2

Evolution, Genetics, and Experience: Thinking About the Biology of Behavior

TABLE OF CONTENTS

CHAPTER-AT-A-GLANCE

Brief Outline	Instructor's Manual Resources
Chapter Introduction (p. 21)	
Thinking About the Biology of Behavior: From Dichotomies to Interactions (pp. 21–25)	Lecture Launchers 2.1, 2.2, 2.7 Activity 2.1
Human Evolution (pp. 25–36)	Lecture Launchers 2.3, 2.8
Fundamental Genetics (pp. 36–44)	Lecture Launcher 2.4
Epigenetics of Behavioral Development: Interaction of Genetic Factors and Experience (pp. 44–47)	Lecture Launcher 2.5
Genetics of Human Psychological Differences (pp. 47–50)	Lecture Launcher 2.6

< Return to Table of Contents

LEARNING OBJECTIVES

After completion of this chapter, the student should be able to:

LO 2.1 Explain the origins of dichotomous thinking.
LO 2.2 Explain why thinking about the biology of behavior in terms of traditional physiological-psychological and nature-nurture dichotomies is flawed.
LO 2.3 Describe the origins of evolutionary theory.
LO 2.4 Explain the evolutionary significance of social dominance and courtship displays.
LO 2.5 Summarize the pathway of evolution from single-cell organisms to humans.
LO 2.6 Describe nine commonly misunderstood points about evolution.
LO 2.7 Describe how research on the evolution of the human brain has changed over time.
LO 2.8 Discuss the field of evolutionary psychology and the study of mate bonding.
LO 2.9 Describe what Mendel's work with pea plants tells us about the mechanisms of inheritance.
LO 2.10 Understand the structure and function of chromosomes.
LO 2.11 Outline the mechanisms of gene expression.
LO 2.12 Discuss several ways in which modern advances have changed out understanding of genetic processes.
LO 2.13 Define epigenetics, and explain how it is transforming our understanding of genetics.
LO 2.14 Discuss what insights into the genetics of behavior was gained from early research on selective breeding.
LO 2.15 Explain how classic research on phenylketonuria (PKU) has informed our understanding of the genetics of behavior.
LO 2.16 Describe how research on the ontogenetic development of birdsong has provided insight into the development of human language.
LO 2.17 Explain why it is important to distinguish between the development of individuals and the development of individual differences.
LO 2.18 Explain heritability estimates and how they are commonly misinterpreted.
LO 2.19 Describe two ways that twin studies can be used to study the interaction of genes and experience (i.e., nature and nurture).

< Return to Table of Contents

BRIEF CHAPTER OUTLINE

Lecture Launcher 2.1: *Opening Your Mind to the Biology of Behavior—It's More Than Nature or Nurture!*
Lecture Launcher 2.2: *Are You a Dualist?*

1. **Thinking About the Biology of Behavior: From Dichotomies to Interactions**
   a. The Origins of Dichotomous Thinking
   b. Problems with Thinking About the Biology of Behavior in Terms of Traditional Dichotomies

Lecture Launcher 2.3: *Understanding the Difference between Adaptations, Exaptations, and Spandrels*

2. **Human Evolution**
   a. Darwin's Theory of Evolution
   b. Evolution and Behavior
   c. Course of Human Evolution
   d. Thinking About Human Evolution
   e. Evolution of the Human Brain
   f. Evolutionary Psychology: Understanding Mate Bonding

Lecture Launcher 2.4: *Understanding the Significance of Mendelian Genetics*

3. **Fundamental Genetics**
   a. Mendelian Genetics
   b. Chromosomes
   c. The Genetic Code and Gene Expression
   d. Human Genome Project
   e. Modern Genetics: Growth of Epigenetics

Lecture Launcher 2.5: *Humans and Birds Share the Same Singing Genes*

4. **Epigenetics of Behavioral Development: The Interaction of Genetic Factors and Experience**
   a. Selective Breeding of "Maze-Bright" and "Maze-Dull" Rats
   b. Phenylketonuria: A Single-Gene Metabolic Disorder
   c. Development of Bird Song

Lecture Launcher 2.6: *Even If We Could, Should We Cure Stupidity?*

5. **The Genetics of Human Psychological Differences**
   a. Development of Individuals Versus Development of Differences Among Individuals
   b. Heritability Estimates: Minnesota Study of Twins Reared Apart
   c. A Look into the Future: Two Kinds of Twin Studies

6. Themes Revisited

< Return to Table of Contents

TEACHING OUTLINE

1. Thinking About the Biology of Behavior: From Dichotomies to Interactions

a. The Origins of Dichotomous Thinking
LO 2.1 Explain the origins of dichotomous thinking.

