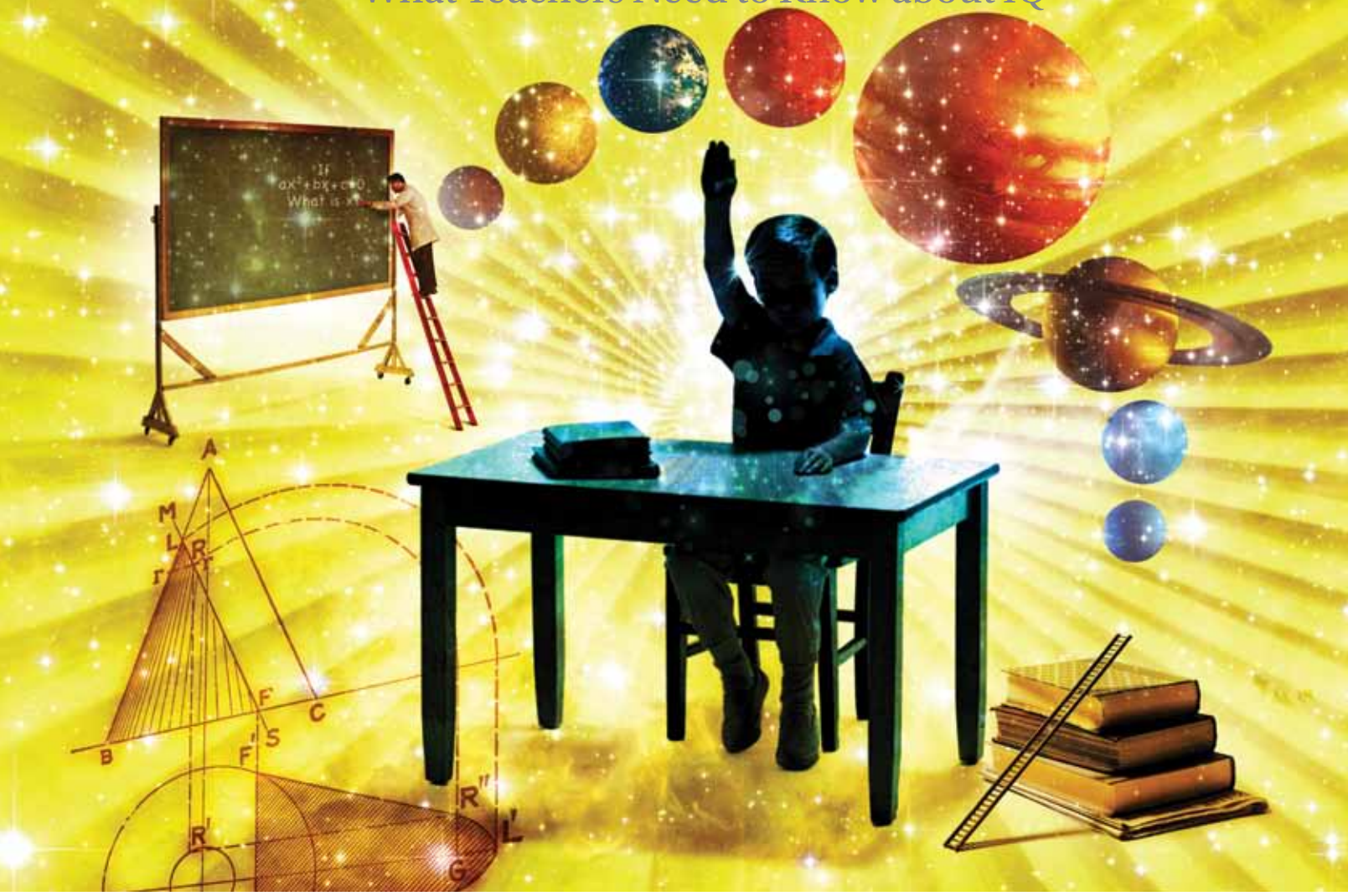
Schooling Makes You Smarter

What Teachers Need to Know about IQ



By Richard E. Nisbett

In 1994, America took a giant step backward in understanding intelligence and how it can be cultivated. Richard Herrnstein, a psychology professor at Harvard University, and Charles Murray, a political scientist with the American Enterprise Institute, published *The Bell Curve*, a best-selling book[1] that was controversial among researchers, but was given enormous, uncritical attention in the popular press. It would be difficult to overestimate the impact of *The Bell Curve*. Even people who never read the book picked up its conclusions from press accounts and from discussions with people who read it. The impact on policymakers was substantial, and many practicing educators today accept the views about intelligence presented in the book and fostered by the media.

