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Chapter 2: Heredity and Environment

BRIEF DESCRIPTION OF CHAPTER

This chapter examines the interaction between genes and the environment in producing developmental outcomes. It begins with a discussion of basic genetics, including the function of genes, cell division, and the relation between genes and behavior. Patterns of genetic inheritance are covered next, highlighting specific examples such as fragile X syndrome, dominant-recessive patterns, X-linked inheritance, and polygenic inheritance. Down syndrome is explored as an example of behavior resulting from chromosomal abnormalities. The chapter then focuses on the interplay between genes and the environment, discussing heritability, shared and non-shared environments, and gene–environment correlations. Lastly, developmental systems frameworks are applied to understanding the complex interplay between genes and the environment.

CHAPTER-AT-A-GLANCE GRID

Chapter Outline	Instructor's Resources	Multimedia Resources
2.1 The Dynamic Gene	Learning Objectives 2.1, 2.2, 2.3, 2.4 Thinking About Your Virtual Child: Reflection Activity Pair and Share: Genetic Testing Activity Break: Discussion of Genetic Inheritance; Dominant versus Recessive Traits Application Activity: National Fragile X Foundation; Linking Fragile X with Genetic Counseling; Huntington's Disease; Polygenic Inheritance Observing the Dynamic Child 2.1: Parental Views on Inheritance Debate: Genetic Testing Writing Assignment: Interview a Genetic Counselor; Interview a Caregiver Guest Speaker or Writing Assignment: X-Linked Inheritance	Simulation Link: Mitosis Fragile X: A Family's Story video (7:38) Mothers, Babies and PKU video (2:07) Chromosome 21: How Accidental Inheritance Can Lead to Down Syndrome video (4:03) Observing the Dynamic Child 2.1: Parental Views on Inheritance video (3:05)
2.2 Genes and Environment in Human Behavior	Learning Objectives 2.5, 2.6, 2.7 Application Activity: Compare and Contrast Twin and Adoption Studies; Minnesota Center for Twin and Family Research; A Group Socialization Theory of Development; Evaluate Behavior Genetics Studies; Height and the Impact of the Environment; Linking Behavior Genetics with Research Methods Pair and Share: Shared and Non-Shared Environments Guest Speaker: Professor of Genetics	Nurture Myth: Parenting, Upbringing Has Very Little Effect on Children video (5:40) Steven Pinker: Parental Influence on Personality video (6:19) The Secret Life of Twins video (51:57; time for excerpts will

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	Application Assignment: Research a Topic in Genetic Counseling The Dynamic Child in the Classroom: Nature and Nurture: Similarities and Differences Among Triplets	vary) The Dynamic Child in the Classroom: Nature and Nurture: Similarities and Differences Among Triplets video (7:32)
2.3 Gene–Environment Transactions	Learning Objectives 2.8, 2.9, 2.10 Application Activity: Gene-Environment Correlations and You; Research Articles and Gene–Environment Interactions; The Dutch Hunger Winter and Epigenetics Observing the Dynamic Child 2.3: Identical Twins, Raised Apart Case Studies: Genetic Testing Class Discussion: Exploring Genetic Testing and Ethics; Identical Strangers Explore Nature and Nurture	Temperament as Passive Gene–Environment Correlation video (5:16) Epigenetics Documentary video clip (13:02) Epigenetics and the Influence of Our Genes video (18:40) Epigenetic Transformation: You Are What Your Grandparents Ate video (21:14) Observing the Dynamic Child 2.3: Identical Twins, Raised Apart video (6:02)
2.4 Developmental and Bioecological Systems Approaches	Learning Objectives 2.11, 2.12 Application Activity: Let's Move Campaign: Distal and Proximal Influences Pair and Share: Causes of Obesity and Bronfenbrenner's Model; Compare and Contrast Developmental Systems Framework and the Bioecological Model of Development; Apply Bronfenbrenner's Bioecological Model to Another Developmental Issue Shared Writing: Combating Obesity in Children	
INNOVATIVE IDEAS FOR CHAPTER 2		

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- Investigate a Genetic Disorder Writing Assignment or Presentation
- Danielle's Story of Child Neglect Video
- Identical Twins, Identical Fates Writing Assignment
- Epigenetics, Smoking, and Public Health Group Presentations
- Nature versus Nurture Writing Assignment or Presentation
- Child Temperament, Passive Gene–Environment Correlations, and the Role of the Family Discussion

CHAPTER OUTLINE WITH LEARNING OBJECTIVES

Introduction: Birth of a Genius
Raising Your Virtual Child
2.1 The Dynamic Gene
The Nature of Chromosomes, Genes, and Sexual Reproduction
LO 2.1 *Explain the three major functions of genes.*
Understanding the Path from Genes to Behavior: Fragile X Syndrome
LO 2.2 *Explain the indirect pathway by which genes affect human behavior, using the example of fragile X syndrome*.
Patterns of Inheritance
LO 2.3 *Explain how genes get passed from generation to generation and produce variability in human development*.
Dominant-Recessive Inheritance
X-Linked Inheritance
Polygenic Inheritance
Chromosomal Errors
LO 2.4 *Describe the cause and the main characteristics of Down syndrome*.
Observing the Dynamic Child 2.1: Parental Views on Inheritance
2.2 Genes and Environment in Human Behavior
Using Family Resemblance to Study Heredity and Environment
LO 2.5 *Explain how scientists identify genetic and environmental contributions to complex traits such as IQ.*
Heritability and Shared and Non-Shared Environment
LO 2.6 *Explain the concepts of heritability and shared and non-shared environment and how their contributions change with age.*
Limitations of Behavior Genetic Studies
LO 2.7 *Explain limitations involved in estimating hereditary and environmental influences on behavior*.
The Dynamic Child in the Classroom: Nature and Nurture: Similarities and Differences Among Triplets
2.3 Gene–Environment Transactions
Gene–Environment Correlations
LO 2.8 *Describe how the three types of gene-environment correlations help explain findings of twin and adoption studies*.
Three Types of Gene–Environment Correlations
Gene–Environment Correlations: Explanations and Evidence
Gene–Environment Interactions
LO 2.9 *Explain how scientists obtain evidence for gene-environment interactions in humans.*
Environmental Influences on Gene Expression

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LO 2.10 *Describe evidence from animal and human studies that environments influence gene expression.*

Evidence of Environmental Effects

Epigenesis: A Possible Mechanism of Environmental Influence on Gene Expression

Observing the Dynamic Child 2.3: Identical Twins, Raised Apart

2.4 Developmental and Bioecological Systems Approaches

The Developmental Systems Framework

LO 2.11 *Describe how the developmental systems framework explains relationships among genes, the brain, behavior, and environment*.

