggestion included).
3. Have a class discussion about reading and interpreting research in scholarly journal articles.
4. Identify and access appropriate journal articles (suggestions included).
5. Prepare discussion questions for students (suggestions included)

Lesson Background

The idea for this assignment is derived from the classic Jigsaw activity developed by Aronson (e.g. Aronson & Patnoe, 2011). The jigsaw method is a cooperative, active learning technique commonly used in the sciences to assist students in their comprehension of primary research articles (Lorn, 2012). In the classic jigsaw method activity, students assigned the same topic meet together first to become familiar with the topic. Next, students meet in a group of individuals where each individual is
assigned a different topic. They explain their topics to each other in order to form a cohesive understanding. Due to time constraints, I typically omit the first meeting (group of all individuals assigned the same topic) and rather they work independently to learn their topic as they write the summary and response paper.

Detailed Explanation of Lesson

Preparation and Implementation
This Collaborative Journal Article Review technique allows a small group of students to review several research articles on an important course concept. Each student in a small group is assigned one journal article to summarize and share with their group. For example, in an introductory neuroscience or biopsychology course, the instructor could select five articles on the topic of ingestive behavior, and assign those articles to each student in a group of five.

Outside of class, students read the article, and write a brief (2-3 page) summary and response paper. Then, in-class, they present the study to their group. Discussion questions may be provided to facilitate group interaction. As a group, students are able to form a cohesive understanding of a topic, without the individual burden of a literature review. This assignment can be completed several times in a term to expose students to important research on a variety of topics and to allow students opportunities to improve their performance in response to instructor feedback.

References
Instructions for Students

Overview: In class this term, we will conduct two group literature reviews. As a group, you will study an important concept in neuroscience. Your group will be assigned five different scholarly journal articles related to the concept. Your job is to review one of those assigned articles. Your attendance is essential on Date 1 and Date 2 for your in-class presentations to your group.

This assignment has three parts: Written Summary, Response, and Presentation

Part 1: Written Summary
Please provide a meaningful and well-considered summary of the assigned scholarly journal article.

- Paraphrase the information from the original source.
- Organize the information meaningfully.
- Cite your source appropriately using APA format
- Focus on the key findings of the study you review and their implications
- Be concise in your summary – it should be approximately 2 pages in length, 12 pt font – Times New Roman – Double spaced – 1 inch margins.

Part 2: Response
In addition to the summary, please provide a response to relate the concept to the “big picture”. Why is this concept important? Can you relate it to a real-life scenario, concepts from class, or material you learned in other settings?

- Continue to use appropriate scientific writing and APA format.
- Your response should be approximately 1 page in length.

Part 3: Presentation
Prepare to present your article to your peers – your presentation should be approximately 7-10 minutes in length, and use strong presentation skills such as eye contact, clear communication, and thorough explanations.

- Practice in advance! Be sure to time yourself and to rehearse your presentations skills.
## Sample Grading Rubric