1. Is It Physiological or Is It Psychological?

- Emerged in Europe in the seventeenth century as **science**, and the **Catholic Church** struggled to describe the natural world.
- The French philosopher **Descartes** came up with a solution: The physical world could be the object of scientific study, while the mind could be the purview of the Church. This separation of mind and body became known as **Cartesian dualism**.
- This notion survives today: People agree with the idea that there is a category of human psychological activity that is independent of the human brain.

2. Is It Inherited, or Is It Learned?

- Also known as the **nature/nurture** controversy; debate on whether behavior is inherited through genetics or learned through experience.
- Epitomized by the struggle between early **behaviorists** and **ethologists** to adequately describe behavioral development.

b. Problems with Thinking About the Biology of Behavior in Terms of Traditional Dichotomies
LO 2.2 Thinking about the biology of behavior in terms of traditional physiological-psychological and nature-nurture dichotomies is flawed: Explain why.

1. Physiological-or-Psychological Thinking Runs Into Difficulty.

- Such dichotomies are overly simplistic and false; illustrate this by discussing the relationship between brain injury and psychological processes (see Figure 2.1 in ***Biopsychology***) or the presence of "mind" in nonhuman species.

2. Nature-or-Nurture Thinking Runs Into Difficulty.

- The thought of nature-or-nurture is based on the premise that genetic factors and experiential factors combine in an additive fashion.

3. A Model of the Biology of Behavior.

- Behavior is best viewed as the product of genetic potential interacting with past experience and current situational factors, as illustrated by Figure 2.3 in ***Biopsychology***.

2. Human Evolution

a. Darwin's Theory of Evolution
LO 2.3 Describe the origins of evolutionary theory.

- Darwin published ***On the Origins of the Species*** (1859) and modern biology was born.
- Darwin's theory that species **evolve** (undergo gradual, orderly change) is the most influential in the biological sciences.

- Darwin was not the first to propose this idea, but he was the first to provide strong evidence for it from: 1) **fossil records**; 2) **structural similarities** among existing species; and 3) programs of **selective breeding**.
- Even stronger evidence comes from modern genetic studies and from observations of evolution in progress (e.g., Grant's (1991) study of changes in Galápagos finches after a one-year drought—beak size increased in response to shortage of small seeds).
- Darwin was also the first to suggest the mechanism by which evolution takes place: **natural selection**, in which normal variations in a characteristic that are associated with increased **fitness** (high rates of survival and reproduction) are most likely to be passed on to future generations.
- The evidence for the theory of evolution is unassailable; it meets with no significant opposition from the biological community.

b. Evolution and Behavior
LO 2.4 Explain the evolutionary significance of social dominance and courtship displays.

1. Social Dominance

- Early studies of evolution focused on structure; **behavior** also plays an important role in determining an organism's fitness.
- The contributions of some behaviors (e.g., eating, sexual behavior, predatory behavior) are obvious; others are less obvious, but no less important. Two examples are **social aggression** and **courtship displays**.
- Males of many species establish hierarchies of social dominance by combative encounters with other males.
- Social dominance influences evolution because dominant males (or females, in some species) are able to copulate more. Example: in a study of bull elephant seals, McCann (1981) found that the highest-ranking bull accounted for 37 percent of copulations; the lowest ranking bull accounted for only 1 percent.

2. Courtship Display

- Courtship displays precede copulation in many species.
- Copulation is unlikely if one partner fails to respond appropriately to the displays of the other.
- Courtship displays are important to evolution because they can promote the formation of new species; the evolution of an idiosyncratic courtship display can form a **reproductive barrier** that is as effective as geographic separation.

c. Course of Human Evolution
LO 2.5 Summarize the pathway of evolution from single-cell organisms to humans.