Bioecological Systems Model

LO 2.12 *Explain how the influences of different levels of the external environment might be studied, using the example of obesity.*

Shared Writing: Combating Obesity in Children

LESSON PLANS

Module 2.1 The Dynamic Gene

Introduction/hook to stimulate students' interest (5 minutes)

- Organizing theme: How do genes account for individual differences in development?
- Link the experiences of Mozart (Introduction: Birth of a Genius) to the discussion of genes and the environment. Highlight the constant interplay between these factors.
- Inform students that we will explore how genes and the environment constantly influence one another, resulting in individual development.

Integrating the Information: Thinking About Your Virtual Child: Reflection Activity (5 minutes): Ask students to consider how their virtual child may demonstrate the gene–environment relationship. *(This may be used as an in-class writing assignment or class discussion.)*

LO 2.1 Lecture Notes: *Explain the three major functions of genes.*

- Research increasingly shows the process of development is ***dynamic***—that is, genes and the environment interact constantly and continuously in every aspect of development.
- Begin the discussion by presenting the most basic features of genes (each bodily cell contains 23 chromosomes, chromosomes contain DNA, ***genes*** are segments of DNA that serve as templates for making one or more proteins in the body).
- In 2004, scientists succeeded in mapping the entire genetic code for humans.
- DNA also serves the function of replication through ***mitosis***, in which cells divide and multiply. DNA additionally makes reproduction possible through ***meiosis***, or cell division that occurs in male and female reproductive cells **(*gametes*)**. In meiosis, chromosomal material separates into gamete cells that only contain 23 chromosomes (sperm and ova). During fertilization, sperm and ovum meet to produce a ***zygote***, an organism that contains a unique combination of DNA from both the mother and father.
- The sex of the offspring is determined at fertilization by the 23rd pair of chromosomes. Each ovum contains only two copies of the X chromosome, while sperm may contain either an X or Y chromosome. Sperm with the X chromosome results in female offspring (XX); sperm with the Y chromosome results in male offspring (XY).

Suggested Activity Break: Discussion of Genetic Inheritance (5 minutes)

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Ask students to consider any ways that they are similar to their biological parents (e.g., personality traits, physical features, athletic skills, musical skills, etc.). Then ask them to consider any ways they are different from biological parents using the same framework. You may also ask students who have biological siblings to consider similarities/differences. Ask students to consider what accounts for these similarities and differences. This should lead to a lively discussion on the interplay between genes and the environment.

Simulation Link: Mitosis

If students want more information on mitosis, suggest the following website: http://www.sumanasinc.com/webcontent/animations/content/mitosis.html. From here, you can view a simulation that walks through the steps in mitosis. In going through the simulation, you may refer to the next section, where discussion of chromosomal abnormalities occurs (e.g., Down syndrome).

LO 2.2 Lecture Notes: *Explain the indirect pathway by which genes affect human behavior, using the example of fragile X syndrome*.

- Fragile X syndrome is the most common single-gene disorder linked with cognitive disability. Fragile X occurs in approximately 1 in 5,000 males and 1 in 10,000 females (Plomin et al., 2008).
- In fragile X syndrome, one gene at the tip of the X chromosome breaks down, resulting in inability to produce the protein FMRP. This gene is critical to normal development.
- Fragile X syndrome shows how genes vary in terms of ***expression***, or the overall impact on development. Females with fragile X often show less effects, because they have a normal version of the fragile X gene on the unaffected chromosome. Males with fragile X do not have a normal version of the fragile X gene to counterbalance the effects. In males, the effects of the fragile X gene are widely varied, ranging from moderate to little impact on intellectual development, highlighting the impact of the environment in gene expression (Plomin et al., 2008).

Application Activity: National Fragile X Foundation

To learn more about fragile X, ask students to visit the website for the National Fragile X Foundation (https://fragilex.org). On the website, students will see a number of different profiles that chronicle people with fragile X. Assign students to select either a male or female profile. As part of a class discussion, have students compare and contrast the differences in the expression of fragile X by sex. Have students apply their understanding of sex and genetics to explaining the differences. This activity could also be used as a writing assignment in which individual students select both a male and a female profile and write a paper comparing and contrasting the sex differences, linking this with their understanding of sex and genetics.

Application Activity: Linking Fragile X with Genetic Counseling (10 minutes)

Have students visit the following website: http://www.ncbi.nlm.nih.gov/books/NBK1384/. The website contains a comprehensive review of the individuals who should seek genetic testing for fragile X. Ask students to use the website to summarize the populations that should seek genetic testing for this particular abnormality. Note: The information can be somewhat complicated, so this might work best as an in-class activity so the instructor can help students understand the biological side better.

Application Video Activity: Fragile X: A Family's Story (7:38)

https://youtu.be/uxjcuyVx5I4

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Have students watch this video outside of class. In a class discussion, ask them to consider the impact that something like fragile X may have on a family unit. The video also showcases the genetic component of the abnormality and the sex differences, so ask students for comments on that, too.