<table>
<thead>
<tr>
<th>Area</th>
<th>Point Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scientific Writing</strong></td>
<td></td>
</tr>
<tr>
<td>5 points:</td>
<td>Ideas are arranged logically, flow is smooth, writing is concise and free of errors in spelling or grammar</td>
</tr>
<tr>
<td>3 points:</td>
<td>In general, the writing is arranged logically, although occasionally ideas fail to make sense together, minor errors in spelling or grammar, and/or lack of concise presentation</td>
</tr>
<tr>
<td>1 points:</td>
<td>Ideas are not arranged in a logical / organized manner, writing contains errors, lack of concise presentation of information</td>
</tr>
<tr>
<td>0 points:</td>
<td>major errors in organization, spelling, grammar</td>
</tr>
<tr>
<td><strong>In-text Citations</strong></td>
<td></td>
</tr>
<tr>
<td>5: Citation provided with proper APA format</td>
<td></td>
</tr>
<tr>
<td>3: Citations provided with minor formatting errors</td>
<td></td>
</tr>
<tr>
<td>0: In-text citations omitted</td>
<td></td>
</tr>
<tr>
<td><strong>End-text Citation</strong></td>
<td></td>
</tr>
<tr>
<td>5: Citation provided with proper APA format</td>
<td></td>
</tr>
<tr>
<td>3: Citations provided with minor formatting errors</td>
<td></td>
</tr>
<tr>
<td>0: End-text citation omitted</td>
<td></td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td></td>
</tr>
<tr>
<td>15: Presentation of relevant information, thoughtful and in-depth analysis of topic.</td>
<td></td>
</tr>
<tr>
<td>10: Information supports a central purpose but analysis is basic or general.</td>
<td></td>
</tr>
<tr>
<td>5: Analysis is vague or not evident. Reader is confused or may be misinformed.</td>
<td></td>
</tr>
<tr>
<td>0: Summary omitted</td>
<td></td>
</tr>
<tr>
<td><strong>Response</strong></td>
<td></td>
</tr>
<tr>
<td>10: Presentation of relevant information, thoughtful and in-depth analysis of topic.</td>
<td></td>
</tr>
<tr>
<td>7: Information supports a central purpose but analysis is basic or general.</td>
<td></td>
</tr>
<tr>
<td>4: Analysis is vague or not evident. Reader is confused or may be misinformed.</td>
<td></td>
</tr>
<tr>
<td>0: Big picture omitted</td>
<td></td>
</tr>
<tr>
<td><strong>Presentation</strong></td>
<td></td>
</tr>
<tr>
<td>10: Major ideas summarized and presented clearly. Inclusion of appropriate detail.</td>
<td></td>
</tr>
<tr>
<td>7: Presentation covers major topics but does not include adequate detail.</td>
<td></td>
</tr>
<tr>
<td>4: Major ideas omitted, inaccurate or inadequate information.</td>
<td></td>
</tr>
<tr>
<td>0: Absent / did not present to group</td>
<td></td>
</tr>
</tbody>
</table>
**Topic suggestion: Ingestive Behavior and Reward Journal articles**

*(in suggested order for student presentations)*:


**Discussion questions:**

1. In comparison with other systems discussed in this class, you may have noticed the redundant and complex nature of the system that regulates ingestive behavior. Why does this make sense from an evolutionary perspective? What is the purpose of food activating the reward system?

2. Consider the topic of obesity - why aren’t homeostatic processes sufficient to protect against weight gain? Why have pharmaceutical interventions for obesity been largely unsuccessful?

3. What is the function of dopamine for regulating ingestive behavior? What is unique about the function of dopamine in obese individuals?

4. Identify some mediators of stress eating. What is the role of endogenous opioids in feeding behavior?

5. Identify the behavioral and neurological similarities in the reactions to drugs and sugars. Do you think it is possible to be addicted to palatable foods? Identify some fundamental differences between addiction to drugs and (potential) addiction to palatable foods.

6. What is the function of serotonin for ingestive behavior? How does serotonin function with eating disorders (both when active and in recovery)? What is unique about the function of the reward system during eating disorders and recovery?
15. Experiential Learning in the Experimental Method: Examining Hick's Law

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This lab gives students exposure to the experimental method, and allows them to pose and test novel hypotheses in a short period of time. The activity allows students to generate their own hypotheses and test them using a demonstration of Hick’s Law.

Lesson Abstract
This activity allows students to investigate “Hick’s Law”, a robust decision making effect. Students work independently or in small groups to use software that allow them to experimentally manipulate the study and create new experiments or quasi-experiments. The activity can be completed by students on their own or as a class and takes roughly 45 minutes.

APA Guidelines
This lesson meets the following APA Guidelines for the Undergraduate Psychology Major:
• 1.3 Describe applications of psychology
• 2.3 Engage in innovative and integrative thinking and problem solving
• 2.4 Interpret, design, and conduct basic psychological research

Learning Objectives
After completing this activity, the student will be able to:
1. Conduct software-based psychological testing
2. Pose and test a novel hypothesis
3. Translate basic findings on response time to decision and human factors applications
4. Visualize basic findings using spreadsheet software

Assessment recommendations
Learning Objective 1: This learning objective can be evaluated by having students conduct a study on themselves and submit data output.

Learning Objective 2: This can be assessed by requiring students to turn in a lab report specifically stating the null and alternative hypotheses, and how they were tested.