1. Evolution of Vertebrates

- About 600 million years ago, the first multi-celled organisms evolved in the oceans.
- About 450 million years ago, the first **chordates** (animals with dorsal nerve cords) evolved.
- 425 million years ago, the first chordates with backbones (i.e., **vertebrates**) evolved; they were bony fishes.
- 410 million years ago, bony fishes first ventured onto land to escape stagnant pools and take advantage of untapped food sources; the Florida walking catfish is a survivor of this stage.

2. Evolution of Amphibians

- 400 million years ago, the first **amphibians** evolved; they are born in water and spend their larval stage there, but as adults, they have legs and lungs and can survive on land.

3. Evolution of Reptiles

- 300 million years ago, the first **reptiles** evolved from amphibians; they spend the first stage of their lives in the watery environment of a shell-covered egg; dry scales reduce water loss and allow adults to live away from water.

4. Evolution of Mammals

- 180 million years ago, during the age of dinosaurs, a line of reptiles evolved that fed their young through **mammary glands**; eventually, **mammals** stopped laying eggs and nurtured their young in the watery environment of their bodies.
- Today, there are about 20 different orders of mammals; the one we belong to is **primates**; there are about 12 different families of primates. Five of the most widely-studied are the **prosimians**, **old-world monkeys**, **new-world monkeys**, **apes**, and **hominids**. The hominid family is composed of two genera: **Homo** and **Australopithecus**.

5. Emergence of Humankind

- Four million years ago, Australopithecus evolved (we believe) from a species of African apes.
- Australopithecines were 1.3 meters (4 feet) tall, had small brains, had an upright walk, and became extinct about 1 million years ago.
- Two million years ago, the first Homo species evolved from Australopithecus; these hominids used tools and fire, but had a relatively small brain.
- 275,000 years ago, modern humans **(homo sapiens)** evolved.
- Interesting point: The human attributes of a big brain, upright posture, and free hands evolved hundreds of thousands of years ago, yet most uniquely human accomplishments occurred only within the last 40,000 years. *Why?*

d. Thinking About Human Evolution (see Figure 2.12 in ***Biopsychology***)
LO 2.6 Describe nine commonly misunderstood points about evolution.

When thinking about human evolution, keep the following eight points in mind:

- Evolution does not proceed in a straight line.
- Homo sapiens do ***not*** represent evolutionary supremacy.
- Evolution is not always a slow, gradual process.
- Present species represent a fraction of the species that have evolved on earth.
- Evolution is not a perfectionist.
- Evolution is not always adaptive; nonadaptive evolutionary byproducts are called **spandrels**.
- Sometimes structures or behaviors evolve in response to one type of evolutionary pressure, but later perform a different function; these types of changes are called **exaptations**.
- Similarities between species do not imply a common evolutionary origin. Keep in mind the differences between homologous structures (with a common evolutionary origin) and **analogous structures** (with different, but convergent evolutionary processes in their origins).

e. Evolution of the Human Brain (see Figure 2.13 in ***Biopsychology*****)**
LO 2.7 Describe how research on the evolution of the human brain has changed over time.

- Size is not the key to the intellectual power of the human brain; there is no relationship between size and intellectual capacity in humans, and human beings do not have the largest brains in the animal kingdom.
- Three key points about the evolution of the human brain:
  - It has **increased in size** during the course of evolution.
  - Most of this increase in size has occurred in the **cerebrum**.
  - The increased size of the cerebrum has been accompanied by increased **convolutions** of the cortex.
- The similarity between the brains of different species is more significant than the differences between them. All brains are composed of neurons; these neurons generally function in a similar fashion, and in most cases, similar structures can be found between species.

f. Evolutionary Psychology: Understanding Mate Bonding

LO 2.8 Discuss the field of evolutionary psychology and the study of mate bonding.