LO 2.3 Lecture Notes: *Explain how genes get passed from generation to generation and produce variability in human development.*

- Genes in the first 22 pairs of chromosomes have two or more ***alleles***, or forms, from the mother and father. The unique combination of alleles forms a person's individual ***genotype***. The observable characteristics (e.g., disease, physical features) of a person's genotype constitute the ***phenotype***.
- In dominant-recessive inheritance patterns, one allele is dominant (expressed) and the recessive allele is expressed only when the person has two recessive alleles.
- Huntington's disease is an example of a dominant disorder. Symptoms include destruction of the brain and nervous system, with accompanying loss of intelligence, muscle control, speech, and balance.
- Phenylketonuria (PKU) is an example of a recessive disorder. In this disorder, the person cannot convert the amino acid phenylalanine to tyrosine (another amino acid). As a result of eating foods with phenylalanine, individuals with PKU experience brain damage and mental impairment. Environmental interventions (e.g., avoiding foods with phenylalanine) greatly reduce the impact of PKU, illustrating the interplay between genes and the environment (Plomin et al., 2008).
- X-linked inheritance describes patterns of mutation that are exclusive to the X chromosome in the 23rd pair. Because males and females differ in the 23rd pair of chromosomes (males: XY, females: XX), the expression of X-linked inheritance differs between males and females. Color blindness, found more often in males than females, is an example of X-linked inheritance.
- ***Polygenic inheritance*** involves patterns of inheritance involving more than one gene. Examples include autism, schizophrenia, and learning disabilities.

Activity Break: Dominant versus Recessive Traits (5 minutes)
Visit the following website: http://www.blinn.edu/socialscience/ldthomas/feldman/handouts/0203hand.htm. Listed on the site are different dominant and recessive traits. You may conduct an informal poll by asking students how many have a few of the particular traits listed. Alternatively, you may copy this list and ask students to check what they have from each column (e.g., either the dominant or recessive trait). Then, ask students to share with a partner and compare lists.

Application Activity: Huntington's Disease
Have students visit the Huntington's Disease Society of America website (http://hdsa.org/), select one topic from the site (possible topics include advocacy, genetic testing, early-onset, nutrition, possible therapies, etc.), and collect information on the topic. *This may be used as a class discussion or in-class writing assignment.*

Application Video Activity: Mothers, Babies and PKU (10 minutes; video 2:07)
https://youtu.be/w3L2SPj7alQ
Show the video, which discusses the implications of mothers with PKU who do not follow dietary recommendations during pregnancy. The result of this may be birth defects in the fetus. Ask students to consider the implications of this research and to suggest ways to increase public awareness.

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Application Activity: Polygenic Inheritance

Have students research some of the possible causes for abnormalities that result from polygenic inheritance, such as schizophrenia, autism, learning disabilities, cleft palate, and spina bifida. Then have students present findings in either class discussion, presentations, or a short (two- to three-page) paper.

LO 2.4 Lecture Notes: *Describe the cause and main characteristics of Down syndrome.*

- During meiosis, problems can occur with chromosomal replications. There may be too many or too few chromosomes present. Often, this results in termination of the pregnancy. When there is an extra 21st chromosome, the pregnancy is often not terminated, resulting in Down syndrome.
- In ***Down syndrome***, there is an extra 21st chromosome. The risk for Down syndrome increases with maternal age (after age 35), and increases somewhat with paternal age.
- Results of Down syndrome include cognitive disability, short lifespan, heart conditions, and early dementia.

Video Link: Chromosome 21: How Accidental Inheritance Can Lead to Down Syndrome (4:03)

https://youtu.be/wtebnV_QFQU

Show the video to demonstrate how the cell replication process can lead to a chromosomal abnormality such as Down syndrome.

Pair and Share: Genetic Testing (10 minutes)

Ask each student to pair with a classmate and consider the role of genetic testing and counseling. As this practice becomes more widespread (especially for older parents), ask students to consider the following prompts:

- Under what circumstances would you seek genetic testing or counseling?
- If you learned through testing results that your child may have Down syndrome, what would you do?
- What are the important factors in making these decisions? (Note: Some students may emphasize things such as religious or ethical concerns, quality of life issues, etc.)

Observing the Dynamic Child 2.1: Parental Views on Inheritance

https://mediaplayer.pearsoncmg.com/assets/mypsychlab-2015-manis1e_0134410971-parental_views_on_inheritance

Ask each student to pair up with another student. Present students with a worksheet containing the following questions and ask them to work in pairs. Show the *Observing the Dynamic Child 2.1: Parental Views on Inheritance* video (3:05). This can be used as an in-class participation grade. NOTE: Be sure to remove the * before using this as a handout for students!

1. What differences in personality does the mother describe in childhood?
   a. One child was interested in music, the other was not.
   b. *One child was more stubborn and persistent and the other easier to persuade.
   c. One child was highly active and excitable and the other moderately active and excitable.
   d. One child seemed anxious to be the best at something, whereas the other was content to be second best.
2. According to the mother, the twins played an active role in their own development in all of the following ways EXCEPT _____.
   a. choosing particular topic areas to read about

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b. choosing a musical instrument (piano or guitar) to specialize in
c. *one actively chose to be in choir and the other did not
d. in their choice of leisure-time activities such as playing video games and making jewelry

3. The mother seems to assume that the consistent tendency for the twins to choose different activities in which to excel was attributable to _____.
   a. a desire to excel in a different area than the twin
   b. a desire to be as similar as possible in their interests
   c. a desire on the part of both twins to please their mother
   d. “natural” (or genetically influenced) differences in interests
   e. *both a and d

To encourage additional critical thinking following the Observing the Dynamic Child video, consider asking students to address this prompt:

> Michael and McCourt are fraternal twins. Their father, David, was a gifted soccer player in high school but had to stop playing due to a permanently impairing injury. David’s brother, Jack, went to the University of Alabama on a football scholarship. Both Michael and McCourt show little interest in soccer, yet are athletically gifted in controlling the soccer ball. However, both boys do have an affinity for football like their Uncle Jack, though neither is nearly as adept in footballs skills. Should David encourage his young sons toward soccer or football? Explain your decision.

