Example Instructional Materials

The purpose of these materials is to provide further specific suggestions on the integration of diversity-related topics in biopsychology courses. We offer examples of instructional activities that can be implemented in the classroom using an economy of resources and include an overview, list of discussion questions, and some example assessment items for each of these activities. We have selected one topic from each of the content units identified in the manuscript for the purpose of diversifying our recommendations.

Example of a Cellular/Molecular Activity: Cellular Reproduction, Telomeres, and Biomolecular Diversity

The purpose of this activity is to examine the diversity of life experiences associated with changes in cellular/molecular structure and function. Specifically, this activity will explore the effects of different psychosocial, behavioral, and environmental factors on cellular biomolecular aging by discussing current literature regarding cellular division in the central nervous system, biomolecular aging, and neurological disorders. This will be accomplished in a "think-pair-share" style review of experimental methods and findings regarding telomere length and their association with elements detailed in Starkweather et al. (2014).

Instructors should begin with an overview of cortical development including prenatal/postnatal cellular proliferation, symmetrical/non-symmetrical cell division, apoptosis, and pruning. Emphasis may be placed on the following points (adapted from the article):

- The purpose of this article was to summarize and critically evaluate the current state of knowledge regarding telomere length in humans.

- Telomeres are protein-bound DNA repeat structures at the end of chromosomes that regulate cellular replicative capacity, protect chromosomes from fusing together during mitosis, and prevent the loss of genetic data (Blackburn et al., 2006).
- Telomere length has emerged as a promising biomarker to assess the cumulative influence of psychosocial, environmental, and behavioral factors on complex disease risk, such as cancer.
    - Telomere shortening plays a protective role by limiting the proliferative capacity of cells that have sustained DNA damage and are vulnerable to oncogenic transformation.

Instructors can then split students into small groups where they will review a small excerpt from Starkweather et al.'s (2014) review of factors affecting human telomere length and its association with biopsychological outcomes.

- Group 1 reviews Table 6 – Psychosocial Factors: Childhood Maltreatment (p. 26)
- Group 2 reviews Table 7 – Psychosocial Factors: Mental Health (p. 27)
- Group 3 reviews Table 8 – Socioeconomic Status and Educational Attainment (p. 28)
- Group 4 reviews Table 3 – Chronic Psychological Stress (p. 23) and Table 5 – Maternal Stress (p. 25)
- Group 5 reviews Table 8 – Behavioral Factors: Physical Activity (p. 30)

All groups should review the introduction, along with the results paragraph associated with their assigned table. Each group represents different factor(s) studied across several reports, and group members work in collaboration to summarize their findings and present the outcome of their research to the rest of the class.

Alternatively, all groups can discuss the same set of tables that represent a specific area (e.g., the relationship between mental health and telomere length) being covered in the course and discuss a subset of questions relevant to that topic.

Example Discussion Questions

1. Describe in your own words: What is/are the major factor(s) assessed and represented in your table(s)?
   a) How is that factor measured in different studies? (e.g., reported childhood sexual abuse, physical abuse, adverse life events)
   b) What is the overall effect of that/those factor(s) on telomere length?
2. Are the results consistent across different experiments?
   a) If yes, how does this affect your interpretation of the validity of these effects?
   b) If not, what could be some reasons why differences emerge across reports?
3. How many different methods were used across the studies in your table(s)? Were outcomes consistent across those different methodologies?
4. Choose three articles from your table(s) to examine in more detail.
   a) In what ways did the articles differ in their group designs?
   b) How were differences in experimental design associated with differences in experimental outcomes in the reports?

Example Multiple Choice Question

What is the overall effect of environmental, behavioral, and social stressors on telomere length in dividing cells? Telomere length is…

A) …increased, leading to prolonged cellular division rates.

B) …increased, leading to shortened cellular division rates.

C) **…shortened, leading to higher rates of telomere erosion and potentially cell death.**

D) ...shortened, leading to lower rates of telomere erosion and potentially cell death.

E) ...unchanged and does not contribute to the longevity of neuronal cells.

Example Short Response Prompt

Identify three environmental factors that can result in changes in telomere length. For each factor, (a) give an example and (b) describe how *specifically* it affects telomere length (i.e., does it increase or decrease telomere length).

Example of a Systems/Neuroanatomy Activity: Divergent Spatial Acuity using the Two-Point Discrimination

The purpose of this activity is to demonstrate neurological diversity within and between individuals. Students will measure perceptual abilities derived from activation of the somatosensory system and measure differences in their own perception of a stimulus (depending on where it is presented), as well as the fact that two people might have different abilities to detect stimulus features even when an object is presented in a similar fashion.