- **Evolutionary psychology** seeks to understand human behaviors by considering the pressures that led to their evolution; much attention has focused on a comparison of **promiscuity** and the less common strategy of **mate bonding** (enduring mating relationships).
- In mammals, this may be due to the fact that they produce relatively few young, and these young are helpless and slow to develop. Thus, it is adaptive for males to stay with females and promote the success of their young, and it is adaptive for females to evolve behaviors that will promote this type of bonding.

1. Polygyny and Polyandry

- **Polygyny** (male bonds with multiple females) is the most common form of mate bonding. The males of most species contribute little more than sperm to the development of the young; the investment of the female is much more substantial. Thus, in many species, the females evolved strategies to promote bonding with the most dominant males (to increase the likelihood their young will survive), whereas males mate with as many females as possible (resulting in polygyny).
- In species where the male's contribution to reproduction outweighs the females, **polyandry** (female mates with multiple males) has evolved. (Example: In the seahorse, the males tend to the eggs and the young until they are mature enough to survive on their own.)

2. Monogamy

- Where males helping to raise the young has enhanced the survival of offspring, **monogamy** (a single male bonds with a single female) has evolved as the optimal reproductive strategy.
- Developments in evolutionary psychology emphasize three key points: 1) evolutionary analyses can be applied to the most complex human behaviors; 2) humans are the product of evolution; and 3) humans are closely related to other animal species.

3. Thinking About Evolutionary Psychology

- Men value youth and attractiveness while women value power and earning capacity.
- Physical attractiveness best predicts which women will bond with men of high occupational status.
- The major mate-attraction strategy of women is to make themselves more attractive, while for men it is displaying their power and resources.
- Men are more likely than women to commit adultery.

3. Fundamental Genetics

a. Mendelian Genetics (see Figure 2.15 in ***Biopsychology***)
LO 2.9 Describe what Mendel's work with pea plants tells us about the mechanisms of inheritance.

- Darwin did not understand how structural or behavioral traits could be passed from generation to generation, or how conspecifics could differ from one another. These processes were first documented by **Gregor Mendel**, an Augustinian monk.
- His success is that he studied **dichotomous traits** (characteristics that occur in one form or another, never a mix; Mendel studied the inheritance of the color of peas) and **true-breeding lines** (in which interbred members always produce offspring with the same trait).
- Key finding: When true-bred brown and white peas are crossed, all the offspring from the first cross have brown seeds, whereas 25 percent of the offspring from the second cross have white seeds; this disproved the prevalent view that offspring inherit their parents' exhibited traits.
- Mendel proposed that each dichotomous trait was due to two kinds of inherited factors; these are called **genes**. Furthermore, each individual contains two genes for each dichotomous trait; these are called **alleles**.
- These results led to Mendel's concepts of:
  - **dominant traits** (appear in 100 percent of first crosses) and **recessive traits** (appear in about 25 percent of second crosses)
  - **genotype** (genetic traits passed on to offspring) and **phenotype** (observable genetic traits)
  - **homozygous** organisms (that possess identical genes for a trait) and **heterozygous** organisms (that possess different genes for a trait)

b. Chromosomes
LO 2.10 Understand the structure and function of chromosomes.

1. Reproduction and Recombination.

- In the early 1900s, genes were localized to paired thread-like structures in the cell nucleus called **chromosomes**.
- **Gametes** (eggs and sperm cells) are produced when cells divide during **meiosis**. One chromosome from each chromosome pair in the parent cell goes to each of two gametes produced when that cell divides; thus, each gamete has half the usual number of chromosomes. When they combine during fertilization, the resulting **zygote** has the normal number of chromosomes (half from each parent).
- The strongest early evidence of this came from studies of **linkage** between various traits in a species (such that individuals expressing one trait usually expressed several other *linked traits*). In each species, the number of clusters of linked traits equals the number of pairs of chromosomes, suggesting that the traits were *linked* by their presence on the same chromosome.
- **Crossing over** (see Figure 2.18) explains why traits on a chromosome are not always linked (i.e., inherited together); crossing over is important because it allows increases in species diversity.
- **Sex chromosomes** are not found in matched pairs. Females have two X-chromosomes; males have an X- and a Y-chromosome. **Sex-linked traits** are traits associated with a sex chromosome; usually the X chromosome as the Y-chromosomes carries few genes other than those that cause a zygote to develop into a male.