Links to Additional Activities, Demonstrations, and Exercises for this Module

1. **Debate: Genetic Testing (15–20 minutes)**
   Divide the class into two groups. Assign one group to be in favor of genetic testing and the other group to be against genetic testing. Have students research their side of the argument. In class, have students debate this controversial topic. Specifically, you may present hypothetical scenarios to students to get the debate started. For instance, how would you respond if you were fairly certain your child will be born with Down syndrome? What if you are pregnant with twins, and only one of the twins is likely to be born with Down syndrome? How would you respond, and why?
2. **Writing Assignment: Interview a Genetic Counselor**
   Direct students to interview a genetic counselor. If they cannot locate one, they may use the National Society for Genetic Counselors website (http://www.nsgc.org/), which provides many answers to the questions below. In the interview, have students include the following questions:
   - What are your typical daily responsibilities?
   - What is your educational background? What types of education and training are required to do this job?
   - Who are your typical clients?
   - When you have bad news to share with clients, how do you do this?
   - What are your responsibilities to the client following the delivery of bad news?
   - What are your favorite parts of this job? Least favorite?
   - What qualities do you need to be successful in this career?

   Students may also add additional questions. At the end of the paper, have students reflect on the responses they gathered. Is this a career option for them? Why or why not? Has their perception of this job changed from their initial impressions? Students may compile responses in a three- to four-page paper.
3. **Writing Assignment: Interview a Caregiver**
   Direct students to locate a person who provides care for an individual with a genetic abnormality (e.g., Down syndrome, fragile X, PKU). If students cannot locate a specific

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person to interview, they may instead locate a video or blog on the topic. In interviewing this person, have students ask the following questions:

- What is a typical day like for you?
- What are the best parts of working with this person? Worst parts?
- What qualities does a person need to be a successful caregiver?
- How has working with this person impacted various areas of your life (e.g., outside career, family relationships, finances, etc.)?

Students may add additional questions. At the end of the paper, have students reflect on the responses they gathered. Has their perception of what it is like to care for someone with a genetic abnormality changed? Why or why not? Students may compile responses in a three- to four-page paper.

4. **Writing Assignment or Guest Speaker: X-Linked Inheritance Interview**
   Direct students to find someone who is color-blind. Students may ask this person to describe the color blindness, such as colors that are difficult to distinguish. To help students apply the X-linked inheritance pattern, have them ask this person if relatives are also color-blind. Ask students to apply what they know about X-linked inheritance to color blindness, specifically how this pattern may be passed from one generation to the next. Students may compile responses in a two- to three-page paper. As an alternative to this assignment, you might invite in a guest speaker who is color-blind. Direct students to prepare at least two questions ahead of time. If the speaker is amenable to it, show the tests for color blindness (Ishihara tests) to demonstrate.

Module 2.2: Genes and Environment in Human Behavior

Introduction/hook to stimulate students' interest (5 minutes)

- Inform students that this section looks at ways to tease out influences of the environment versus genetic influences in development.
- Ask students to consider how their own genetic inheritance has played a role in the people they are today. Prompt students to discuss ways in which they are similar to their parents.

LO 2.5 Lecture Notes: *Explain how scientists identify genetic and environmental contributions to complex traits such as IQ.*

- The field of ***behavior genetics*** attempts to determine how much variation in a particular trait is due to genes versus the environment.
- Twin designs seek to separate the impact of genes and the environment on particular traits by comparing identical (share 100 percent of segregating genes) and fraternal twins (share 50 percent of segregating genes). ***Segregating genes*** are genes that have different alleles that can result in individual differences.
- In examining the correlation between genetic relatedness and IQ scores, individuals who share more genetic relation tend to have more highly correlated IQ scores.
- Behavioral geneticists use different designs to account for the role of genetics and the environment, including identical twins reared together or apart and adoption designs.
- ***Adoption designs*** compare biological parents with their adopted-away children to correlations between adopting parents and their genetically unrelated children. Correlations in IQ between adoptive parents and their genetically unrelated children support the role of environmental influence.

Application Activity: Compare and Contrast Twin and Adoption Studies (5 minutes)

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Have students pair up and compare and contrast twin and adoption studies. How are they similar? How are they different? What types of conclusions may be drawn from each, and what is the relative contribution of each to developmental science?

Application Activity: Minnesota Center for Twin and Family Research

The University of Minnesota is credited with much of the early research on twin studies. Have students visit the website (https://mctfr.psych.umn.edu/research/UM%20research.html) and summarize the information presented there. In particular, students may focus on the "Research" tab, or examine the other studies that now occur at the MCTFR. *This may be used as an in-class writing assignment or class discussion.*

LO 2.6 Lecture Notes: *Explain the concepts of heritability and shared and non-shared environment and how their contributions change with age.*

- Behavioral geneticists calculate ***heritability***, a mathematical index of the proportion of variance in a given trait that is due to variation in genes. Heritability for IQ is estimated to be approximately 48 percent in adoption studies and 52 percent in twin studies (Plomin et al., 2008).
- Behavioral geneticists are concerned with environmental influences as well. The ***shared environment*** refers to similar influences that children and adults raised in the same environment experience. The ***non-shared environment*** refers to experiences that are unique to the individual child or adult. The shared environment accounts for approximately 25 percent of the variability in IQ scores in children, and the non-shared environment accounts for approximately 15 percent of this variability.
- Heritability generally increases with age for most characteristics.

Application Activity: A Group Socialization Theory of Development

Have students visit http://faculty.weber.edu/eamsel/Classes/Child%203000/Lectures/3%20Childhood/SE%20development/JudithHarris.html outside of class to read the following article:

Harris, J. R. (1995). Where is the child's environment? A group socialization theory of development. *Psychological Review*, *102*, 458–489.

The article argues that parents have very little influence on development, and peers/genetics are largely responsible for child outcomes. After reading the article, have students evaluate the claims made. What evidence is provided for the limited role of parents? What evidence is provided for the impact of the non-shared environment? What evidence is provided for the role of genetics? How does this argument compare with what is presented in Chapter 2 of the text? (Note: This article is also useful in Chapters 9 and 12 in discussions of the impact of parenting on socioemotional development.) *This may be used as an in-class writing assignment or class discussion.*

Pair and Share: Shared and Non-Shared Environments (5 minutes)

Ask each student to pair with a classmate to discuss the shared and non-shared environments they experienced growing up. For students who do not have siblings, ask them to think about their environments compared with that of a close friend or school classmate. Ask students to consider the impact the shared and non-shared environments may have had on their development. For example, are students very similar or different from siblings? How do they explain this? What activities did they participate in that siblings did not? How might this non-shared environment impact development?