The conclusions that many people drew from the book were that IQ tests are an accurate and largely sufficient measure of intelligence, that IQ is primarily genetically controlled, that IQ is little influenced by environmental factors, that racial differences in IQ are likely due at least in part, and perhaps in large part, to genetics, and that educational and other interventions have little impact on IQ and little effect on racial differences in IQ. *The Bell Curve* encouraged skepticism about the ability of public policy initiatives to have much impact on IQ or IQ-related outcomes.

But in fact, *all of the conclusions I have just summarized are*

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ILLUSTRATIONS BY WILLIAM DUKE

mistaken. Even at the time the book was published, many cognitive scientists believed that some of these conclusions were erroneous.[2] Now we know that all of them are. In this article, I will describe the new knowledge that is most relevant to educators. The basic conclusions are that environmental factors are much more important in determining intelligence than previously believed, that racial group differences owe little or nothing to genes, and that interventions, including school, influence intelligence at every level from prenatal care to college and beyond.

To begin, let's take a look at what intelligence and IQ are. My working definition of intelligence is the one offered by Linda Gottfredson, a professor at the University of Delaware:[3]

> [Intelligence] involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience. It is not merely book learning, a narrow academic skill, or test-taking smarts. Rather, it reflects a broader and deeper capability for comprehending our surroundings—"catching on," "making sense" of things, or "figuring out" what to do.

The measurement of intelligence is one of psychology's greatest achievements, and one of its most controversial. Critics complain that no single test can capture the complexity of human intelligence, all measurement is imperfect, and no single measure is completely free from cultural bias; they also point out that there is the potential for misuse of scores on tests of intelligence. There is some merit to all these criticisms. But the measurement of intelligence is extremely useful because it is a reasonably good predictor of grades at school, performance at work, and many other aspects of success in life.

The chief measure that I focus on in this article is IQ because the bulk of evidence pertinent to intelligence comes from IQ tests. IQ stands for "intelligence quotient" because originally the index was "mental age" divided by chronological age. IQ tests provide a way of evaluating an individual's cognitive capacities relative to others of the same age. Today's widely used IQ tests, such as the Stanford-Binet and Wechsler, are considered valid because they are strongly related to real-life outcomes. For example, IQ, SAT, and ACT scores are all highly correlated,[4] and students who score higher on tests such as the SAT and ACT tend to perform better in school than those who score lower.[5] Similarly, people in professional careers, such as attorneys, accountants, and physicians, tend to have high IQs. Even within professions, those with higher IQs outperform those with lower IQs on average, with the effects of IQ being largest for those occupations that are most demanding of cognitive skills. It's important to remain vigilant for misuse of scores on tests of intelligence or any other psychological assessment, and to look for possible biases in any measure, but intelligence test scores remain useful when applied in a thoughtful and transparent manner.

One of the most important uses is in developing interventions; measuring intelligence is essential to figuring out how to increase it. Some group differences in IQ are large, and much evidence indicates that it would be difficult to overcome a broad array of racial disparities if IQ differences could not be ameliorated. IQ tests help us to track the changes in intelligence of different groups (and of entire nations) and to determine if interventions intended to improve intelligence are working.

Although this article focuses on findings from the hundreds of high-quality studies done with IQ tests, types of intelligence other than the analytic kind examined by IQ tests certainly have a reality—and researchers are working to learn more about them. For example, Robert Sternberg, the provost of Oklahoma State University, and his colleagues have studied *practical intelligence*, which they define as the ability to solve concrete problems in real life that require searching for information not necessarily contained in a problem statement, and for which many solutions are possible. They have also studied *creativity*, or the ability to come up with novel solutions to problems and to originate interesting questions.[6] Sternberg and his colleagues maintain that both practical intelligence and creativity can be measured, that they correlate only moderately with analytic intelligence as measured by IQ tests, and that they can predict significant amounts of variation in academic and occupational achievement over and above what can be predicted by IQ measures alone. Measures of curiosity also predict school grades above and beyond the degree of predictability that can be attained by IQ tests.[7]

Interventions, including school, influence intelligence at every level from prenatal care to college and beyond.