2. *Structure and Replication* (see Figures 2.17, 2.18, and 2.19 in ***Biopsychology***)

- Each chromosome is a double-stranded molecule of **deoxyribonucleic acid (DNA)**—which is made up of 4 nucleotide bases: **adenine**, **thymine**, **guanine**, and **cytosine**. The sequence of those bases on each chromosome constitutes the genetic code.
- Each strand of DNA is the **complement** of the other, as thymine is attracted to adenine and guanine is attracted to cytosine (see Figure 2.17). During **replication**, as the strands of DNA unwind, each base in a strand attracts its complement so that when unwinding is complete, two new strands of DNA are created.
- DNA serves as a template for the transcription of **messenger RNA** (mRNA). It is called mRNA because it carries a code outside of the nucleus.
- MRNA then attaches to a ribosome, moving along it to make a protein.
- Three consecutive nucleotide bases (of the mRNA) make a ***codon***.
- Each ***codon*** instructs the ribosome to add 1 of 20 different amino acids to the protein.
- Each amino acid is carried to the ribosome by ***transfer RNA***.

3. Sex Chromosomes and Sex-Linked Traits

Sex chromosomes are found in matched pairs. Females have two X-chromosomes; males have an X- and a Y-chromosome. **Sex-linked traits** are traits associated with a sex chromosome – usually the X chromosome because the Y-chromosome carries fewer genes.

c. Genetic Code and Gene Expression

LO 2.11 Outline the mechanisms of gene expression.

- **Structural genes** are genes that contain information for the synthesis of proteins.
- Proteins are long chain of amino acids.
- Structural genes compose a small portion of each chromosome.
- The stretches of DNA that lack structural genes include portions called ***enhancers*** (or ***promoters***).
- The function of ***enhancers*** is to determine whether particular structural genes start the synthesis of proteins and at what rate.
- Enhancers determine how a cell will develop and function.
- Proteins that bind to DNA and influence gene expression are called ***transcription factors***.
- Transcription factors are influenced by signals received by the cell from the environment.
- Messenger RNA carries the genetic code out of the nucleus of the cell.
- Ribosomes translates the genetic code.
- Codons are three consecutive nucleotide bases that instructs the ribosomes to add 1 of the 20 different kinds of amino acids available.
- The process of gene expression involves transcription of the DNA to the RNA and the translation of the RNA base sequence code into a sequence of amino acids.

d. Human Genome Project

LO 2.12 Discuss several ways in which modern advances have changed our understanding of genetic processes.

- Perhaps the **most ambitious scientific project** of all time; has mapped the base sequence of each of the 3,000,000,000 base letters that comprise the 46 chromosomes that human beings possess.
- Many were surprised to note that the human genome includes only about **20,000 genes**—about the same number as a mouse, and far fewer than corn! Human complexity appears to be due to **refinements in gene expression**, rather than in a huge increase in the number of genes

involved. The function of the many bases found in human chromosomes that are not involved in classic protein synthesis remains a mystery.

- Researchers have now generated a nearly complete map of the entire set of proteins encoded for by our genes called the **human proteome**.
- It was initially hoped that genomic variations would be directly linked to human diseases. The revealed relationships would then drive personalized medical treatments.
- These hopes have not been realized because so many genes are involved with disease and they often account for a small portion of heritability.
- Genome research is now focused on understanding the complex interactions between multiple genes, their variants, and experience.

e. Modern Genetics: Growth of Epigenetics

LO 2.13 Define epigenetics, and explain how it is transforming our understanding of genetics.

