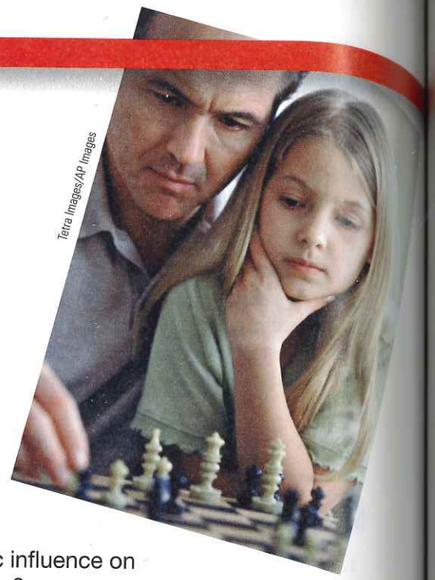
Module 63

Studying Genetic and Environmental Influences on Intelligence


Tetra Images/AP Images

Module Learning Objectives

63-1 Discuss the evidence for a genetic influence on intelligence, and explain what is meant by heritability.

63-2 Discuss the evidence for environmental influences on intelligence.

"I told my parents that if grades were so important they should have paid for a smarter egg donor."

heritability the proportion of variation among individuals that we can attribute to genes. The heritability of a trait may vary, depending on the range of populations and environments studied.

63-1 What evidence points to a genetic influence on intelligence, and what is heritability?

Intelligence runs in families. But why? Are our intellectual abilities mostly inherited? Or are they molded by our environment?

Few issues arouse such passion or have such serious political implications. Consider: If we mainly inherit our differing mental abilities, and if success reflects those abilities, then people's socioeconomic standing will correspond to their inborn differences. This could lead to those on top believing their intellectual birthright justifies their social positions.

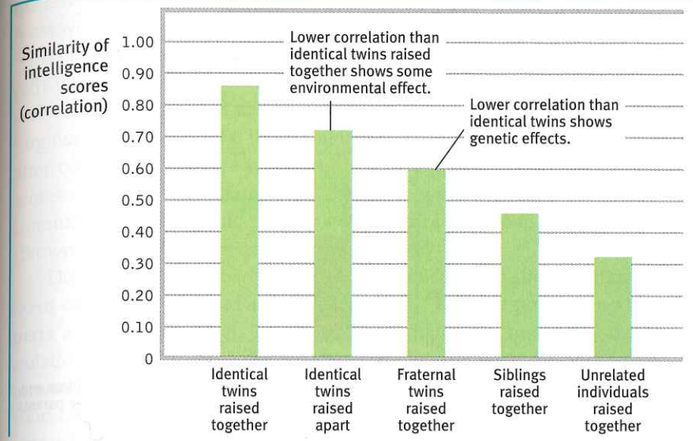
But if mental abilities are primarily nurtured by our environments, then children from disadvantaged environments can expect to lead disadvantaged lives. In this case, people's standing will result from their unequal opportunities.

For now, as best we can, let's set aside such political implications and examine the evidence.

Twin and Adoption Studies

Do people who share the same genes also share mental abilities? As you can see from **FIGURE 63.1**, which summarizes many studies, the answer is clearly *Yes*. Consider:

- The intelligence test scores of identical twins raised together are virtually as similar as those of the same person taking the same test twice (Lykken, 1999; Plomin, 2001). (The scores of fraternal twins, who share only about half their genes, are much less similar.) Estimates of the **heritability** of intelligence—the extent to which intelligence test score variation can be attributed to genetic variation—range from 50 to 80 percent (Johnson et al., 2009; Neisser et al., 1996; Plomin, 2003). Identical twins also exhibit substantial similarity (and heritability) in specific talents, such as music, math, and sports (Vinkhuyzen et al., 2009).
- Brain scans reveal that identical twins' brains are built and function similarly. They have similar gray and white matter volume (Deary et al., 2009). Their brains (unlike those of fraternal twins) are virtually the same in areas associated with verbal and spatial intelligence (Thompson et al., 2001). And their brains show similar activity while doing mental tasks (Koten et al., 2009).




© Christopher Fitzgerald/The Image Works

Figure 63.1
Intelligence: Nature and nurture The most genetically similar people have the most similar intelligence scores. Remember: 1.0 indicates a perfect correlation; zero indicates no correlation at all. (Data from McGue et al., 1993.)

