Discovering Behavioral Neuroscience 5th edition Freberg Solutions Manual

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Discovering Behavioral Neuroscience 5th edition Freberg Solutions Manual

Instructor Manual

Laura A. Freberg, Discovering Behavioral Neuroscience: An Introduction to Biological Psychology, 2024, 9780357798256; Chapter 01: What Is Behavioral Neuroscience?

TABLE OF CONTENTS

Purpose and Perspective of the Chapter **3**
Chapter Objectives **3**
Complete List of Chapter Activities and Assessments **3**
Key Terms **4**
What's New in This Chapter **6**
Chapter Outline **6**
Additional Discussion Questions **16**
Additional Activities and Assignments **16**
Lecture Enrichment **16**
II. B. 4. – Unusual Circumstances Surrounding the Death and Burial of René Descartes 16
Section III. C. – Using Neuroimaging Examples in the Classroom 17
Supplemental Teaching Strategies and Tools 17
Discussion of Trepanation 17
Understanding Fluid Dynamics as a Functional Model of the Nervous System 18
Discussion of Neuroimaging Techniques 18
Clicker Questions For Audience Response Systems **18**
Additional Resources **20**
External Videos/Film Clips 20
Primary Sources and Supplemental Reading 22
History of Neuroscience 22
High-Power Magnets and Aversive Physiological Effects 22
Handbook of Functional Neuroimaging of Cognition 23

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Discovering Behavioral Neuroscience 5th edition Freberg Solutions Manual

Open Science Resources 23
Ethical Use of Animals in Research 23
Public Policies and Stem Cell Research 24

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Purpose and Perspective of the Chapter

The purpose of this chapter is to provide an overview of behavioral neuroscience approaches, including classification of various neuroscience subfields, discussion of major historical findings, and a description of various brain imaging technologies and study designs. Open science approaches and ethical research practices for working with human and animal subjects will also be discussed.

[return to top]

Chapter Objectives

The following objectives are addressed in this chapter:

1. Classify the subfields of neuroscience and explain how behavioral neuroscience fits within the field.
2. Interpret the significance of the major historical highlights in the study of the nervous system.
3. Differentiate the brain imaging technologies, including CT, PET, SPECT, MRI, fMRI, fNIRS, and DTI.
4. Assess the use of microscopic the use of microscopic, peripheral, recording, stimulation, optogenetic, lesion, and biochemical methods in behavioral neuroscience.
5. Analyze the relative strengths and weaknesses of twin studies, adoption studies, and molecular genetics for understanding behavior.
6. Evaluate the contributions of open science approaches and ethical research practices to progress in behavioral neuroscience.

[return to top]

Complete List of Chapter Activities and Assessments

The following table organizes activities and assessments by objective, so that you can see how all this content relates to objectives and make decisions about which content you would like to emphasize in your class based on your objectives. For additional guidance, refer to the Teaching Online Guide.

Chapter Objective	Activity/Assessment	Source (i.e., PPT slide, Workbook)	Duration	Certification Standard
LO1	Icebreaker	PPT	5–10 min	
LO6	Think Pair-Share Activity	PPT	5–10 min	

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LO3	Knowledge Check 1	PPT	2 min	
LO4	Knowledge Check 2	PPT	2 min	
LO6	Discussion Activity	PPT	5–10 min	
LO1	Self Assessment Activity	PPT	5–10 min	

[return to top]

KEY TERMS

invasiveness: A measure of the degree of harm involved with a method.

spatial resolution: The ability to see fine detail in an image.

temporal resolution: The ability to obtain information without delay.

facial electromyography (fEMG): The recording of the activity of facial muscles used to assess the quality and intensity of emotional expression.

heart rate variability (HRV): A measure of the variability in the spacing of heartbeats believed to reflect a person's level of stress.

skin conductance recording (SCR): A measure of general arousal taken with surface electrodes placed on the skin; also known as a Galvanic skin response.

eye tracking: A method for identifying where a person is looking and for how long.

pupil dilation: A measure of general arousal and positive or negative reactions to visual stimuli.

positron emission tomography (PET): An imaging technique that provides information regarding the localization of brain activity.

magnetic resonance imaging (MRI): An imaging technique that provides very high-resolution structural images.

voxel: Short for "volume pixel." A pixel is the smallest distinguishable square part of a two-dimensional image. A voxel is the smallest distinguishable box-shaped part of a three-dimensional image.

functional MRI (fMRI): A technology using a series of MRI images taken 1 to 4 seconds apart in order to assess the activity of the brain.

diffusion tensor imaging (DTI): Use of MRI technology to trace fiber pathways in the brain by tracking the flow of water.