Learning Objective 3: This learning objective can be assessed by requiring students to turn in lab report involving part I of the lab (discuss results and implications).
Learning Objective 4: This learning objective can be assessed by having students include a graph in the laboratory report that shows whether their hypothesis was supported by the data.

Course and level recommendations
Undergraduate: All levels
General Psychology, Research Methods

Characteristics for success
This would be appropriate for small laboratory classes/sections, but could also be given in large lectures as a take-home or extra credit assignment.

Lesson Preparation: 30 minutes
1. Instructor should ensure that software is available and installed on available computers before class.

Lesson Background
Experiential Learning can be an effective way to introduce and solidify concepts for students (Mueller & Klein, 2011). Instruction on research methods in psychology provides challenges for students and faculty alike, who are accustomed to lecture-style coursework, whereas lecture-only classes afford little opportunity to form lasting and effective memory for material (cf. Freeman et al., 2014). The following activity empowers students into becoming experimental scientists, using freely available software that allows them to modify existing paradigms to conduct new experiments in a short time period.

The following chapter describes a laboratory activity that can be completed with guidance in a 45-minute class period, or be given to students in a lecture class to complete outside of class. The Appendix (also available in a .doc format) is intended as a basic laboratory guide for students, whereas the main body of the text is intended to provide background and suggestions for the instructor. Goals of this activity include:

- Experiential training with the experimental method
- Exposure to Hick's law, a fundamental property of human decision making useful in a number of applied contexts.
- Introduction to computer-based testing and self-experimentation, providing skills and tools students can use to get involved in psychological research.

Hick's Law
Donders (1868/1969) laid the groundwork for understanding how decision time is impacted by the number of options being decided between (cf Meyer et al. 1988). Donders collected data comparing response times to identify and repeat stimuli chosen at random from sets of 1, 2, and 5 stimuli (e.g., vowel sounds, or visual colors or characters). He showed examples of how mean response time increased as the number
of options increased. This was examined more systematically by Merkel (1885), who varied the number of options from 2 to 10 and established that the time needed to decide between alternatives increased as the number of alternatives increased. However, W. E. Hick (1952) is credited as establishing the law-like relationship between response time and number of options. Hick reported data collected from only a handful of participants (including himself), in which the participant pressed a telegraph key corresponding to a light, but across conditions the number of lights (and keys) varied from 1 to 10. For the simplest response (one light), the participant merely pressed the key when the light lit. As the number of lights increased (and the number of corresponding responses), response time increased, but its rate of increased decreased, as shown in Figure 1.

Figure 1. Illustration of Hick's (1952) Experiment 2, Subj. A, as well as the mathematical prediction of Hick's law $rt = .518 \log(N+1)$.

Based on these data, Hick proposed a logarithmic relationship between the 'degree of choice' and the response time, and this value is fitted in Figure 1.

$$rt = 0.518 \log10(N+1).$$

This logarithmic relationship was interpreted as evidence for the operation of Shannon's (1948) information theory, which also provided a prominent explanation for aimed movements (Fitts's Law; see Fitts, 1954). Although the historical importance of the law comes from its logarithmic form and its relationship to information theory, its fundamental behavioral contribution is that response time increases as number of options increase, and the rate of this increase tends to diminish as the number of options increase.
Explanation and Advances in Hick’s Law

Hick provided a basic explanation for the law in terms of a decision tree account that is consistent with Information theory. This is a conceptual model of the effect, but fairly instructive. Consider a two-option case. In this case, assuming responses are made with the left and right index finger, one simply needs to make one decision—left or right. Next, consider a four-option case, where responses are made with the index and middle fingers of the right and left hand. In this situation, we need to make at most two decisions: first we decide left-versus-right hand, and then for the hand, we decide index-versus-middle finger. This type of tree scheme naturally predicts a logarithmic form, as we can double the number of options with each additional decision we want to allow, as shown in Figure 2.

Figure 2. Depiction of decision tree explanation of Hick’s Law. Every time the number of stimuli doubles, the number of decisions needed to distinguish them increases by one unit.