The two-point discrimination task is an activity that can be accomplished in small groups (2-3) and requires two stimulus probes that contain a fine tip (such as a paperclip or toothpick). In this task, one student, the "participant", closes their eyes is presented with the two stimulus probes gently on a skin surface (for example, a fingertip). The participant is asked to verbally identify whether they perceive "one" or "two" tips. The experiment begins by having the probes presented next to one another, which the participant identifies as "one tip". As the points move farther and farther away, the participant is less likely to perceive "one tip", and eventually correctly identify the presence of "two tips". However, even on the finger (a sensitive area of the body), this does not occur immediately if the tips are moved apart slowly; participants will continue to identify the two probes as "one tip", even when the points are slightly separated. Once the participant identifies "two tips", students can measure and record the minimum separation distance that required for the participant to be able to distinguish between "one" and "two" tips. This process can be repeated across multiple areas of skin in accordance with student comfort levels, such as the fingertips, arm, shoulders, upper back, and/or legs. After the experiment is conducted, the students can switch roles and the student who began by presenting the probes can become the "participant".

Two observations will likely emerge over the course of this experiment:

- The minimum distance required to identify two points is different across various areas of the skin, illustrating that perception is not absolute and depends not only on *what* is presented, but *how* it is presented.
- Despite similarities across individuals in spatial acuity (the fingertip, for example, is often more sensitive than the arm), it is rare that two people will have the exact same measurements.

This difference emerges because everyone has a slightly different spatial perception, which emerges from the naturally occurring variation in sensory systems across individuals (and importantly, variation within a task that should be objective).

This task highlights differences in sensory systems that illustrates neurodiversity. There are many illustrations of this fundamental point, including auditory perception (e.g., differences between individuals to detect a low-frequency tone), colorblindness (e.g., differences between individuals' abilities to perceive colors), and even taste preferences. We recommend this task specifically because it can be accomplished in most classrooms and it is not prohibitive in terms of technology or materials, so it can be simultaneously administered among dozens of individuals. Additionally, this activity is distinct because students are not likely to have discussed spatial acuity differences outside of the classroom (other differences, such as taste, visual perception, or auditory perception, might be more frequent items of conversation).

Example Discussion Questions

1) Was spatial acuity uniform across the body for each participant individually?
   a) What areas were most similar?
   b) What areas were most different?
   c) What might be the reason for having differences in spatial acuity across the body?
   d) Do we perceive the same stimulus in a similar fashion under all circumstances?
      i) What is an example of a real-life implication of this finding?
2) Was spatial acuity uniform across both participants?
   a) What areas were most similar?
   b) What areas were most different?
   c) What kinds of common features of the nervous system might account for the similarities observed?
   d) What kinds of divergent features of the nervous system might account for the differences observed?
   e) Would it be possible for two people to have the exact same spatial acuity?
      i) Explain your response.
   f) What are some factors that might influence spatial acuity and explain differences?
   g) Do you think that the brains of these two individuals are identical? Use your findings to justify your response.

Example Multiple Choice Question

The two-point discrimination task uses stimulus probes presented to the skin and measures the minimum distance required to distinguish one point from two. This task demonstrates that…

A) **…spatial acuity varies across different areas of the body.**

B) …spatial acuity varies between people, but not within individuals.

C) …sensory perception is identical when examined across individuals.

D) …on most parts of the body, it is impossible to distinguish one tactile stimulus from two, no matter how far apart they are.

Example Short Response Prompt

Describe the outcome of the two-point discrimination task. What does this task tell us about sensory perception across individuals (is it uniform or different from person-to-person)?

Example of a Cognitive/Behavioral Activity: Declarative Memories and Eyewitness Testimony

The purpose of this activity is to demonstrate the variability of recognition memory between individuals using an animated facial recognition task. This exercise allows students to reflect on the sociocultural implications of recognition memory in the context of eyewitness misidentifications.

Prior to class, students should be instructed to review a PBS/Frontline interview transcript with Elizabeth Loftus (Frontline, 1997), which includes her responses to questions regarding effects of attention, stress, and cross-race effects on memory retrieval accuracy. Students should also review a special feature from the Innocence Project (Innocence Staff, 2020) characterizing the direct effects of subject misidentification on wrongful conviction rates and how recognition memory (especially cross-race identifications) can be altered through the use of suggestions by interviewing officers or hearing testimonies from other witnesses.

In class, the instructor may review some of the different types of learning and memory, with particular attention towards perceptual learning, recognition memory, and episodic memory. It may be beneficial to discuss various perceptual learning tasks students may encounter in everyday activities (e.g., getting better at distinguishing between the voices of friends after spending more time with them) and reviewing facial recognition as a form of visual perceptual memory that results from plastic changes in the fusiform face area in humans.