- Epigenetics focuses on mechanisms that influence the expression of genes without changing the genes themselves.
- Epigenetic mechanisms are responsible for the fact that a small number of genes are responsible for human development.
- There are four factors that lead to the rise of epigenetics.
- The assumption was that the function of DNA was to synthesize proteins.
- Epigenetics focuses on mechanisms that influence the expression of genes without changing the genes themselves.
- Epigenetic mechanisms are responsible for the fact that a small number of genes are responsible for human development.
- There are four factors that lead to the rise in epigenetics.
    - The assumption was that the function of DNA was to synthesize proteins.
    - The portions of DNA that do not make proteins are referred to as ***junk DNA***. Ninety-nine percent of DNA regarded as junk DNA.
    - For decades we've known there is an interaction between genes and environment, but the mechanisms have been unknown.
    - New techniques for research discovered through the Human Genome Project.
- Five advances

  The portions of DNA that do not make proteins are referred to as junk DNA.
    - It has been newly discovered that these active nongene DNA control structural gene expression.
    - Many types of RNA found, each with different functions.
    - Advances in gene expression
        - DNA methylation is an epigenetic mechanism whereby a methyl group is attached to DNA
        - Histone Remodeling is when DNA is coiled around proteins called histones (see Figure 2.21). Histones can change their shape, consequently increasing or decreasing adjacent gene expression. Remodeling is induced by environmental experiences.
    - RNA editing-changes incorporated from the environment
    - Epigenetic mechanisms are enduring
        - Transgenerational epigenetics is a subfield of epigenetics that examines the transmission of experiences via epigenetics mechanisms across generations.

4. Epigenetics of Behavioral Development: Interaction of Genetic Factors and Experience

- **Ontogeny** refers to the development of an individual through their lifespan; **phylogeny** refers to the evolutionary development of a species through the ages.
- **Behavioral development** is a consequence of **genetic potential** interacting with the **experience** of an individual organism. To help you understand this idea, here are three examples:

a. Selective Breeding of "Maze-Bright" and "Maze-Dull" Rats (see Figures 2.21 and 2.22 in *Biopsychology*)

LO 2.14 Discuss what insight into the genetics of behavior was gained from early research on selective breeding.

- Tryon raised **maze-bright** and **maze-dull** strains of rats; however, the maze-bright rats do better than the maze-dull rats only if both are raised in **impoverished environments**; if they are both raised in enriched environments, the differences disappear.
- Maze-bright rats are not generally more intelligent, they do better because they are less emotional.

b. Phenylketonuria: A Single-Gene Metabolic Disorder

LO 2.15 Explain how classic research on phenylketonuria (PKU) has informed our understanding of the genetics of behavior.

- A form of mental retardation that results from the accumulation of **phenylalanine** in the body.
- Due to absence of gene for **phenylalanine hydroxylase**, which converts phenylalanine to tyrosine.
- Sufferers develop the disorder if they eat phenylalanine-rich foods during development. It is diagnosed by high levels of **phenylpyruvic acid** in urine; it is treated by keeping sufferers on a phenylalanine-free diet during childhood (though subtle cognitive deficits remain).

c. Development of Bird Song (see Figure 2.24 in *Biopsychology*)

LO 2.16 Describe how research on the ontogenetic development of birdsong has provided insight into the development of human language.

- Some birds learn to sing by hearing conspecific songs early in life.
- Research has revealed that birdsong develops in two stages: 1) a **sensory phase**, in which exposure to conspecific songs leads to memories that later guide song development and 2) a **sensorimotor phase**, in which birds must practice (and receive sensorimotor feedback) for songs to develop properly.
- Zebra finches and white-crowned sparrows are **age-limited learners**, meaning that once a bird develops an adult song, it crystallizes, remaining unchanged for life. By contrast, male canaries are **open-ended learners**, meaning that they can add new songs to their repertoire each mating season.
- Canary song circuit is remarkable in four ways: 1) it is **lateralized** to the left hemisphere (like human speech); 2) the vocal center is four times **larger in males** than in females; 3) in the spring, as new songs are acquired, the vocal centers **double in size**—only to shrink again in the fall; and 4) this growth is due to **neurogenesis**, a feat thought impossible in the adult vertebrate brain until very recently.

5. Genetics of Human Psychological Differences

a. Development of Individuals Versus Development of Differences Among Individuals

LO 2.17 Explain why it is important to distinguish between the development of individuals and the development of individual differences.