The tree account is somewhat problematic if the stimuli or responses are not easily partitioned into halves. The most prominent modification addressing this was proposed by Hyman (1953), and is sometimes called the Hick-Hyman law. Hyman noted that if alternatives are not equally probable, the number of options no longer predicts response time well. Instead, the overall entropy or uncertainty of the stimulus set is a good predictor, so that two alternatives with equal probability might be equally difficult to three alternatives in which one option occurs a majority of the time. Several exceptions to Hick’s law have also been noted (cf. Longstreth et al., 1985). These include verbal responses, highly-practiced responses, and the like. In recent years, a number of computational models have proposed explanations for Hick’s law (i.e., Usher & McClelland, 2002; Schneider & Anderson, 2011), and these offer alternative
explanations that, although somewhat consistent with Hick and Hyman's information-theory accounts, identify alternate mechanisms.

In recent times, research has shown the 'paradox' of choice (Schwartz, 2004): that although we prefer to have more options when making a decision, our decisions can sometimes be worse when given more options. This is at least partly consistent with Hick's finding. It takes us longer to make decisions with more options, but the time spent evaluating each option may go down. This, in the long run, may lead to poorer overall examination of options, or a willingness to decide before all options are considered.

**Detailed Explanation of Lesson**

**Preparation**

*Installation.* Using an existing computer lab is recommended for this activity. Pre-install the required PEBL software before the lab activity.

*Number of participants.* The relationship between number of options and response time is highly reliable, and can even be shown on an individual level if sufficient data are collected.

*Time requirements.* The default Hick's law experiment takes about six minutes to collect data, with 50 trials per condition, and 1,2,3,4,6, and 8-option conditions being tested. The number of trials can be reduced somewhat to make a shorter study or the number of options can be reduced. Even with 50 trials per condition, there will often be particular conditions that deviate substantially from the Hick's law prediction, and so it may be useful to either increase the number of trials, or pool students' data together. For classes with limited time, one or two students serve as demonstrators (watched by the rest of the class).

**Implementation**

*Data Interpretation.* Depending on the capabilities of the students, the instructor may need to act as the data coordinator, entering the data into a spreadsheet projected on a screen as students complete the task. Along with the summary data provided at the end of the task, each trial is recorded in another data file, allowing substantially deeper examination of the data.

*Secondary Lessons.* Depending on the goals of the instructor and the learning objectives of the course, the present activity could be used or adapted for the following learning objectives:

1. Experience conducting a true or quasi-experiment.
2. Introductory tasks for creating graphs using a spreadsheet
3. Basic foundations of Human-factors design
4. Introduction to response time interpretation.
5. Discussion of the concept of a confounding variable. In the baseline test, number of options is confounded with order of testing, and number of options is also confounded with centrality of the stimulus on the screen. Manipulations and counterbalanced conditions could be designed to reduce or avoid these confounds.

References


**Additional Material**

**Background**

http://en.wikipedia.org/wiki/Hick%27s_law

**Usability:**

http://www.usabilityfirst.com/glossary/hicks-law/
http://www.smashingmagazine.com/2012/02/23/redefining-hicks-law/
http://3.7designs.co/blog/2010/07/ten-laws-to-design-by/

**Decision Making:**

http://www.forcenecessary.com/article-hicks-law/ “Hick’s law in combat”


**Background and Instructions for Hicks Law Laboratory Demonstration**

Hick’s law (Hick, 1952) generally describes the phenomenon that it takes us longer to decide between more options that fewer, and but that the cost per option diminishes. For example, suppose you were stopped at a stop light on a multi-lane road, but different lanes will get a green light before others. Suppose on a one-lane road, it might take 0.5 seconds to hit the accelerator after the light turns green. If there were two lanes, and you needed to decide whether the changing light was for your lane or another lane, it might take 0.8 seconds: longer than just a single lane, but less time (0.4 s) per lane. In laboratory tests, this relationship tends to follow a logarithmic relationship, meaning that as the number of options increases, the time increases but the amount of increase gets smaller with more options. This law has important implications for how we design software interfaces, how we can react to signals while driving, and the like.

In this lab, you will collect data in a short demonstration of this effect. To do so, you may need to download and install PEBL Version 0.14 or later onto your computer (Windows or OSX). Instructions for doing so are below. If PEBL is already installed on your computer, you may go on to the next step.