Students can then engage in a facial memory task (see Chudler, n.d.). In this activity, students must memorize random features of a human face caricature and recall those features to reconstruct a composite of the original face. When students hit "Start", the program generates a random combination of features to construct a face for the student to memorize (the encoding phase). Instructors should give a set time for this encoding period (e.g., 30 seconds). When students hit "Ready", the face is removed and students can select the features that correspond to each of ten elements in the original face. When finished, students hit "OK" to see their accuracy score (from 1-10) based on the number of features they correctly recalled. The trials can be repeated as students record their results and compare them between the first and final trials of the experiment.

Discussions regarding recognition memory and eyewitness testimony can relate the topic of learning and memory to real-world consequences while incorporating biopsychological processes such as synaptic plasticity (Tsanov & Manahan-Vaughan, 2008) and parietal lobe activity (Tranel et al., 2009) that contribute to this task. Additionally, after repeated trials of the facial recognition task, students may observe improvement in their recognition memory, as the program repeats the same features randomly throughout the trials. This can be related to the sensory processing in the fusiform face area and how the level of experience with specific facial features (e.g., within a racial group) could contribute to variability in recognition memory.

Example Discussion Questions

1) Was there variation in recognition memory across participants?
2) Did recognition memory change with an increased number of trials?
    a. What does this tell you about the speed of synaptic changes?
3) Was there anything about the conditions under which you took this task that might have contributed to your performance?
    a. Describe the implications of this for everyday memory formation.
    b. Describe the implications of this for eyewitness testimony.
4) What cortical regions might be involved in the retrieval of episodic memory of an event?
    a. How might these cortical areas be affected by stress?
5) Discuss how memory consolidation might contribute to the incorporation of false information into the memory.

Example Multiple Choice Question

Eyewitness memory can be problematic during criminal trials because:

A) **The cross-race effect reduces recognition memory and increases misidentification rates when witnesses and potential suspects are from different racial groups.**
B) Episodic memory is a near-perfect reflection of the original event, making prosecutor cross-examination more difficult.
C) Details encoded during sensory learning require additional information from other bystanders to be transferred to long-term memory.

D) Episodic memories retrieved long after the event has occurred are often more accurate, giving an unfair advantage to the prosecution.

Example Short Response Prompt

Imagine you are a bystander to a purse snatching near your home, which you perceive as a stressful event. Three days after you witness the event, you are asked to recall and describe the events in a room with other witnesses as they also recount their observations. Ten days later, police tell you they have a suspect in custody, and you are called in to identify the suspect in a line up. (a) Describe how the encoding and consolidation stages of memory processing might be affected by environmental features in this example. (b) From a biological standpoint, is the memory you retrieve at the 10-day time point represented the same way as the one retrieved at the 3-day time point? Why/why not?

Example of a 12-week Course Schedule with Embedded Diversity-Related Topics

The following is an example class schedule for a 12-week introductory neuroscience course that connects with diversity-related topics (i.e., race, ethnicity, gender identity/expression, sexual orientation, age, religious affiliation, health and disability status, national identity and immigration status, social class, and sex) and/or general diversity (e.g., plasticity, understanding human differences) several times within each unit. Also included is a sample class schedule for one of those units to provide further examples for how diversity-related topics might be distributed during a course meeting.

We have included three example topics per week to facilitate common course scheduling (twice or thrice weekly meetings). Additionally, we have included recommendations for where to incorporate these topics during instruction by providing some examples of related topics typically included in neuroscience courses; these topics have been underlined for emphasis and ease of identification.

Cellular/Molecular Foundations

- Week 1: History and foundations
  - Phrenology and racism
    - Incorporate into discussion of historical figures and localizationism
  - How neuroscience research contributes to understanding of diversity
    - Incorporate into discussion of objectives of neuroscience research
  - Neuroscience and public policy
    - Incorporate into discussion of applications of neuroscience
- Week 2: Cell biology
  - Telomere length and biological aging

    - Incorporate into discussion of nucleus and gene expression
  - Eugenics and racism
    - Incorporate into discussion of gene expression and genetic engineering in research
  - Dendritic morphology, health, and aging
    - Incorporate into discussion of neurites and general cell anatomy
- Week 3: Action potentials
  - Myelination and multiple sclerosis
    - Incorporate into discussion of the axon and saltatory conduction
  - Disorders associated with mutations of channel proteins
    - Incorporate into discussion of membrane properties and proteins
  - Action potentials, stress, and aging
    - Incorporate into discussion of action potential conduction
- Week 4: Synaptic transmission
  - Epilepsy and seizures
    - Incorporate into discussion of post-synaptic potentials
  - Mechanisms of action for antidepressant and anxiolytic drugs
    - Incorporate into discussion of post-synaptic potentials, GABA receptors, and transporter proteins
  - Drugs of abuse
    - Incorporate into discussion of chemical transmission and receptor trafficking