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functional near-infrared spectrometry (fNIRS): A method of measuring brain activity similar to fMRI.

electroencephalogram (EEG): The recording of the brain's electrical activity through electrodes placed on the scalp.

event-related potential (ERP): An alteration in the EEG recording produced in response to the application of a particular stimulus.

magnetoencephalography (MEG): A technology for recording the magnetic output of the brain.

single-cell recording: The recording of the activity of single neurons through microelectrodes surgically implanted in the area of interest.

hyperscanning: A method of simultaneously recording brain activity from two or more individuals using fMRI, fNIRS, or EEG.

repeated transcranial magnetic stimulation (rTMS): A technique for stimulating the cortex at regular intervals by applying a magnetic pulse through a wire coil encased in plastic and placed on the scalp.

transcranial electrical stimulation (tES): A method for delivering electrical current to the brain through surface electrodes.

optogenetics: The genetic insertion of molecules into specific neurons that allows the activity of the neurons to be controlled by light.

lesion: Pathological or traumatic damage to tissue.

microdialysis: A technique for assessing the chemical composition of a very small area of the brain.

functional magnetic resonance spectrometry (fMRS): A non-invasive method for assessing changes in the activity of neurochemicals in the brain.

concordance rate: The statistical probability that two cases will agree; usually used to predict the risk of an identical twin for developing a condition already diagnosed in their twin.

heritability: The amount that a trait varies in a population due to genetics.

molecular genetics: A field of study that attempts to link features of organisms to their underlying DNA.

forward screen: A method that begins with a phenotype and attempts to discover its underlying genetic correlates.

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genome-wide association study (GWAS): A method using the entire genome to search for individual genes that vary between particular phenotypes.

reverse screen: The replacement of a gene of interest with a knockout version to discover the effects of the gene on the resulting phenotype.

open science: Initiatives aimed to improve the openness, integrity, and reproducibility of scientific research.

[return to top]

What's New in This Chapter

The following elements are improvements in this chapter from the previous edition:

- Included new Connecting to Research topic: The effects of loneliness on the immune system.
- Added description of applied areas of forensic and consumer neuroscience.
- Introduced organizing principles for evaluating methods: invasiveness, spatial resolution, and temporal resolution.
- Added section on peripheral methods, including facial electromyography, heart rate variance, skin conductance, eye tracking, and pupil dilation. Related the use of these technologies to applied fields, such as consumer neuroscience.
- Added description of functional near-infrared spectrometry (fNIRS), hyperscanning, EEG microstates, transcranial electrical stimulation (tES), and functional magnetic resonance spectrometry (fMRS).
- Added section on Open Science related to neuroscience, including discussion of power and fMRI studies.

[return to top]

Chapter Outline

The following outline organizes activities (including any existing discussion questions in PowerPoints or other supplements) and assessments by chapter (and therefore by topic), so that you can see how all the content relates to the topics covered in the text.

I. Neuroscience as an Interdisciplinary Field (PPT Slides 5–6)

The following film clips provide interesting insights into how and why we study neuroscience and make a good introduction to this unit:

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Film Clip #1: Discovering the Human Brain: New Pathways to Neuroscience

Film Clip #2: V.S. Ramachandran at Beyond Belief 2.0

Film Clip #3: Jill Bolte Taylor on T.E.D.

A. **Neuroscience** is an interdisciplinary area of study involving psychology, biology, chemistry, medicine, mathematics, physics, engineering, and computer science.
B. The functions of the brain and nervous system are studied on many different levels.
    1. The molecular level focuses on DNA, RNA, proteins, and gene expression and includes the subtopics of neural cell physiology and psychopharmacology.
    2. The cellular level is concerned with the structure, physiological properties, and functions of neural cells.
    3. The synapse level defines the connections between neural cells at the synapse. Synaptic neuroscience studies the strength and flexibility of these connections and the implications on complex processes, such as learning and memory.
    4. At the network level, neuroscientists study how interconnected neurons form pathways.
    5. Behavioral neuroscience seeks to understand the biological correlates of behavior, using all of the previous levels of analysis.
    6. All analytical levels use computational neuroscience to develop computational models that can be compared to living systems.
C. Researchers have a specific interest in the relationships between the nervous system and behavior.
    1. Neurological illnesses have economic costs. For example, delaying the onset of Alzheimer disease by 5 years would save $50 billion annually in health care costs in the United States.
    2. Connections between biology and behavior are relevant to neurological diseases and to overall health, as many health conditions (e.g., diabetes, cancer) are tightly linked to behavior.
    3. Nervous system responses are linked to behavioral scenarios, such as relationships, parenting, child development, and thinking and learning. Understanding the interaction between the nervous system and behavior can promote well-being.