**A. Download and install PEBL 0.14**

If PEBL is not already installed on your computer, the newest version of PEBL can be obtained at http://sourceforge.net/projects/pebl/files/pebl/, or http://pebl.sf.net/downloads.html. The most recent version of PEBL is 0.14, but in the future other versions may be available.

**MS Windows:**

If you are able to install software on your computer, download the setup.exe file and install on your computer. You will need to enter your administrator password to install PEBL. The first time PEBL is run, it will copy the testing files to your Documents folder in a folder called pebl-exp.0.14\. After that, when PEBL is run (by clicking on an icon in your programs menu), the PEBL launcher will run, shown in section B below.

If you are unable to install software on your computer, download the PEBLPortable.14.zip file. Unzip this anywhere on your computer (i.e., your desktop or
Documents directory), and click on the file called runpebl to start the launcher. Instructions can be found at http://peblblog.blogspot.com/2014/03/running-pebl-without-installing.html

Macintosh OS X:  
The OS X package can be downloaded from the same location as above, with a file named pebl-osx_0.14.zip. To run, download onto your computer and uncompress the .zip file. PEBL will run by double-clicking on the pebl application bundle, but you may want to copy this to your Applications folder. Depending on your security settings, OSX may say that the application is not trusted. To run an application that is not trusted, right-click (or ctrl-click) on the icon and run it from that menu. More information can be found at: http://peblblog.blogspot.com/2014/02/installing-pebl-013-on-mac-osx-109.html

B. Select the hicks law base experiment

PEBL Version 0.14 (Mueller, 2014) is a software platform for developing computerized psychological experiments. When you open PEBL, the launcher window below will appear. Many of the options in the launcher are useful for laboratory experiments. For this demonstration, simply navigate to the hicks directory (in the “File listing” scrollbox on the left) by clicking twice on ‘battery’, scrolling down, and then clicking twice on “hicks”. Once you have opened the hicks folder, select hicks.pbl, but don’t continue until you read the next section. Note that your data will be stored in a file related to the ‘Participant Code’ selected near the top middle of the screen.

The hicks law study involves making 50 responses in a number of conditions (the baseline experiment uses 1,2,3, 4, 6, and 8-option conditions), involving the screen below. For each condition, you will place your hands on the number line of the keyboard,
and make a response corresponding to a lit up number. A single run should take about 6 minutes, and when you are done, a screen will appear showing your response times across conditions of the study.

C. **Start the study.** To start the study, be sure 'hicks.pbl' is selected and click on the 'run selected test' button. When you are complete, your data will appear on-screen, and you should record the mean values before exiting the study. Those numbers will also be available in the 'debug messages' window at the bottom of the screen following the study. You can open this file (to copy it to a spreadsheet) using the “Open debug output” button.

<table>
<thead>
<tr>
<th>Debug messages</th>
<th>Error messages</th>
<th>Reload</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mon May 12 13:19 2014</strong></td>
<td><strong>Closed time:</strong> 6.00262 min</td>
<td><strong>Participant code:</strong> share</td>
</tr>
<tr>
<td>Numoptions</td>
<td>Options</td>
<td>responses</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>56</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>567</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>4567</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>345076</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>25456789</td>
<td>50</td>
</tr>
</tbody>
</table>

D. **Identify data**

Once complete, a table describing the data will appear on the final screen of the experiment. You can record those numbers on paper or transfer them to a spreadsheet. The table will also appear in the bottom of the 'Debug messages' window at the bottom of the screen, and in a file in hicks\data\XX, where XX indicates the participant code originally entered at the top of the screen.

The table shows one line per condition. Two important dependent variables are shown: accuracy (percent correct), and response time (in ms, or 1/1000s of a second). In the above screen, it took about 1/4th of a second to decide between two options, and about a half second to decide between eight options. It will be typical for error rates to be above 90%, and not depend on number of options. However, with 40 trials, mean response time should typically increase as number of options increases.
E. Create an x/y (scatterplot) of your data using a spreadsheet.
Transfer the data into a spreadsheet and create a scatterplot of the results. Below is an example created using several runs of the test with different numbers of options (1-8). Also, the figure plots the relationship that Hick obtained. Remarkably, the values collected by Hick more than 60 years ago are nearly identical to those produced by this software. However, there is a caveat: the data produced in this demonstration appears to be more linear than Hick's data. Your own data may or may not show this same effect.