Neuroanatomy and Systems

- Week 5: General neuroanatomy
  - Historical foundations of neuroanatomy and racism
    - Incorporate into discussion of brain size, gyri, and sulci
  - Hemispheric asymmetry and sex
    - Incorporate into discussion of cerebral hemispheres
  - Brain damage and functional recovery
    - Incorporate into discussion of cerebral arteries and stroke
- Week 6: Sensory systems
  - Two-point discrimination task
    - Incorporate into discussion of mechanoreceptors and the somatosensory cortex
  - Neuroplasticity in primary sensory cortices
    - Incorporate into discussion of somatosensory, auditory, and/or visual cortex
  - Blindness, colorblindness, hearing impairment, and/or deafness
    - Incorporate into discussion of sensory receptors, sensory pathways, and cortical processing of environment
- Week 7: Motor systems
  - Neuroplasticity in motor cortical areas
    - Incorporate into discussion of motor cortex
  - Parkinson's and Huntington's disease
    - Incorporate into discussion of basal ganglia
  - Cerebellar hypoplasia

        - Incorporate into discussion of cerebellum

- Week 8: Neurohormones, autonomic nervous system
    - The stress response
        - Incorporate into discussion of hypothalamus, pituitary, and hormones (i.e., ACTH, cortisol)
    - Social hormones and sex
        - Incorporate into discussion of hypothalamus, pituitary, and hormones (i.e., oxytocin, vasopressin)
    - Socioeconomic status and autonomic activity
        - Incorporate into discussion of autonomic nervous system

Cognition and Behavior

- Week 9: Development
    - Organizational effects of estrogens and androgens
        - Incorporate into discussion of hormone influences on brain development
    - Language development and bilingualism
        - Incorporate into discussion of critical periods
    - Social neuroscience and cross-race effects
        - Incorporate into discussion of the impact of childhood experiences
- Week 10: Mental health, disease, disorders, and neurodiversity
    - Sociocultural health disparities: prevalence and treatment of mental illness
        - Incorporate into discussion of diagnosis, prevalence, and treatments
    - Effects of trauma and environmental stressors
        - Incorporate into discussion of depression, anxiety, and PTSD

  - Neurodiversity, neurotypicals, and neurominorities
    - Incorporate into discussion of <u>autism spectrum disorder</u>
- Week 11: Circadian rhythms and sleep
  - Environmental influences on circadian rhythms
    - Incorporate into general discussion on <u>circadian rhythms</u>
  - Connections of between circadian rhythms and disease
    - Incorporate into discussion of <u>health outcomes associated with circadian rhythms</u>
  - Socioeconomic status sleep disparities
    - Incorporate into discussion of <u>health outcomes associated with sleep</u> and the <u>cognitive effects of sleep</u>
- Week 12: Learning and memory
  - Memory retrieval and eyewitness testimony
    - Incorporate into discussion on <u>memory stages</u> and <u>protein synthesis</u>
  - Role of learning and unconscious memory systems in stereotypes and racism
    - Incorporate into discussion of <u>memory systems</u> and <u>outcomes of learning</u>
  - Memory enhancement, memory impairment, and amnesia
    - Incorporate into discussion of <u>biological mechanisms of memory</u> and <u>health outcomes associated with memory</u>

Sample Class Schedule for a Course Meeting covering Sensory Systems (Week 6)

1) Mechanoreceptors and somatosensory pathways
    a) Touch pathways
    b) Pain pathways
    c) Mechanisms of altered sensation (age, health and disability status)
2) Primary somatosensory cortex
    a) Somatotopic mapping
    b) Plasticity in somatosensory cortex
        i) Brain maps and phantom limbs in amputees (health and disability status)
            (1) Borsook et al. (1998)
        ii) Discussion of early-life experience on maps (age)
            (1) Seelke et al. (2012)
    c) Experience-dependent somatotopic remapping
        i) Jenkins et al. (1990)
        ii) Discussion: sociocultural norms, jobs, tasks, and experiences that could shape cortical development (ethnicity, national identity, religious affiliation)
3) Connections between somatosensory system and visual/auditory systems
    a) Receptors
    b) Sensory pathways
    c) Cortical areas
    d) Discussion: mechanisms of deafness/blindness (health and disability status)

References

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