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Behavioral Neuroscience Goes to Work: What Can I Do with a Degree in Neuroscience? (p. 4)

II. Historical Highlights in Neuroscience (01.05 through 01.08, PPT Slides 7–11)

A. Key points

1. Although some periods of enlightenment regarding the relationship between the nervous system and behavior emerged among the Egyptians and Greeks, the major advancements in biopsychology such as the understanding of electrical activity and functional neuroanatomy have been relatively modern and recent, being established within the last 200 years.
2. We take for granted that the brain and nervous system are the sources of intellect, reason, sensation, and movement. This disarmingly simple fact has not been universally accepted throughout human history.
3. The history of neuroscience parallels the development of tools for studying the nervous system.

B. Ancient people's view of the nervous system

1. Trepanation, the drilling of holes in the skull, may represent a prehistoric understanding of the brain's role in behavior.

   **See the Supplemental Teaching Strategies and Tools section for additional information regarding the modern day use of trepanation.*

2. The Edwin Smith Surgical Papyrus indicated an understanding that paralysis and lack of sensation were due to damage to the nervous system. In addition, Egyptians discarded the brain during mummification yet provided modern-sounding descriptions of structure and the effects of brain injury, including the irreversible nature of brain trauma.
3. Ancient Greeks understood that the brain was the organ of sensation.

   **See the Supplemental Teaching Strategies and Tools section for additional information regarding the use of fluid dynamics as the functional model of the nervous system.*

   a. Hippocrates understood that epilepsy originated in the brain.
   b. Galen made many accurate anatomical observations but continued the misunderstanding of the role of the ventricles and the central nervous system as a fluid-filled network of interconnected tubes.

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4. René Descartes (1596–1650)

   **See the Lecture Enrichment section for additional information regarding the unusual circumstances surrounding the death and burial of René Descartes.*

   a. Continued the notion that fluids produced movement.
   b. Proposed **mind–body dualism**, which maintains that the body is mechanical and the mind is neither physical nor suited to scientific observation as opposed to the modern monism philosophical perspective that the mind is a product of physical neural activity.

Clicker Question #1

5. Discovery of the light microscope by Anton van Leeuwenhoek in 1674. (p. 8)
6. In the late 1700s, Luigi Galvani and Emil du Bois-Reymond established electricity as the mode of communication used by the nervous system.

   Figure 1.4 is an interesting depiction of Galvani's basement laboratory where he connected wires from a rooftop antenna to the legs of frogs to demonstrate that electrical disturbances could stimulate the leg muscles of the frogs.

7. Charles Bell (1774–1842) and François Magendie (1783–1855) demonstrated that sensory and motor information travel in separate pathways.

C. Modern neuroscience
   1. Camillo Golgi, an Italian neuroanatomist, developed new staining techniques allowing the visualization of the structure of single neurons. Santiago Ramón y Cajal, a Spanish neuroanatomist, made classic trace drawings of neural circuitry leading to the proposal of the Neuron Doctrine, which stated that the nervous system is composed of separate nerve cells rather than the interconnect network of continuous fibers proposed by Golgi. In 1906, Golgi and Cajal shared the Nobel Prize for their neuroanatomical work and theories.
   2. **Phrenology**, the correlation of bumps on the skull with personal traits and intellectual abilities, was misguided in most respects, but modern in its acceptance that different cognitive functions may be localized to specific areas in the brain.

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3. Work by Paul Broca, who examined the postmortem brains of patients with language deficits, and Fritsch and Hitzig, who observed contralateral muscle movements when stimulating the motor cortex of a rabbit and dog, further established the concept of localization of function in the brain.
4. Hughlings Jackson proposed that the nervous system acted as a hierarchy, with simpler processing carried out by lower levels and sophisticated processing carried out by the cerebral cortex.
5. Charles Sherrington coined the word synapse and conducted research on reflexes and the motor systems of the brain. Otto Loewi demonstrated chemical signaling at the synapse. Sir John Eccles, Bernard Katz, Andrew Huxley, and Alan Hodgkin furthered our understanding of electrical signaling.

III. Behavioral Neuroscience Research Methods (01.08 through 01.22, PPT Slides 12–31)

These film clips illustrate emerging technologies not covered in the textbook. However, this emphasizes the rapid innovations in neurotechnology and the symbiosis between advances in technology and our understanding of the nervous system.

Clicker Question #2
Film Clip #4: Two-Photon Microscope at MIT
Film Clip #5: A Diffusion Spectrum Imaging Tour of the Brain

A. **Histology** refers to the study of microscopic structures and tissues.
   1. Tissue to be viewed must be fixed by freezing or formalin and sliced thinly by a **microtome**.
   2. Stains are applied to highlight structures of interest, such as the structural analysis of single cells (**Golgi stain**), clusters of cell bodies within a central nervous system nucleus (**Nissl stain**), axonal pathways (**myelin stain** or **horseradish peroxidase**), or specific proteins found in a particular cell (antibodies).