![Hick's Law Relationship](image)

It might have arisen because the options were labeled with the key you were supposed to press; perhaps labeling with another character would produce a strong effect. But before we can claim assert that Hick's law is dead though, we must recognize that Hick's data were collected after thousands of practice trials, and using hundreds of responses. Consequently, the law might be difficult to see with a modest amount of noise, or it might only apply after substantial practice.

F. Modifying the Test
Now that you have completed one run of the experiment, click on the 'Edit' button near the parameters pulldown at the center of the PEBL launcher. A screen like the one below should appear:

![Screenshot](image)

This screen allows you to control many aspects of the experiment. The final five rows allow you to specify the response options used in each round (up to five rounds). You can select any subsets of the numbers 1..0 for any particular round. Several parameters are colors, and you can use the names of many colors here. Levels of grey can be
specified using grey0 (black) to grey100 (white). Look at each parameter and think about what changing it might do to performance in the test. To use adjusted parameters, click the 'save file and exit' button.

G. Hypothesis Generation.
Now, you need to generate a hypothesis that can be tested with this experiment. Although the original experiment examined the relationship with number of options, many other aspects of the experiment might lead to changes in a dependent variable (either response time or accuracy). You can manipulate aspects of the experiment (number of options, color of options, which options are used, which fingers or hands are used to respond), or you can manipulate things outside the experiment (i.e., speed-accuracy instructions, distraction, etc.). One way to help generate a hypothesis is to look at your own experiences in the world. Think about similar situations, and try to identify how the current study might look different under those circumstances.

Before you begin, be sure to state clearly a testable hypothesis, in the form of a hypothetical relationship between independent and dependent variables. For Hick’s original study, you might say “I hypothesize that as the number of options gets larger, the response time will increase”.

H. Test new hypothesis.
Using one or more additional runs, test your hypothesis. This will probably involve collecting at least one additional control run for comparison to an experimental run. Using your spreadsheet developed earlier, graph these new findings in a way that illustrates whether or not there is a difference between conditions.

I. Discuss results and implications.
After you collect your data, determine whether your hypothesis was supported. It can be difficult to be certain about this without running statistical tests, but make a reasonable argument about the effect based on mean response time. You should consider how and whether these findings relate to software design, decision making, consumer choice, safety, and other applied domains.

A spreadsheet that can be copied or downloaded to record and display Hick’s Law Data is available at:
https://docs.google.com/spreadsheets/d/1fW6k2hFniBVHqKzXosEosR-pFLKU6iG2kUYPfrzEZgc/edit?usp=sharing
Additional Manipulations. The following are some ideas with comments about potential experimental manipulations.

- **Speed-accuracy manipulations.** Without making any changes to the task, a speed-accuracy manipulation could be performed. For this manipulation, the student would perform the test twice under two different instruction conditions. This also maps closely onto Hick's (1952) Experiment 3.

- **Distraction or Dual-task conditions.** Some very successful manipulations have included different dual-task or distraction conditions. Some variations include requiring a memory load, requiring concomitant tapping, or having experiments talk to the participant while doing the test.

- **Stimulus-response compatibility.** The labels given to the stimulus can be changed in the parameter setting dialog. This could be used to make responses incompatible (duplicating number labels, reversing their order, etc.)

- **Gender comparisons.** These are typically very easy to conduct, but because individual differences typically swamp any potential gender differences, the results will be difficult to interpret, and any observed gender differences are likely to occur simply because of random chance.

- **Handedness.** An easy manipulation is to test whether a student's dominant versus non-dominant hand produces similar Hick's law effects.

- **Finger/position manipulations.** A potential confound in the default design is that smaller numbers of options are more central. Alternate conditions could be used to compare several versions of two-option tests. For example, 5-6 responses could be compared to 4-7 responses, or 6-9 responses.

Adapting for other tasks. The PEBL test battery (Version 0.14) provides more than 80 tests, many of which could be substituted for the Hick's law in different classes. The Fitts law demonstration makes a nice comparison.