- To assess the relative contribution of genes and experience to the development of differences in psychological characteristics, researchers often study individuals with varying degrees of genetic similarity. For example, they might compare **identical (monozygotic) twins** (genetically identical) with **fraternal (dizygotic) twins** (no more genetically the same than any two siblings in a family).

b. Heritability Estimates: Minnesota Study of Twins Reared Apart

LO 2.18 Explain heritability estimates and how they are commonly interpreted.

- Studies such as the **Minnesota Study** have found high correlations for a variety of complex human traits and behaviors for identical twins separated at birth; **heritability estimates** based on these range from 40 to 80 percent..

c. A Look into the Future: Two Kinds of Twin Studies

LO 2.19 Describe two ways that twin studies can be used to study the interaction of genes and experience (i.e., nature and nurture).

1. Twin Studies of Epigenetic Effects.

- More recent twin studies have focused on epigenetic changes in humans, triggered by environmental experiences.
- Monozygotic twins are genetically identical at conception but their epigenetic profiles diverge with advancing age.
- Wong et al. (2010) examined DNA methylation and found that it is mainly a consequence of experiential factors.

2. Twin Studies of the Effects of Experience on Heritability.

- Turkheimer et al. (2003) found that heritability estimates of IQ in seven-year-old twins varied as a function of socioeconomic status (SES). In low SES families, the heritability estimate was near zero, while in high SES families, the heritability estimate approached 1.00.
  - Discuss the implications of this finding to the idea that behavior is not a consequence of physiology or psychology, or of nature or nurture—instead, it is the product of neural activity shaped by interactions among genes, past experience, and an organism's present situation.

< Return to Table of Contents

LECTURE LAUNCHERS

Lecture Launcher 2.1: Opening Your Mind to the Biology of Behavior—It's More than Nature or Nurture!

Spend some time discussing the commonly held notions that behavior is a function of **physiology or psychology**, or that behavior is **learned or innate**. This discussion is pretty easy to get rolling; for example, ask the class what the relationship between brain and mind is, or about the common observation that "They can't help their behavior, they were born that way!"

Lecture Launcher 2.2: Are You a Dualist?

After reviewing Cartesian dualism, poll students about their personal philosophy. Are they monists, dualists, or unsure? Encourage students to reflect on their explanations of their own behavior. Do they view themselves as a ghost in the machine, somehow distinct from the biological reality of their brain? Point out to students that a dualist philosophy might make it difficult for them to appreciate the remarkably complex chemical and cellular functions that produce all of their own behavior.

Lecture Launcher 2.3: Understanding the Difference between Adaptations, Exaptations, and Spandrels

Students sometime have difficulty understanding the difference between an adaptation, an exaptation, and a spandrel. This is probably due, in part, to the fact that it is often difficult to determine what a particular anatomical structure might be. Provide the students with a list of anatomical structures and ask them whether that structure is an exaptation, an adaptation, or a spandrel. There might not be a correct answer for every particular structure; knowing this should help them understand this abstraction.

Lecture Launcher 2.4: Understanding the Significance of Mendelian Genetics

Many students struggle with the basic ideas underlying Mendelian genetics, and the significance of these ideas to inherited contributions to behavior. You can use a combination of the resources available from the Genetic Science Learning Center at the University of Utah (http://learn.genetics.utah.edu/) to illustrate concepts like DNA/gene/chromosome, genetic mixing, and genetic and environmental interactions in the expression of behavioral traits.

Lecture Launcher 2.5: A Genetic Link between Human Language and Bird Song?

This chapter emphasizes the idea that human behavior has evolved from behaviors observed in other species. You can initiate a class discussion about this idea in this section, based on recent evidence that a gene known to be involved in human language is also important to the development of birdsong, at least in species where imitation is important to song acquisition. Background information can be found at on the BBC website. Go to http://www.bbc.com. Once there, click on the link to "earth" in the menu at the top of the page. Once on the "earth" website enter "language and birdsong" in the search bar. The first article that comes up from the search is is titled "songbirds may have helped us talk". Click on that link for your article.

Lecture Launcher 2.6: Even If We Could, Should We Cure Stupidity?