B. Autopsy (“to view for oneself”) is the examination of a body after death.
   1. Autopsy as a research method has been largely replaced by imaging techniques.

C. **Peripheral Methods**

   Several non-invasive methods are used by scientist to study emotion and attention.

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1. **Facial electromyography (fEMG)** measures the movement of facial muscles associated with emotional expression.
2. **Heart rate variability (HRV)** can reflect activity of the autonomic nervous system where higher HRV reflects greater parasympathetic (relative to sympathetic) activity, which is associated with better health and well-being.
3. **Skin conductance response (SCR)** examines the activity of sweat glands activated by sympathetic arousal.
4. **Eye tracking and pupil dilation** are assessed with wearable technology to show where and how long the eyes are focused. Pupil dilation is also another measure of arousal, where increased pupil size (dilation) associated with greater sympathetic activation.

D. **Imaging**

Clicker Question #3 Film Clip #6: Mind Reading with Imaging

**See the Lecture Enrichment section for additional information regarding the use of neuroimaging examples in the classroom.*

1. **Computerized tomography (CT)** uses X-ray technology to provide structural information about the brain and ventricles.

   Disadvantages of CT technology include the inability to discriminate between active and inactive regions, and repeated exposures to X-rays.

2. **Positron emission tomography (PET)** provides information about brain activity based on the utilization of radioactive glucose or oxygen, the two primary nutrients needed to produce neural signals.

   Disadvantages of PET technology include a high expense of the machine and the injection of radioactive substances into the participant.

3. **Magnetic resonance imaging (MRI)** uses magnetism and radio frequency waves to provide high-resolution images of structure.

   Although the use of high-power magnetic fields is generally considered safe, as larger magnets are employed, questions arise about their effect on the physiology of the body. MRI

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technology provides significantly higher resolution images than CT; however, MRI technology is much more expensive than CT technology.

**See the Supplemental Reading section for additional information regarding the potential negative effects of exposure to high-power magnetic fields.*

Film Clip #7: How MRI Works

4. **Functional magnetic resonance imaging (fMRI)** uses a series of images taken in a short period of time to analyze brain activity by measuring the flow of blood and oxygen use in the central nervous system.
5. **Diffusion tensor imaging (DTI)** uses MRI machinery to track the movement of water in the fiber pathways of the nervous system. This imaging technique allows scientists to visualize the negative effects of binge drinking on the adolescent brain fiber integrity.
6. Functional near-infrared spectroscopy (fNIRS). This non-invasive technology exposes the head to near-infrared light just outside the visual spectrum. Similar to fMRI, fNIRS method distinguishes between blood carrying a rich supply of oxygen and blood that does not. fNIRS allows for more natural movement compared to fMRI.

Connecting to Research: Thinking About Yourself as Lonely or Socially Connected Can Influence Your Immune System (p. 3)

E. **Recording**

Neural recording methods allow researchers to record the electrical and magnetic output from the brain. Non-invasive recording techniques such as EEG, evoked potentials, and MEG are often used on humans, whereas invasive recording techniques such as single-cell recordings are typically reserved for use in animal research models.

1. **Electroencephalography (EEG)**, useful in examining states of consciousness, such as sleep and epilepsy, is recorded through scalp electrodes. The EEG provides information about the relative activity of large groups of neurons close to the surface of the brain. Recent advances using computerized EEG recordings have enabled the diagnosis of many disorders, such

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as schizophrenia, dementias, epilepsy, and attention deficit disorder. Computerized EEG brain tomography generates maps of brain activity, allowing the identification of the source of abnormal activity.

2. **Event-related potentials (ERPs)**, a specialized use of EEG technology, detect the brain's response to environmental stimuli.
3. **Magnetoencephalography (MEG)**, in which the brain's tiny magnetic output is assessed, provides information about the activity of particular areas of the brain. Often the activity measured through MEG is superimposed on an MRI structural scan of the brain. Measuring magnetism instead of electrical activity reduces the interference of the skull bones and tissues common with EEG.
4. **Single-cell recordings**, using surgically implanted microelectrodes, allow researchers to observe the responses of individual neurons and apply electrical stimulation.
5. **Hyperscanning** involves simultaneous recording of brain activity from multiple individuals and can provide information about the relative synchrony of neural activity during social interactions. It makes use of several imaging and/or recording technologies, including fMRI, fNIRS, or EEG.