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LO 2.7 Lecture Notes: *Explain limitations involved in estimating hereditary and environmental influences on behavior.*

- Behavior genetic studies have several limitations:
  1. First, it is difficult to precisely parse out the influences of genes and the environment.
  2. Additionally, genes have different effects in different environments.
  3. Lastly, environments influence gene expression.
- These limitations make it very challenging to estimate the relative impact of genes and the environment in producing individual differences.

Application Activity: Evaluate Behavior Genetic Studies (5 minutes)

Ask students to consider how the different limitations of behavior genetic studies impact the usefulness of the conclusions drawn. Ask them to consider if there will ever be a point in time in which behavior genetic studies will precisely parse out the impact of genetics and the environment. Why or why not?

Application Activity: Height and the Impact of the Environment

Since height is a feature known to be impacted by the environment (e.g., nutrition), have students locate research on changing heights with improved nutrition standards. Have students draw the connection between genes and the environment. *This may be used as an in-class writing assignment or class discussion.*

Application Activity: Linking Behavior Genetics with Research Methods (10 minutes)

Direct students to the following website: http://www.nature.com/scitable/topicpage/estimating-trait-heritability-46889. It provides a detailed description of behavior genetic studies, including comparison of heritability to correlation coefficients. Have students summarize the information and relate it back to the research methods discussed in Chapter 1. Specifically, you may use this to discuss correlations again, highlighting the types of conclusions drawn using this method. *This may be used as an in-class writing assignment or class discussion.*

Links to Additional Activities, Demonstrations, and Exercises for this Module

1. **Video Link: Nurture Myth: Parenting, Upbringing Has Very Little Effect on Children (5:40)**
   https://youtu.be/ekI31kzb6iU
   or Steven Pinker: Parental Influence on Personality (6:19)
   https://youtu.be/IcVu6fgN3-g
   Direct students to watch the video(s) (or show during class time). The videos show Steven Pinker discussing the research on parenting and its limited effects on child outcomes. Use this to stimulate discussion. Do students agree with the statements? Why? How could research on parenting be improved to more fully account for the role of genetics?
2. **Guest Speaker: Professor of Genetics**
   If you have a professor on your campus who teaches genetics, ask this person to come to your class to speak about the world of genetic testing. In particular, the speaker may highlight things such as the ethics of testing and how this is approached in the scientific community. Direct students to come prepared with at least two questions for the speaker on the topic.
3. **Application Assignment: Research a Topic in Genetic Counseling**
   Have students visit the website of the National Society of Genetic Counselors (http://www.nsgc.org/). Ask students to choose a particular topic from the site (e.g., patient advocacy, patient concerns, education, public policy statements) and present their findings

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to the class. You may also choose to have students write a short paper summarizing their findings.

4. **Video Link: The Secret Life of Twins (51:57)**
   https://youtu.be/NLipq8r_0QE
   Excerpts from this video may be used to supplement discussion of identical twin development in class. For example, there is a fascinating story of Chinese twins, separated at birth and raised by two separate families in Norway (Alexandra) and California (Mia). The families discover that they are raising identical twins and reunite them. Other topics covered in the video include twins who suffered identical illnesses at the same time, medical research on physical similarities in twins, and a continuing story of twin doctors who seek to discover how many of their developing traits are attributable to genes and how many to environment.

The Dynamic Child in the Classroom: Nature and Nurture: Similarities and Differences Among Triplets

https://mediaplayer.pearsoncmg.com/assets/mypsychlab-2016-manis1e_0136049745-fraternal_and_identical_twins

Overview

The Chapter 2 video (7:32; for in-class use) introduces students to adult triplets. (They are likely a pair of identical twins and one sister who is not identical to the other two. However, without genetic testing, it is impossible to know for sure.) The triplets reflect on the ways in which their similarities and differences—in childhood and adulthood—were influenced by both nature and nurture. On-screen questions help students consider how personality traits (e.g., introversion/extroversion) work with environment (e.g., parental decisions to create similar or different childhood environments) to affect individual siblings and the siblings as a unit.

Discussion Questions from the Video

1. In what ways are the sisters' personalities alike and different? How might we attribute these similarities and differences to genetics, shared environment, and non-shared environment?
   Chris and Jess gravitated toward certain aspects of their father's personality, which they describe as agreeable and laid-back, while Faith seems to share certain aspects of their mother's personality, which involves a willingness to disagree or to express controversial opinions. Similarities within families are attributed to shared environment. Chris and Jess shared a more similar environment because they were more influenced by their father. Faith and her mother shared a more similar environment in their willingness to disagree or go against the flow.
   However, we also have to bear in mind that each child shares on average 50 percent of their genes with each parent. Therefore, these similarities to parents could be a result of both genetic tendencies and environmental influences. Faith and Chris (the identical twins) seem more similar in terms of extroversion and risk-taking behavior (such as a willingness to perform in front of a group) than Jess, who prefers quieter and more "behind-the-scenes" activities. Extroversion is a heritable trait, but we must also consider that Faith's and Chris's behavior might have taken them to different settings (e.g., traveling or doing activities without the other sisters), which would involve both a non-shared environment (an environment they did not share with Jess) and a gene–environment correlation (e.g., they experienced these new environments in part because of genetic tendencies toward extroversion and risk-taking).
2. How might the sisters' dating and spousal choices reflect a gene–environment correlation?
   The sisters agree that the more extroverted personalities of Chris and Faith were associated with more extroverted dating and marriage partners. This could be a gene–environment correlation because a behavior trait that was partly genetically based

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(extroversion) led to different kinds of interpersonal experiences (the experience of being married to or dating an extroverted person).

3. To what extent do the sisters share interests and activities? How might this be attributed to genetics, shared environment, and non-shared environment?