Some widely known examples of different types of intelligence come from Howard Gardner's theory of multiple intelligences. I don't doubt that the kinds of intelligence he has proposed—bodily-kinesthetic, musical, spatial, etc.—are genuine and can be important in specific domains of life.[8] The same is true for emotional intelligence and social intelligence. But none of these more specific intelligences have been shown to predict school success or career attainment above and beyond their association with general intelligence. Such predictive value might be found in the future, but for now the bulk of evidence pertinent to intelligence comes from IQ tests.

Let's take a closer look at what those tests measure.

IQ Tests Measure Two Types of Intelligence

IQ tests measure two types of intelligence: crystallized and fluid. *Crystallized intelligence* refers to the individual's store of knowledge about the nature of the world. This includes vocabulary, information, and comprehension of the way the world works as shown by answers to questions such as "why are houses on a street numbered consecutively?" It also includes learned skills such as arithmetic.

Fluid intelligence consists of the ability to solve novel problems that depend relatively little on stored knowledge, as well as the capacity to learn (i.e., the capacity to store knowledge in long-term memory). Fluid intelligence depends on the capacity of one's working memory (the mental "space" in which thinking occurs), as well as the extent of one's attention control (ability to focus on the most important aspects of a problem) and inhibitory control (ability to suppress tempting but irrelevant actions).

A test that is widely considered the best available measure of fluid intelligence is Raven's Progressive Matrices. This test requires examination of a matrix of geometric figures that differ from one another according to a rule to be identified by the individual being tested. This rule is then used to generate an answer to a question about what new geometrical figure would satisfy the rule. The figure below shows a sample item like the Raven's test.

The example that the problem solver must follow is set up by the two figures on the top in the left panel. The figure at the left on the bottom then specifies what has to be transformed in order to solve the problem. The problem solver must choose an answer from the six figures on the right.

Solving the problem requires that you notice that the top and bottom figures on the left of the panel are diamonds, and the figure on the upper right is a square. This tells you that the answer has to be a square. Then you must notice that the lower half of the diamond on the upper left is divided in two, with the left portion in black. The fact that the corresponding portion of the square on the right is also black tells you that the same must be true in the answer square. That's the entire bottom half. Comparing the bars in the upper diamond and square, you notice that one of the bars has been removed from the square while preserving the symmetry of the bars. Since the diamond on the lower left has two bars, this establishes that the answer square must have one centered bar. Now you know that the correct answer must be the square at the bottom right of the answer panel.

In nations that were fully modern by the beginning of the 20th century, IQ has increased by about 3 points per decade from the end of World War II to the present.

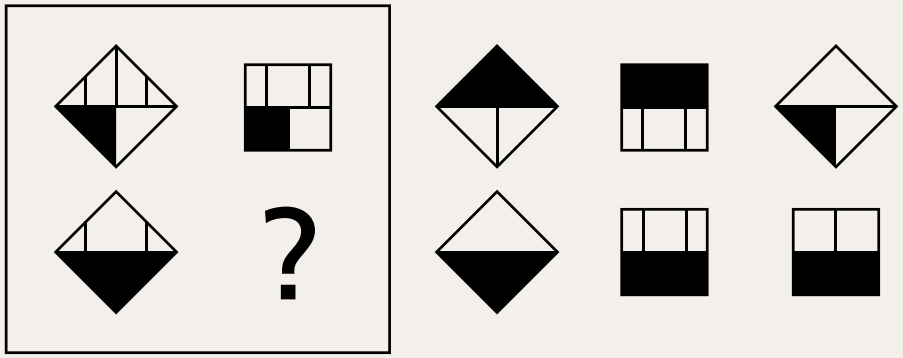
Crystallized intelligence and fluid intelligence are very different aspects of intelligence. Much evidence points to this conclusion; here is a brief summary of the key findings: 1) Fluid intelligence is mediated by the prefrontal cortex (PFC)—the part of the brain just behind the forehead. Crystallized intelligence is mediated by a wide variety of different structures in the brain. 2) Fluid intelligence declines from early adulthood on. Crystallized intelligence actually keeps growing until old age. 3) The PFC deteriorates with age more rapidly than the rest of the cortex does, which makes sense given that fluid intelligence diminishes more over time than does crystallized intelligence. 4) Changes in fluid intelligence and crystallized intelligence across the teenage years can be substantial, and those changes are independent of one another and are associated with changes in gray matter in different parts of the brain.[9] 5) Severe damage to the PFC is associated with marked impairment of fluid intelligence but little or no impairment of crystallized intelligence. 6) Severe impairment of crystallized intelligence, such as occurs in autism, is sometimes associated with near-normal or even superior fluid intelligence. 7) Crystallized intelligence can be increased by techniques that have no effect on fluid intelligence and vice versa.