Thinking Ethically: Can we Read Minds with Neuroscience Technologies? (p. 16)

F. **Brain stimulation**

Clicker Question #4
Film Clip #8: Deep Brain Stimulation for Parkinson's Disease
Film Clip # 9: Repeated Transcranial Magnetic Stimulation
Film Clip #10: Magnetic Brain Boost
Film Clip #11: Jose Delgado and his Bull

1. Stimulation of the brain is used to assess the functions of particular areas, as well as the areas to which they are connected.
2. Surface electrodes used during neurosurgery assess changes in behavior in response to stimulation in the conscious patient.

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This strategy can identify regions of the brain that participate in certain behaviors (e.g., Penfield).

3. Surgically implanted electrodes allow stimulation of deeper regions of the brain (e.g., Heath, Parkinson disease treatment).
4. **Repeated transcranial magnetic stimulation (rTMS)** can temporarily change brain activity immediately below the stimulation site (e.g., treatment of auditory hallucinations).
5. **Transcranial electrical stimulation (tES).** Similar to rTMS, tES is also a non-invasive stimulation approach. tES has a more surface effect on brain activity compared to rTMS.
6. Optogenetics uses light to turn living neurons on and off. This is done with the use of molecules genetically inserted into specific neurons in the brain and optical fibers either attached to the skull or surgically implanted.

G. **Lesions**, which are also used to assess function, may result from naturally occurring (due to injury or disease) or deliberate brain injury (in laboratory animals).

Electrical or heat lesions destroy small areas of neurons and pathways, whereas chemical lesions destroy small areas of either neural cell bodies or axons, allowing researchers to selectively examine the function of nuclei or pathways in a particular area. The term **ablation** is used instead of lesion when sections of the central nervous system are surgically removed.

H. **Biochemical methods**

1. Drugs of interest may be administered in a variety of ways, including injection, eating, inhaling, chewing, or direct administration through micropipettes.
2. **Microdialysis**, in which extracellular fluid samples are removed through micropipettes, allows researchers to identify chemicals present in precise areas of the brain.

I. **Genetic methods**

Film Clip #12: Human Genome Project

1. **Family studies** have shown in early observations that certain psychological disorders seem to run in families, which led to more systematic twin and adoption studies.
2. The effect of **genetic concordance rates** on behavior is examined by comparing monozygotic (identical) and dizygotic (fraternal) twins. Studies comparing twins, including those

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adopted by different sets of parents, provide some insight into relative contributions of genetics (**heritability**) and environment.

3. **Molecular genetics** methods help scientists associate genotypes (underlying DNA) and phenotypes (outwardly expressed traits and behavior).
4. In a **forward genetic screen**, genes are identified that are important in phenotype development by locating individuals with a particular phenotypical trait of interest, such as a particular disorder or health condition.
5. Due to technological advances, researchers can now examine the entire genome using **genome-wide association studies (GWAS)** which may incorporate data from hundreds of thousands of participants.
6. In a **reverse genetic screen**, in contrast to most forward screens, genetically modified animals have had a defective gene (knockout gene) inserted into their chromosomes, allowing researchers to correlate changes in behavior and physiology with the associated genes affected by the knockout technique.
7. Epigenetics studies the effects of external factors on gene expression; specifically, alteration of gene function due to factors other than changes in the gene sequence, itself.

IV. Open Science and Research Ethics in Behavioral Neuroscience (01.22 through 01.25, PPT Slides 32–37)

A. **Open science** initiatives aim to increase the "openness, integrity, and reproducibility of science" (Center for Open Science, 2022).

B. The ethical use of experimental methodology, including animal and human subjects, is subjected to multiple levels of review (university review boards, national organizational review boards, and peer review at the time of publication) to ensure compliance with federal, state, and local laws and ethical use guidelines.

Clicker Questions #5 and #6

C. **Human participant guidelines** ensure lack of subject coercion, informed consent of subject, and privacy protection.

Clicker Question #7

D. **Animal subjects guidelines** focus on the necessity of using animals to answer a research question, the provision of excellent housing and health care, and the minimizing of the number of animals used and any pain and suffering that is necessitated by the research protocol. (p. 23)

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See the Supplemental Reading section for additional information regarding the protection of animals used in laboratory research.

Clicker Question #8

See the Supplemental Reading section for additional information regarding the private, U.S. federal, U.S. state, and international public policies and stem cell research.

[return to top]

Additional Discussion Questions

The following are discussion questions that do not appear in the text, PPTs, or courseware (if courseware exists) – they are for you to use as you wish. You can assign these questions several ways: in a discussion forum in your LMS; as whole-class discussions in person; or as a partner or group activity in class.

1. Discussion: Open Science Practices (15–20 min)
   Ask student to discuss the following questions:
   a. "Why do you think open science practices are important for behavioral neuroscience and how might they change the field over the next 10 years?"
   b. "What are the advantages of open science and are there any potential challenges or drawbacks?"