- Are there known genes for genius? Today's researchers have identified chromosomal regions important to intelligence, and they have pinpointed specific genes that seemingly influence variations in intelligence and learning disorders (Dick, 2007; Plomin & Kovas, 2005; Posthuma & de Geus, 2006). But intelligence appears to be *polygenetic,* involving many genes, with each gene accounting for much less than 1 percent of intelligence variations (Butcher et al., 2008). Intelligence is like height, suggests Wendy Johnson (2010): 54 specific gene variations together have accounted for 5 percent of our individual differences in height, leaving the rest yet to be discovered. Do we really need to discover them all—or is it enough to know that few individual genes have a big effect on height, or intelligence? What matters is the combination of many genes.

AP® Exam Tip

Figure 63.1 is worth spending some time on. Try grabbing a study buddy and explaining whether each of the five conditions provides more support for nature or more for nurture. In most cases, it's some of each and you have to look at comparisons between categories to really be able to draw conclusions.

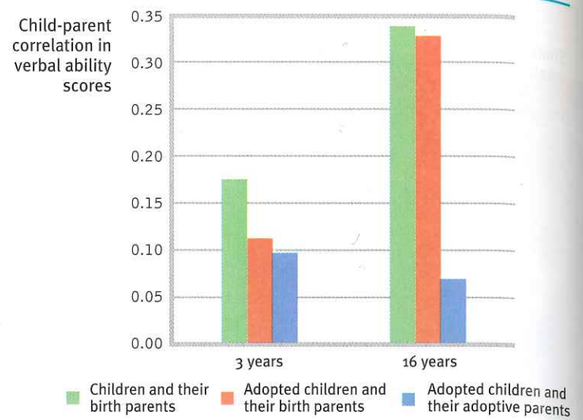
Other evidence points to the effects of environment. Twin studies show some environmental contribution to IQ score variation among top scorers (Brant et al., 2009; Kirkpatrick et al., 2009). Where environments vary widely, as they do among children of less-educated parents, environmental differences are more predictive of intelligence scores (Rowe et al., 1999; Tucker-Drob et al., 2011; Turkheimer et al., 2003). Studies also show that adoption enhances the intelligence scores of mistreated or neglected children (van IJzendoorn & Juffer, 2005, 2006).

Seeking to disentangle genes and environment, researchers have compared the intelligence test scores of adopted children with those of (a) their adoptive siblings, (b) their biological parents (the providers of their genes), and (c) their adoptive parents, the providers of their home environment. During childhood, the intelligence test scores of adoptive siblings correlate modestly. Over time, adopted children accumulate experience in their differing adoptive families. So would you expect the family-environment effect to grow with age and the genetic-legacy effect to shrink?

If you would, behavior geneticists have a stunning surprise for you. Mental similarities between adopted children and their adoptive families wane with age, until the correlation approaches zero by adulthood (McGue et al., 1993). Genetic influences—not environmental ones—become more apparent as we accumulate life experience. Identical twins' similarities, for example, continue or increase into their eighties. Thus, report Ian Deary and his colleagues (2009), the heritability of general intelligence increases from "about 30 percent" in early childhood to "well over 50 percent in adulthood." In one massive study of 11,000 twin pairs in four

"Selective breeding has given me an aptitude for the law, but I still love fetching a dead duck out of freezing water."

Figure 63.2
Who do adopted children resemble in verbal ability?
As the years went by in their adoptive families, children's verbal ability scores became modestly more like their *biological* parents' scores. (Adapted from Plomin & DeFries, 1998.)



"There are more studies addressing the genetics of *g* [general intelligence] than any other human characteristic."
-Robert Plomin (1999)

countries, the heritability of *g* increased from 41 percent in middle childhood to 55 percent in adolescence to 66 percent in young adulthood (Haworth et al., 2010). Similarly, adopted children's verbal ability scores over time become more like those of their biological parents (**FIGURE 63.2**). Who would have guessed?