For educators, the most important point in this description of fluid and crystallized intelligence is that both can be increased. In fact, they have increased substantially over the past several decades.

The Flynn Effect: Massive Gains in Population IQ Over Time

Americans' average years of schooling have increased from a median of 8 in 1910 to a median of 14 in 2010. If school makes you smarter, then we ought to have gotten noticeably smarter in the last century. And, indeed, we have gotten smarter—a lot smarter. The citizens of all developed countries have gotten smarter, in fact. James Flynn, an emeritus professor at the University of Otago in New Zealand, reports that, in nations that were fully modern and industrialized by the beginning of the 20th century, IQ has increased by about 3 points per decade from the end of World War II to the present.[10] That amounts to a gain of 18 points, which is equivalent to moving from a 50th percentile score (IQ equal to 100) to a score at the 93rd percentile (IQ equal to 118). (The actual mean IQ has been static at 100 because the tests are revised every few years, making them more difficult, so that the convenient mean of 100 can be maintained.) In nations that began to modernize during the early to mid-20th century,

A problem similar to those on the Raven's Progressive Matrices test



SOURCE: JAMES R. FLYNN, *WHAT IS INTELLIGENCE? BEYOND THE FLYNN EFFECT* (NEW YORK: CAMBRIDGE UNIVERSITY PRESS, 2007). REPRINTED WITH PERMISSION.

the increase in IQ began somewhat later, but now they are also on track to gain 3 or more points per decade. Nations that have only recently begun to modernize, such as Kenya, Sudan, and the Caribbean nations, have begun to show extremely high rates of gain.

The causes of these IQ gains are debated. Almost surely, increased schooling has contributed to the difference, and almost equally surely, improvements to the curriculum have contributed. For example, some skills that could be expected to improve performance on the Raven's test of fluid intelligence, such as analyzing and making comparisons among shapes, are now taught in kindergarten. At the same time, society has become more complex in every way, making ever greater demands on intelligence. The culture has changed to meet those demands. Computer games,

A child with a bigger vocabulary is a child with more concepts to work with—and therefore really is smarter.

some of which have been shown to improve working memory and other executive functions that underlie fluid intelligence, provide one example.

IQ has increased, but has *intelligence* really increased? Some IQ experts, and many laypeople, would say no. But a look at IQ subtests is enough to convince me that we really have gotten smarter in some respects. A child who can tell you why houses are numbered consecutively, or why doctors go back and get more education, is smarter than a child who can't tell you these things. A child with a bigger vocabulary is a child with more concepts to work with—and therefore really is smarter. A child who can tell you how revenge and forgiveness are alike is smarter than a child who draws a blank on that question. And today's children have improved greatly in all these respects, as compared with children a few decades ago.

The fact that IQ has increased so much is enough by itself to establish that intelligence is highly modifiable.

Genes and the Environment

Several strands of evidence suggest that the effects of genes on intelligence, though undeniable, are not nearly as determinative as hereditarians (like the authors of *The Bell Curve*) misbelieved, or environmentalists feared, 25 years ago. Let's start with an example. Height within a given population is 90 percent heritable. That is to say, 90 percent of the height variation in the population is due to genetic differences. Between 1979 and 2009, the average height of male South Korean high school seniors increased so much that a boy with average (i.e., 50th percentile) height in 1979 would have been far below average (at about the 10th percentile) in 2009.[11] Korean male height in 1979 was 90 percent heritable and Korean male height in 2009 was 90 percent heritable, but environmental factors such as nutrition and health practices nevertheless had a massive effect on height. This is similar to the Flynn effect discussed earlier. The crucial point both of these examples make is that a characteristic can be mostly heritable, yet still be hugely influenced by the environment. Heritability places no limits on modifiability.