[return to top]

Additional Activities and Assignments

The following are activities and assignments developed by Cengage but not included in the text, PPTs, or courseware (if courseware exists) – they are for you to use if you wish.

Lecture Enrichment

II. B. 4. – Unusual Circumstances Surrounding the Death and Burial of René Descartes

René Descartes proposed the mind–body dualism theory in an attempt to clarify the distinction between the physiology and behavior of humans versus other animals.

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Descartes professed to believe in the existence of God and submitted to the authority of the Catholic Church but was often caught in conflict between the church and his scientific endeavors. Despite his best intentions and efforts, the Catholic Church placed Descartes' writings on an index of banned books. Discouraged in 1650, Descartes left France accepting a position as the philosopher-in-residence for Queen Christina of Sweden. During the first winter, Descartes caught pneumonia and died. He was subsequently buried as a distinguished foreigner in Sweden. Some 16 years following Descartes' death, his body was exhumed so that friends and pupils could properly return his body to France as his final resting place. However, the specially constructed transportation casket was too small, and Descartes' head was severed from the body to allow shipment. During the shipping, the head was stolen and traded on the black market among collectors. Descartes' body was returned to Paris and buried sans Descartes' head. Eventually, over 100 years later, the head of Descartes was returned to the French government and was shelved at the Academie des Sciences. So, to this day, the head and body of the mind–body dualism theorist, René Descartes, remain separated.

Section III. C. – Using Neuroimaging Examples in the Classroom

Using images of the brain from publications, websites, and texts can provide a useful and engaging illustration for many cognitive functions and neurological deficits. It is important when viewing brain sections from neuroimaging techniques such as CT scans to orientate the image of the brain with regard to left versus right and rostral versus caudal poles as often the brain section may be shown as a mirror image.

Supplemental Teaching Strategies and Tools

Discussion of Trepanation

Trepanation was likely the first attempt at neurosurgery. Archeological evidence suggests trepanation was employed up to 7,000 years ago. Given our current enlightened view of the brain, trepanation seems a gross and wholly (excuse the puns) procedure by our modern standards. Yet, in the 1970s, there was a resurgence of trepanation as a means of achieving mental clarity with some unusual case studies to say the least. The following websites and reports can be used in a classroom discussion of the appropriateness of trepanation:

What's the story on trepanation? Cecil Adams. Straight Dope. September 6, 2002.

You Need It Like... a Hole in the Head? Michael Colton. Washington Post. May 31, 1998.

The Skull Doctors Stephanie Pain. New Scientist. September 16, 2000; 167(2256): 32.

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Trepanation Joe Schwarcz, Ph.D. Quackwatch. April 28, 2003.

Neurophilosophy has found a gory but completely astonishing film of a **Kisi medicine man in Tanzania performing a trepanation operation.**

Understanding Fluid Dynamics as a Functional Model of the Nervous System

A discussion about the basis for the development of the fluid dynamics model will help the students fully understand and remember the early philosophies of the biology underlying behavior. Given our knowledge base today, it may seem absurd that the Greek and Renaissance philosophers thought that internal fluids were the controlling force underlying human behavior. Students often have a hard time appreciating the perspective of this model given the knowledge base during that time. It is important to remember that prior to the mid-1700s, there was no real understanding of electricity. Physical sources of energy were limited to hydraulic and fire. It became clear to the ancient philosophers that fire was not the source of human energy and that our bodies contained vast amounts of fluids. As evidenced by trauma to the brain, the central nervous system gained importance in sustaining life and behavior. Furthermore, fluid-filled cavities or ventricles were observed in the brain containing a different type of fluid (cerebrospinal fluid) that was not like the circulating blood. Therefore, hydraulic energy became the acceptable model of energy for human behavior. In the early 1600s, René Descartes took up residence in the Paris suburb of St. Germain. In St. Germain, there were a series of fountains and statues that were set in motion, sometimes to accompanying music, by hydraulic power when nearby observers stepped on special flagstones attached to a series of pipes. Descartes observed this phenomenon and applied the concept of plumbing and hydraulic power used to produce complex movements in inanimate objects to the notion of a fluid-filled nervous system being able to produce complex human behavior.

Discussion of Neuroimaging Techniques

There are many advantages and disadvantages associated with each of the neuroimaging techniques discussed in Chapter 1. Lead a discussion centered on a cost/benefit analysis of using different techniques in the examination of various clinical conditions, such as stroke, car accident victim, or sports-related concussion, and research questions, such as attention, memory, development, or aging.