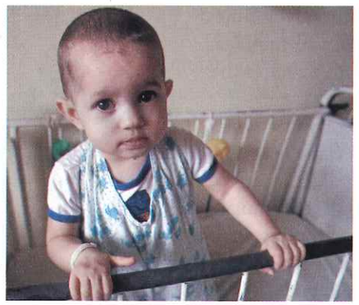
Environmental Influences

63-2 What does evidence reveal about environmental influences on intelligence?

Genes make a difference. Even if we were all raised in the same intellectually stimulating environment, we would have differing aptitudes. But life experiences also matter. Human environments are rarely as impoverished as the dark and barren cages inhabited by deprived rats that develop thinner-than-normal brain cortexes (see Module 50). Yet severe deprivation also leaves footprints on the human brain.

Early Environmental Influences

Nowhere is the intertwining of biology and experience more apparent than in impoverished human environments such as J. McVicker Hunt (1982) observed in a destitute Iranian orphanage. The typical child Hunt observed there could not sit up unassisted at age 2 or walk at age 4. The little care the infants received was not in response to their crying, cooing, or other behaviors, so the children developed little sense of personal control over their environment. They were instead becoming passive "glum lumps." Extreme deprivation was bludgeoning native intelligence—a finding confirmed by other studies of children raised in poorly run orphanages in Romania and elsewhere (Nelson, et al., 2009; van IJzendoorn et al., 2008).


Josef Polleross/The Image Works

Devastating neglect
Some Romanian orphans, such as this child in the Leaganul Pentru Copii orphanage in 1990, had minimal interaction with caregivers, and suffered delayed development.

Aware of both the dramatic effects of early experiences and the impact of early intervention, Hunt began a program of *tutored human enrichment.* He trained caregivers to play language-fostering games with 11 infants, imitating the babies' babbling, then engaging them in vocal follow-the-leader, and finally teaching them sounds from the Persian language. The results were dramatic. By 22 months of age, the infants could name more than 50 objects and body parts, and so charmed visitors that most were adopted—an unprecedented success for the orphanage.

Hunt's findings are an extreme case of a more general finding: Among those economically impoverished, environmental conditions can depress cognitive development. Schools with many poverty-level children often have less-qualified teachers, as one study of 1450 Virginia schools found. So these children may receive a less-enriched education. And even after controlling for poverty, having less-qualified teachers predicted lower achievement scores (Tuerk, 2005). Malnutrition also plays a role. Relieve infant malnutrition with nutritional supplements, and poverty's effect on physical and cognitive development lessens (Brown & Pollitt, 1996).

Do studies of such early interventions indicate that providing an "enriched" environment can "give your child a superior intellect," as some popular products claim? Most experts are doubtful (Bruer, 1999). Although malnutrition, sensory deprivation, and social isolation can retard normal brain development, there is no environmental recipe for fast-forwarding a normal infant into a genius. All babies should have normal exposure to sights, sounds, and speech. Beyond that, Sandra Scarr's (1984) verdict still is widely shared: "Parents who are very concerned about providing special educational lessons for their babies are wasting their time."

Still, explorations of intelligence promotion continue. Some parents, after exposing their 12- to 18-month-old babies to educational DVDs such as from the *Baby Einstein* series, have observed their baby's vocabulary growing. To see whether such cognitive growth is a result of the DVD exposure, or simply of infants' natural language explosion, two research teams assigned babies to DVD exposure or a control group (DeLoache et al., 2010; Reichert et al., 2010). Their common finding: The two groups' word-learning did not differ.

Schooling and Intelligence

Later in childhood, schooling is one intervention that pays intelligence score dividends. Schooling and intelligence interact, and both enhance later income (Ceci & Williams, 1997, 2009). Hunt was a strong believer in the ability of education to boost children's chances for success by developing their cognitive and social skills. Indeed, his 1961 book, *Intelligence and Experience,* helped launch Project Head Start in 1965, a U.S. government-funded preschool program that serves more than 900,000 children, most of whom come from families below the poverty level (Head Start, 2010). Does it succeed? Generally, the aptitude benefits dissipate over time (reminding us that life experience *after* Head Start matters, too). Psychologist Edward Zigler, the program's first director, nevertheless believed there are long-term benefits (Ripple & Zigler, 2003; Zigler & Styfco, 2001).