Direct students to the *New Scientist* review of James Watson's comments on using gene therapy to cure stupidity (found at http://www.newscientist.com/. Once on the main page place "DNA and stupidity" in the search field and select the first article). Use these comments to focus class discussion on the future role of genetic screening and gene therapy in determining human behavior. Video of Watson's controversial comments can be found in the PBS video series "DNA, Episode 5: Pandora's Box."

Lecture Launcher 2.7: The History of the Brain

Use the PBS Website on the history of research on the brain to find events and illustrations for use in a classroom presentation. Images can often be copied from a Website and inserted into a PowerPoint presentation for use in class. (Make sure you keep a record of where the image came from. This is not only good for legal defense of fair use, but it may allow you to find something again when you need it.)

Web Link 2.1: History of the Brain

Lecture Launcher 2.8 Basic Evolution

Evolution is easily misunderstood. The Talk.Origins Website is an exceptional resource for basic evolutionary biology. Large parts of the Website, including the "Introduction to Evolutionary Biology" page, assume the reader has had little or no biology background. This makes it very accessible to most psychology majors.

Web Link 2.5: Talk.Origins Homepage

< Return to Table of Contents

WEB LINKS

Web Link 2.1: History of the Brain

http://www.pbs.org/wnet/brain/ (Once on the page for "The Secret Life of the Brain", click on the link for the history of the brain.) "The history of our quest to understand the brain is certainly as long as human history itself. Use this extensive timeline to meander through some of the highlights (and lowlights) of this great journey of understanding."

Web Link 2.2: *Discourse on the Method of Rightly Conducting the Reason and Seeking for Truth in the Sciences*, Rene Descartes (1637)

Guide students to http://www.marxists.org. Once there, have students use the drop down menu on the left side of the homepage to select Rene Descartes. After arriving on the Rene Descartes webpage, have students select the article called "Discourse on Method".
Source: *Discourse on Method* (1637). Cambridge University Press, edited by Haldane and Ross; first five parts.

Web Link 2.3: *The Descent of Man* (2nd ed.), Charles Darwin (1874)

http://psychclassics.yorku.ca/ Once you arrive at the home page, click on the "author" link available on that page. Click on the "D" on the alphabetical bar at the top of the page. At the top of the page is the link for Charles Darwin and his article on "The Descent of Man".

Web Link 2.4: *The Origin of Species*, Charles Robert Darwin

http://www.bartleby.com/ Once you arrive at the home page, find the search by "author" link on the right hand side of the page. Click on "author". Page down to the link for Charles Darwin and his "Origin of Species" article.
"Over fifteen years in the writing, this scientific treatise not only revolutionized every branch of the natural sciences with its theory of evolution, but influenced every literary, philosophical and religious thinker who followed."

Web Link 2.5: Talk.Origins Homepage

http://www.talkorigins.org/
"Talk.Origins is a Usenet newsgroup devoted to the discussion and debate of biological and physical origins."

"The Talk.Origins Archive is a collection of articles and essays, most of which have appeared in Talk.Origins at one time or another. The primary reason for this archive's existence is to provide mainstream scientific responses to the many frequently asked questions (FAQs) that appear in the Talk.Origins newsgroup and the frequently rebutted assertions of those advocating intelligent design or other creationist pseudosciences."

Web Link 2.6: Introduction to Evolutionary Biology

http://www.talkorigins.org/ Once on the home page, select "search the archive" from the menu on the left hand side of the page. Place "Introduction to Evolutionary Biology" in the search bar and select "search". Scroll down the page to the first link below the ads by Google. Click on the link.

Web Link 2.7: Comparative Mammalian Brain Collection

http://www.brainmuseum.org/

Web Link 2.8: Sources of Human Psychological Differences: The Minnesota Study of Twins Reared Apart

http://euvolution.com/ Once on the home page, select the "Science" link available on the left hand side of the page. From the Science page, select the link for the "Nature versus Nurture" debate. From the "Nature versus Nurture" debate page, select the link titled "Sources of Human Psychological Differences".

Web Link 2.9: Heredity and Heritability

http://plato.stanford.edu/ Once on the home page, type "heredity" in the search bar and click "search". After receiving the search results, click on the link for "heritability".
Stanford Encyclopedia of Philosophy

< Return to Table of Contents