[return to top]

Clicker Questions For Audience Response Systems

1. What do you believe in?

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A. Mind–body dualism—there is more to "mind" than just the physical self.
B. Monism—the "mind" is what the brain does.
C. I'm just not sure.
Question type: React

2. Professor Williams wants to check the density of cell bodies in a sample of rat hippocampus. Which type of stain should Dr. Williams use?
A. Horseradish peroxidase
B. Nissl stain
C. Myelin stain
D. Golgi stain
Question type: Check Your Learning

3. Which technologies tell us about the activity of the brain?
A. CT and PET
B. CT and MRI
C. PET and fMRI
D. PET and MRI
Question type: Check Your Learning

4. Which technique is used to identify the functions of a particular part of the brain?
A. Autopsy
B. Computerized tomography (CT)
C. Evoked potentials
D. Electrical stimulation
E. Microdialysis
Question type: Check Your Learning

5. Do you think researchers should be allowed to use PET scans on healthy adult volunteers?
A. Yes
B. No
Question type: React

6. Do you think researchers should be allowed to use PET scans on healthy children with their parents' consent?
A. Yes
B. No
Question type: React

7. When is animal research ethical?
A. Never
B. When steps are taken to ensure that the animal experiences minimal pain and suffering
C. When human lives can be saved as a result of the knowledge gained

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D. When research is conducted at universities rather than by for-profit organizations
Question type: React

8. Is stem cell research ethical?
   A. Yes
   B. No
   C. Only if it uses adult, not embryological stem cells
   Question type: React

[return to top]

ADDITIONAL RESOURCES

EXTERNAL VIDEOS/FILM CLIPS

1) Discovering the Human Brain: New Pathways to Neuroscience (4:04)

   Using the resources of the Brain Research Center at UCLA, this film illustrates the development of neuroscience, from its reliance on information from brain injuries and autopsies, through new insights discovered with electronic microscopes, EEG equipment, PET scans, and MRI machines. With Susan Bookheimer, Ph.D. (2006). This is a short version of a 30-minute film.

   http://youtu.be/RREoQJUHSYE

2) V.S. Ramachandran at Beyond Belief 2.0 (9:23)

   V.S. Ramachandran is a neurologist, best known for his work in the fields of behavioral neurology and psychophysics.

   http://www.youtube.com/watch?v=N9hy7oOhHxk&feature=related

3) Jill Bolte Taylor talks about the results of her stroke (20:11)

   Neuroanatomist Jill Bolte Taylor had an opportunity few brain scientists would wish for: One morning, she realized she was having a massive stroke.

   http://www.youtube.com/watch?v=UyyjU8fzEYU&feature=related

4) Science Tools: Brain Imaging (1:55)

   ScienCentral takes you on a visit to the Tonegawa Lab at MIT to see their two-photon microscope and electrophysiology lab, and how they combine to study brain cell growth.
   http://www.youtube.com/watch?v=t61h9idEC0Q&feature=channel_page

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5) A Diffusion Spectrum Imaging Tour of the Brain

   Technology Review provides a step-through tour of the white matter of the brain using diffusion spectrum imaging (DSI).
   http://www.technologyreview.com/player/08/08/06Singer/1.aspx

6) Mind Reading with Imaging (1:36)

   As pollsters have well demonstrated this presidential primary season, reading minds, whether of voters or the person next to you, is close to impossible. However, as this ScienCentral News video explains, scientists are actually one step closer to reading our thoughts.

   http://www.youtube.com/watch?v=jq_nAm4rOu0&feature=channel

7) How MRI Works (2:26)

   Wizard of Schenectady Howard Hart explains how the MRI works. Howard Hart pioneered MRI design with General Electric by the Edison Exploratorium.

   http://youtu.be/pGcZvSG805Y

8) Deep Brain Stimulation for Parkinson's Disease (2:30)

   You've heard of a pacemaker for the heart, but what about for the head? We'll go under the knife with a Cardington, Ohio, farmer who's getting electrodes implanted into his brain to alleviate the debilitating physical effects of a rare neurological disorder.

   http://www.youtube.com/watch?v=EMnfROo7k9A

9) Repeated Transcranial Magnetic Stimulation (4:15)

   Transcranial magnetic stimulation lets you deactivate selected parts of your brain.

   http://www.youtube.com/watch?v=XJtNPqCj-iA&feature=PlayList&p=1E617238454CAA9E&playnext=1&playnext_from=PL&index=6

10) Magnetic Brain Boost (1:32)

    Lack of sleep often comes at times when we need to perform at our best. Now brain researchers studying how sleep deprivation impairs memory have found a potential remedy—rTMS.

    http://www.youtube.com/watch?v=WzYwIs35pPs&feature=channel_page

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11) Jose Delgado and his Bull (0:38)

Jose Delgado implants stimulating electrodes into a Spanish fighting bull.