Genes and experience together weave the intelligence fabric. (Recall from Module 14 that *epigenetics* is one field that studies this nature–nurture meeting place.) But what we accomplish with our intelligence depends also on our own beliefs and motivation. One analysis of 72,431 collegians found that study motivation and study skills rivaled previous grades and aptitude as predictors of academic achievement (Credé & Kuncel, 2008). Motivation even affects intelligence test performance. Four dozen studies show that, when promised money for doing well, adolescents score higher (Duckworth et al., 2011).

Psychologist Carol Dweck (2006, 2007, 2008) reports that believing intelligence is biologically set and unchanging can lead to a "fixed mindset." Believing intelligence is changeable, a "growth mindset" results in a focus on learning and growing. As collegians, these believers also tend to happily flourish (Howell, 2009). Dweck has developed interventions that effectively teach young teens that the brain is like a muscle that grows stronger with use as neuron connections grow. Indeed, as we noted earlier, superior achievements in fields from sports to science to music arise from disciplined effort and sustained practice (Ericsson et al., 2007).

Before You Move On

▶ ASK YOURSELF

How have genetic and environmental influences shaped your intelligence?

▶ TEST YOURSELF

As society succeeds in creating equality of opportunity, it will also increase the heritability of ability. The heritability of intelligence scores will be greater in a society marked by equal opportunity than in a society of peasants and aristocrats. Why?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Module 63 Review

63-1 What evidence points to a genetic influence on intelligence, and what is heritability?

- Studies of twins, family members, and adoptees indicate a significant hereditary contribution to intelligence scores.
- Intelligence seems to be polygenetic, and researchers are searching for genes that exert an influence.
- *Heritability* is the proportion of variation among individuals that can be attributed to genes.

63-2 What does evidence reveal about environmental influences on intelligence?

- Studies of twins, family members, and adoptees also provide evidence of environmental influences.
- Test scores of identical twins raised apart are slightly less similar (though still very highly correlated) than the scores of identical twins raised together.
- Studies of children raised in extremely impoverished environments with minimal social interaction indicate that life experiences can significantly influence intelligence test performance.
- No evidence supports the idea that normal, healthy children can be molded into geniuses by growing up in an exceptionally enriched environment.

Multiple-Choice Questions

1. Heritability relates to the
   a. percentage of a person's intelligence that is due to environmental influences.
   b. percentage of a person's intelligence that is due to genetics.
   c. correlation of intelligence test scores among family members.
   d. extent to which variability among individuals' intelligence scores can be attributed to genetic variation.
   e. genetic stability of intelligence over time.

2. The correlation between the IQ scores of fraternal twins raised together is lower than IQ scores of identical twins raised together. What conclusion can be drawn from this data?
   a. Nothing, because the type of twin has not been held constant.
   b. Nothing, because there is no comparison between twins and adopted children.
   c. Nothing, because cultural differences have not been considered.
   d. There is a genetic effect on intelligence.
   e. There is an environmental effect on intelligence.

3. Which of the following is true of the mental similarities between adoptive children and their adoptive parents as they age?
   a. Adoptive children become much more similar to their adoptive families over time.
   b. Adoptive children become slightly more similar to their adoptive families over time.
   c. There is hardly any similarity, either when the adoptive children are young or when they are older.
   d. Adoptive children become slightly less similar to their adoptive families over time.
   e. Adoptive children become much less similar to their adoptive families over time.

4. According to Carol Dweck, students are often hampered by a "fixed mindset." This means they believe:
   a. intelligence is biologically set and unchangeable.
   b. it is never good to change your mind once it is made up.
   c. intelligence can be "repaired" by doing specific mental exercises.
   d. they have already done everything they can to improve.
   e. problems can only be solved a particular way.

Practice FRQs

1. Explain two environmental interventions that might help poverty-level schoolchildren develop better cognitive skills.

Answer

1 point: The presence of more highly qualified teachers is positively correlated with higher student achievement.

1 point: Nutritional supplements can help alleviate the effects of the poor nutrition that often accompanies economic poverty.

2. Explain whether each of the following comparisons indicates a greater influence of genetics on intelligence or a greater influence of environment on intelligence.
- The correlation of intelligence test scores for identical twins raised *together* is about +.85. For identical twins raised *apart,* the correlation is about +.72.
- The correlation of intelligence scores for identical twins raised together is about +.85. For fraternal twins raised together, it is about +.60.

(2 points)