   Chris and Faith shared similar interests in sports and music, suggesting that their similar interests might be due to their greater genetic similarity. However, Jess was also interested in sports, which suggests a shared environment in which their parents encouraged sports and took all three to the same practices at the same time for convenience. They also mention a shared interest in scrapbooking that they believe is due to the high value they all place on family relationships, a likely candidate for a shared environmental influence. Likewise, their common interest in travel might be a shared environmental influence because their parents took them on frequent trips. However, it could also be a genetic influence from their parents, stemming from personality traits having to do with curiosity and openness to new experiences.

4. Siblings often try to carve out different niches. Both Chris and Jess are fifth-grade teachers. Listen to Faith talk about her career choice. How might this process be more intense among triplets?

   The choice of a career seems to involve carving out different niches. Faith describes being drawn to helping children, but she wanted to avoid falling into the familiar role of doing the same thing as her sisters. Hence, even though being an elementary school teacher was an attractive career, she decided to pursue pediatric nursing. She mentions that her mother was a nurse, which gave her opportunities to observe this career choice firsthand. The process might be more intense because triplets grow up at the same time and in the same place, and are placed in similar activities for convenience by their parents. This makes issues of developing an individual identity especially salient. An interesting point is that Faith suggested she was more similar to her mother in certain personality traits, and this may have had something to do with selecting the same career as her mother.

Module 2.3 Gene-Environment Transactions

Introduction/hook to stimulate students' interest (5 minutes)

- Organizing theme: How do developmental scientists attempt to account for the constant interplay between genes and the environment in explaining individual differences in development?
- Inform students that we will explore different ways to account for the mutual influence of genes and the environment in producing individual outcomes. Developmental scientists account for the ***transactions of genes and the environment***, recognizing that these do not develop in isolation and are constantly interacting.

LO 2.8 Lecture Notes: *Describe how the three types of gene–environment correlations help explain findings of twin and adoption studies.*

- In ***gene–environment correlations***, genetic variations among people influence the environment to which they are exposed (Plomin et al., 2008; Rutter, 2006).
- ***Passive*** gene–environment correlations result when children inherit genotypes associated with family environment. ***Evocative*** gene–environment correlations occur when individuals evoke reactions from the environment based on genetic predispositions. ***Active*** gene–environment correlations occur when the individual seeks out environments that support genetic predispositions.
- Research evidence supports the roles of passive, evocative, and active correlations in development (Plomin et al., 1997; Tucker-Drob & Harden, 2012).

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Application Activity: Gene–Environment Correlations and You (5 minutes)

Ask students to come up with their own examples of gene–environment correlations. You may need to prompt students to think about the types of extracurricular activities they engaged in as children. Then ask them why they were in particular activities. Often, students will cite parental influence, natural talent, enjoyment, etc. Help students connect these reasons to the gene–environment correlations.

Application Video Activity: Temperament as Passive Gene–Environment Correlation (5:16)

https://youtu.be/CVJBzvaylH8

In this video, Jerome Kagan describes his research on temperament in infancy and possible associated outcomes. Ask students to apply the concept of the passive gene–environment correlation here. How do temperaments in early childhood represent a passive influence? How do temperaments shape the environment?

LO 2.9 Lecture Notes: *Explain how scientists obtain evidence for gene–environment interactions in humans.*

- Specific genes affect a child's responsiveness to specific environmental hazards (Kim-Cohen & Gold, 2009).
- In ***gene–environment interactions***, negative environmental effects are seen for only one version of a particular gene.
- For example, research by Caspi et al. (2003) shows that the effects of child maltreatment and number of stressful life events are stronger in individuals with the short form of a particular allele (they had the highest levels of depression at age 26; *Figure 2.7*).

Application Activity: Research Articles and Gene–Environment Interactions

Have students visit http://www.ncbi.nlm.nih.gov/pubmed/21199959 to find the following article on gene-environment interactions:

Karg, K., Burmeister, M., Shedden, K., & Sen, S. (2011). The serotonin transporter promoter variant (5-HTTLPR), stress, and depression meta-analysis revisited: Evidence of genetic moderation. *Archives of General Psychiatry, 68* (5), 444-454.

Outside class, have students read the article and provide a summary of the main points. Direct students to link the article findings to gene–environment interactions. *This may be used as a writing assignment (a two- to three-page paper), class discussion, or presentation.*

LO 2.10 Lecture Notes: *Describe evidence from animal and human studies that environments influence gene expression.*

- The expression of genes is influenced by a variety of factors, including the internal environment of the cell and body and the external environment. For example, rat pups who were genetically predisposed to have low anxiety levels showed elevated levels of anxious behavior as adults when reared by non-nurturant mothers. Pups reared by nurturant mothers showed less anxious behaviors as adults (Weaver et al., 2004; Meaney, 2010).
- ***Epigenesis*** refers to chemical processes that surround the gene to control expression of the gene. Unlike genetic mutations, epigenetic effects do not alter the DNA sequence in activating or silencing gene expression. Epigenesis works in humans by attaching methyl groups to DNA, reducing the expression of some genes.
- Evidence for the effects of epigenetic changes comes from twin studies (Fraga et al., 2005) and studies of the impact of stress in the first four years of life (Essex et al., 2013).

Video Link: Epigenetics Documentary NOVA Science

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Short clip (13:02): https://youtu.be/M4boKud1MRk
After students have watched the video clip (in class or outside of class), discuss the field of epigenetics and what it tells us about the role of the environment and genetic inheritance. *This may be incorporated into an in-class writing assignment or class discussion*.

Video Link: TED Talk: Epigenetics and the Influence of Our Genes (18:40)

https://youtu.be/JTBg6hqeuTg
Courtney Griffins, a geneticist, explains the role of epigenetics in understanding twin studies. For example, why might one twin develop schizophrenia and the other does not? Have students watch this video outside of class. Then, use the video as a discussion starter. What does the video say about the interaction between genetic inheritance and the environment? *This may be used as an in-class writing assignment or class discussion*.