http://www.youtube.com/watch?v=be9YlbafKys

12) Human Genome Project

Introduction (2:37)

How It Started (2:50)

How It Was Paid For (6:11)

Practical Implications (3:58)

Ethics (4:08)

http://www.nature.com/nature/supplements/collections/humangenome/video

13) Hair Follicle Stem Cells (1:49)

Non-invasive method for developing stem cells from hair follicles in mice.

http://www.youtube.com/watch?v=n0UzdYRnMtY&feature=channel_page

Primary Sources and Supplemental Reading

History of Neuroscience

This text provides an overview of neuroscience history organized by major research area. Finger, S. (1994). *Origins of neuroscience: A history of explorations into brain function.* Oxford University Press. ISBN: 0195146948.

High-Power Magnets and Aversive Physiological Effects

Recent evidence has shown that exposure to high-power magnetic fields (at least 7 Tesla and stronger) may produce aversive effects. Current MRI technology used in clinical practice is still in the 1–2 Tesla range; however, increasing the magnetic field strength allows better imaging, and MRI technology used in research settings is now in the 4–9 Tesla range. The research examining the efficacy and safety of high magnetic field exposure mirrors the studies initially conducted on the effects of exposure to radiation. The following articles describe conditioned taste aversion, vestibular related behaviors, and central nervous system activation induced in rats that received short (15–30 min) exposures to high-power magnetic fields.

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Houpt, T. A., Pittman, D. W., Barranco, J. M., Brooks, E. H., & Smith, J. C. (2003). Behavioral effects of high-strength static magnetic fields on rats. *The Journal of Neuroscience, 23*(4), 1498–1505.

Lockwood, D. R., Kwon, B., Smith, J. C., & Houpt, T. A. (2003). Behavioral effects of static high magnetic fields on unrestrained and restrained mice. *Physiology & Behavior, 78*(4–5), 635–640.

Nolte, C. M., Pittman, D. W., Kalevitch, B., Henderson, R., & Smith, J. C. (1998). Magnetic field conditioned taste aversion in rats. *Physiology & Behavior, 63*(4), 683–688.

Snyder, D. J., Jahng, J. W., Smith, J. C., & Houpt, T. A. (2000). c-Fos induction in visceral and vestibular nuclei of the rat brain stem by a 9.4 T magnetic field. *NeuroReport, 11*(12), 2681–2685.

Handbook of Functional Neuroimaging of Cognition

This text provides a historical account of the development of functional neuroimaging, a detailed explanation of the theory and methods involved in the production of functional neuroimages, and a summary of the latest functional neuroimaging research organized according to system (attention, language, aging, etc.). Publication information: Cabeza, R., & Kingstone, A. (Eds.). (2006). *Handbook of functional neuroimaging of cognition.* The MIT Press. ISBN: 0262032805.

Open Science Resources

Center for Open Science (COS)

https://www.cos.io/

Open Science Framework (OSF) is a free and open platform to support research and enable collaboration.

https://osf.io/

NIMH National Data Archive (NDA)

https://nda.nih.gov/

Ethical Use of Animals in Research

The following websites are good resources of information regarding the legal and ethical use of animals in research.

The Office of Laboratory Animal Welfare:
http://grants.nih.gov/grants/olaw/olaw.htm/

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The Animal Welfare Information Center of the U.S. Department of Agriculture: **http://www.nal.usda.gov/awic**

Public Health Service Policy on Humane Care and Use of Laboratory Animals: **http://grants.nih.gov/grants/olaw/references/phspol.htm**

The American Psychological Association's Committee on Animal Research and Ethics (CARE): **http://www.apa.org/science/leadership/care/index.aspx**

The Society for Neuroscience's Policies on the Use of Animals and Humans in Neuroscience Research: **http://www.sfn.org/Advocacy/Policy-Positions/Policies-on-the-Use-of-Animals-and-Humans-in-Research**

Public Policies and Stem Cell Research

The following websites are good resources of information regarding current governmental public policy on stem cell research and the privatization of stem cell research.

Stem Cells and the Future of Regenerative Medicine: **http://www.nap.edu/books/0309076307/html/**

United States federal policy on funding stem cell research: **http://stemcells.nih.gov/policy/Pages/Default.aspx**

Executive Order E9-5441, March 9, 2009.

Removing Barriers to Responsible Scientific Research Involving Human Stem Cells:

http://edocket.access.gpo.gov/2009/pdf/E9-5441.pdf

NIH Stem Cell Basics: **http://stemcells.nih.gov/info/basics/**

Stem cell research regulations in European countries: **http://www.eurostemcell.org/stem-cell-regulations**

California's Stem Cell Agency: **http://www.cirm.ca.gov/**

[return to top]

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