Video Link: Epigenetic Transformation: You Are What Your Grandparents Ate (21:14)

https://youtu.be/Udlz7CMLuLQ
In this video, Dr. Pamela Peeke, a physician, describes the field of epigenetics. Specifically, she examines the mounting evidence that the food choices made in previous generations impacts development in future generations. Ask students to consider the implications of this finding. In particular, ask them how this information might be applied to working with pregnant women. *This may be used as an in-class writing assignment or class discussion.*

Observing the Dynamic Child 2.3: Identical Twins, Raised Apart

https://mediaplayer.pearsoncmg.com/assets/mypsychlab-2015-manis1e_0134410971-Twins_Separated_at_BirthReunited
Ask each student to pair up with another student. Present students with a worksheet containing the following questions and ask them to work in pairs. Show the *Observing the Dynamic Child 2.3: Identical Twins, Raised Apart* video (6:02). This can be used as an in-class participation grade. NOTE: Be sure to remove the * before using this as a handout for students!

1. The two women had some similar interests (film and collecting dolls). How might similar genes have led to having similar interests?
   a. Genes might have produced a tendency toward artistic expression.
   b. Genes might have determined how well they understood film.
   c. Genes may have produced tendencies toward personality traits and abilities that led them to be interested in films: creativity, curiosity, shyness, and verbal ability.
   d. *Both a and c are true.
2. Some of the similar experiences (such as vacations) were likely coincidences, but how might their genetic similarity have led to similar experiences, such as having bouts of depression?
   a. They might have had the gene for depression, which would cause depression regardless of the environment.
   b. They may have had a genetic susceptibility to depression that was triggered by the stress of leaving home and going to college.
   c. They may have had other traits that made it more likely they would have triggering experiences for depression (such as social awkwardness or social anxiety).
   d. *Both b and c are true.

To encourage additional critical thinking following the Observing the Dynamic Child video, ask students to address these questions: What are some specific examples of environmental factors that could influence interests such as film and doll collecting as well

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as symptoms of depression? Is it possible to discern with absolute certainty the origin of traits as either nature or nurture? If yes, what explains your certainty?

Links to Additional Activities, Demonstrations, and Exercises for this Module

1. **Application Activity: Case Studies: Genetic Testing**
   For a storehouse of case studies that examine the role of genetic testing and counseling, visit the following website: http://sciencecases.lib.buffalo.edu/cs/collection/results.asp?subject_headings=genetics%20/%20heredity. Here, you will find many different case studies that you may use both during and outside class.
2. **Class Discussion: Exploring Genetic Testing and Ethics**
   Visit the following website: https://www.nwabr.org/sites/default/files/Genetic_Testing_Lesson3_NWABR.pdf. Here, you will find a very detailed lesson plan for ways to discuss genetic testing in the classroom. In particular, this lesson provides solid background on the ethics of genetic testing and applies this to a case study. This lesson could be used to stimulate class discussion on the ethical side of genetic testing. *This may also be used as a writing assignment.*
3. **Class Discussion: Identical Strangers Explore Nature and Nurture**
   Direct students to read/listen to the following NPR news story outside class: http://www.npr.org/2007/10/25/15629096/identical-strangers-explore-nature-vs-nurture. This story builds on the story of the twins covered in *Observing the Dynamic Child 2.3: Identical Twins, Raised Apart***.** Use the story to provide additional information regarding the twins in the video. Ask students to consider the relative roles of genetics and environmental experience. *This may also be used as a writing assignment.*
4. **Application Activity: The Dutch Hunger Winter and Epigenetics**
   The field of epigenetics gathers evidence from many sources, such as the Dutch Hunger Winter, to illustrate the impact of starvation on the epigenome. To get started, have students visit the following website: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2579375/. Here, students will read an article that looks at the relation between the timing of starvation in adults and the developing fetus. Have students link this evidence to the field of epigenetics and speculate about the long-term consequences found in the study. Additionally, you may ask students to recommend specific social policies that may address the impact of starvation during pregnancy. What could be done from a societal level to prevent negative impact to the fetus? *This may be used as a writing assignment or class discussion.*

Module 2.4: Developmental and Bioecological Systems Approaches

Introduction/hook to stimulate students' interest (5 minutes)

- Organizing theme: How do developmental systems and bioecological systems explain the interplay between genes and the environment?
- Inform students that we will apply these two frameworks to understanding the transactional nature of genes and the environment, and explain that these approaches attempt to provide a holistic account of genes and the environment.

LO 2.11 Lecture Notes: *Describe how the developmental systems framework explains relationships among the brain, behavior, and environment.*

- A developmental system includes the genetic and environmental influences on the developing organism, including changes over time.
- In Gottlieb's developmental systems framework, development is probabilistic, meaning that a behavior or trait is not determined by any single factor or combination of factors with any certainty. Applying this framework to human development, individual development involves

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the interplay among genetic activity, neural activity, behavior, and the environment (*Figure 2.9*). The environment encompasses all influences outside genes (Gottlieb, 2007). The systems constantly interact to produce development.

LO 2.12 Lecture Notes: *Explain how the influences of different levels of the external environment might be studied, using the example of obesity.*

- Bronfenbrenner's bioecological model of development examines the role of the microsystem, exosystem, macrosystem, and chronosystem in explaining development.
- ***Distal influences*** are macro-level influences that impact ***proximal influences***, which operate more in the child's immediate experience.
- Applied to obesity, distal influences include changes in portion size at fast food restaurants without corresponding changes in price (the text uses the example of french fries). This impacts children at the proximal level, in that families who have less time to prepare foods at home might turn to fast food as a viable option. Children then are exposed to larger portion sizes of the fast food, and this contributes to obesity.

Pair and Share: Causes of Obesity and Bronfenbrenner's Model (10 minutes)

Have each student pair with a classmate and discuss causes of childhood obesity. Then, have students outline how each cause fits in Bronfenbrenner's model. For instance, students may draw connections between distal influences such as federal policy (e.g., school lunch funding, importance of achieving test scores) and proximal influences (e.g., quality of food available for child's lunch, schools with low test scores may remove recess or physical education from the curriculum) and the link to childhood obesity.

Application Activity: Let's Move Campaign: Distal and Proximal Influences

As one initiative to combat childhood obesity, have students research the Let's Move campaign started by First Lady Michelle Obama. In researching this topic, have students draw connections between distal and proximal processes and how these impact the individual child. *This may be used as a writing assignment or class discussion.*

Shared Writing: Combating Obesity in Children

The following is the shared writing prompt from REVEL. It can be assigned within REVEL, with the guideline of writing a minimum of 140 characters, or as a longer in-class writing activity.

> *Suppose you are collaborating with others to produce an educational program for parents regarding the cause of obesity and means of preventing it. Identify one environmental influence on obesity in children. State what recommendation you have to community leaders to change the environment or to families and children to change their behavior in order to reduce the impact of this environmental factor.*

Links to Additional Activities, Demonstrations, and Exercises for this Module

1. **Pair and Share: Compare and Contrast Developmental Systems Framework and the Bioecological Model of Development (10 minutes)**
   Have each student pair with another student to compare and contrast the basic tenets of the developmental systems approach and the bioecological model for development. How are they the same? How are they different? Link this comparison back to the discussion of theory in Chapter 1. How well does each describe, explain, and predict development? Caution students that these approaches are quite difficult to test, so they are used as a framework instead of a theory.
2. **Pair and Share: Apply Bronfenbrenner's Bioecological Model to Another Developmental Issue (Aside from Childhood Obesity) (10 minutes)**

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Have each student pair with another student to choose another developmental issue that applies the distal and proximal factors in the bioecological model of development. For instance, students may choose issues such as educational policies or access to health care. Have students outline the distal and proximal factors for the chosen issue. How does the model specifically account for these factors? How might a researcher measure the impact of the distal and proximal factors?

INNOVATIVE IDEAS FOR CHAPTER 2

Writing Assignment or Presentation: Investigate a Genetic Disorder (To be completed outside class)

Students should choose one genetic disorder (covered in the text or elsewhere) to investigate. In researching the disorder, students should address the following areas:

- Risk factors for disorder
- Etiology of disorder—what causes it?
- Affected population
- Symptoms of disorder and related effects
- Prognosis of disorder
- Available treatments
- Ways to prevent the disorder

Have students write a two- to three-page paper that presents the relevant information. You may also choose to have students present this information to the class in a formal presentation.

Video Link: Update on Danielle's Horrific Story of Child Neglect (6:16)

https://youtu.be/P_IBGS1FQw4

This video follows a young girl, Dani, who experienced severe child neglect. In the video, there are many instances of the constant interplay between genetics and the environment. Ask students to view the video and connect it to the concepts in the chapter. For example, what instances do they see of gene–environment correlations? How might Dani's early experiences have shaped her epigenome? Additionally, this video highlights some of the challenges that a family faces in caring for a child with disabilities. *This may be used as a class discussion or in-class writing assignment.*

Writing Assignment: Identical Twins, Identical Fates?

This case study explores twin studies and epigenetics. Direct students to the following website: http://sciencecases.lib.buffalo.edu/cs/files/epigenetics.pdf. From here, students will read short vignettes and answer questions regarding the role of the environment in gene expression by following identical twins with different life experiences. Note: Some parts of the case study may be more complicated than what is necessary for this course (i.e., provide very technical information on DNA and methylation). You might address this by assigning only the application questions that are most pertinent to this course, or by using this as a class activity so you can clarify any questions.

Student Group Presentations: Epigenetics, Smoking and Public Health

Direct students to visit the following website: http://www2.le.ac.uk/departments/genetics/vgec/schoolscolleges/epigenetics_ethics/case-studies/epigenetics-smoking-and-public-health. From here, students will find information on the role of smoking and prenatal development. Students are tasked with assessing the resources that discuss the effects of smoking on epigenetics and its association with disease. Students should then form opinions as to whether there is sufficient evidence that smoking negatively

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affects epigenetics. From this, students will consider whether smoking should be banned nationally to prevent damage to the health of the population as well as future generations. Students are directed to imagine that their recommendations will be considered by public health entities.

Writing Assignment or Presentation: Nature versus Nurture

Direct students to the following website: http://www.amnh.org/learn/genetics/Resource1. This article by Dr. Claudia Englbrecht details the impact of genetics and the environment, and applies it to specific issues such as intelligence, aggression, and humor. Have students read the article and links to the relevant research. Then, have students summarize the main findings. *This may be used as a short paper (two to three pages) or as a group presentation*.

Class Discussion: Child Temperament, Passive Gene–Environment Correlations, and the Role of the Family

Outside class, have students visit the website below to read the following article:

Lemery-Chalfant, K., Kao, K., Swann, G., & Goldsmith, H. H. (2013). Childhood temperament: Passive gene–environment correlation, gene–environment interaction, and the hidden importance of the family environment. *Development and Psychopathology*, *25*(1), 51–63. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3581153/

The article discusses many of the concepts presented in this chapter, including heritability, genetic inheritance, passive gene–environment correlations, and the role of the environment. In discussing the article, have students consider how each of these concepts may be applied to child temperament. What evidence is there for the heritability of temperament? Ask students to consider how the role of temperament may function over time—for instance, is it always a passive influence, or might it change as children age?

INNOVATIVE IDEAS REFERENCES

Englbrecht, C. (n.d.). Nature versus nurture. [Web long file.] Retrieved from http://www.amnh.org/learn/genetics/Resource1.

Lemery-Chalfant, K., Kao, K., Swann, G., & Goldsmith, H. H. (2013). Childhood temperament: Passive gene–environment correlation, gene–environment interaction, and the hidden importance of the family environment. *Development and Psychopathology*, *25*(1), 51–63.

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University of Leister (n.d.). *Epigenetics, Smoking and Public Health.* Retrieved from: http://www2.le.ac.uk/departments/genetics/vgec/schoolscolleges/epigenetics_ethics/case-studies/epigenetics-smoking-and-public-health.

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