When talking about IQ, people frequently assume that heritability reflects the proportion of a person's intelligence that is genetically determined. This belief is quite mistaken. In fact, it's nonsensical. There could never be a way of determining what fraction of an individual's intelligence is inherited and what fraction is environmentally produced. Heritability of a characteristic refers to *the proportion of variation in the characteristic in a given population that is accounted for by genes*.

The heritability of a trait depends on the relative contributions of genetic makeup and environment. The concept of heritability has been influenced by animal breeding experiments, where variations in genetic makeup and environment are under the control of the experimenter, and under these conditions, the concept has some real-world applications. In free-ranging humans, however, variability is uncontrolled, there is no "true" degree of variation to estimate, and heritability can take practically any value for any trait depending on the relative variability of genetic endowment and environment in the population being studied. In any naturally occurring population, the heritability of intelligence is not zero (if genetic makeup varies at all, it will be reflected in IQ scores), and it is not 100 percent (if environment varies at all, it will be reflected in IQ scores). This said, most studies estimate that the heritability of IQ is somewhere between 40 and 80 percent.

Research on socioeconomic status (SES) and IQ highlights just how much heritability of IQ can vary—and just how important the environment is. Most of the variation in intelligence for children from higher-SES families is explained by genes. Most of the variation in intelligence for lower-SES families is due to environmental differences. In some studies, the heritability of IQ for upper-middle-class children was as high as 70 percent, and the heritability for lower-class children was as low as 20 percent.[12]

Why should genes be more important to variation in IQ of

higher-SES children than of children who are worse off? The environments of higher-SES families are usually very favorable for increasing the intelligence of children and, more importantly for heritability, those environments probably don't differ much from one another. The environment of Doctor Smith's family doesn't differ much from the environment of Lawyer Jones's family in the factors that support intellectual growth. When environments don't differ much, the differences between children's IQs have to be largely due to genetic factors.* The environments of lower-SES families, in contrast, range from as favorable as you would find in any upper-middle-class family to chaotic and disruptive in every respect. When environments are drastically different, the importance of genes fades. To see this, think of a child with great genetic potential for having a high IQ. If the environment is extremely poor, the child will never attain that potential. Another child, with lower genetic potential but growing up in a superb environment, will have a higher IQ. An important implication of the fact that heritability of IQ is very low for lower-SES individuals is that many children in poverty do not get to develop their full genetic potential. That means there is plenty of room for interventions to have large effects on IQ.

New Knowledge about the Effects of the Environment

Much more is known about the effects of environmental factors on intelligence now than was the case when *The Bell Curve* was published, especially regarding the interplay of biological and social factors, thus blurring the line between biological and environmental effects on intelligence.

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Biological Factors

A wide range of environmental factors of a biological nature influence intelligence. Most of the known factors are detrimental, having to do with poor nutrition and toxins of various kinds ranging from lead poisoning to alcohol consumed during pregnancy. Most of these detrimental factors are more prevalent among black children than white children, and among children from lower-SES families than children from higher-SES families.†

One biological factor may actually increase intelligence: being breastfed throughout infancy. Breastfeeding may increase IQ by as much as 6 points for infants born with normal weight[16] and by as much as 8 points for those born prematurely,[17] and the advantage seems to persist into adulthood.[18]

Human breast milk contains fatty acids that are not found in formula and that have been shown to prevent neurological deficits in mice.[19] An important study has shown that the 6-point gain with breastfeeding occurs only in people who have a specific form of a gene that regulates fatty acids and is influenced by breast milk—but a large portion of the population has it.[20]

Social Factors

We can be confident that the environmental differences that are associated with social class have a large effect on IQ. The most convincing evidence for this comes from studies of adopted children. Adoption typically moves children from lower- to higher-SES homes; and there are marked differences, beginning in infancy, between the environments of higher-SES families and those of lower-SES families in factors that plausibly influence intellectual growth. The impact on IQ is dramatic: adopted children typically score 12 or more points higher than comparison children (e.g., siblings left with birth parents or children adopted by lower-SES parents).[21] That's roughly equivalent to moving from the 50th percentile in IQ to the 79th percentile.

One of the more important findings about social factors that influence cognitive skills concerns talking to children. An intensive study in which researchers observed 42 families for 2.5 years has shown that, on average, children of professional parents heard 30 million words by the age of 3, whereas children of working-class parents heard 20 million words, and children of unemployed African American mothers heard 10 million words. Increasing the disparities, the vocabulary that the higher-SES children heard was much richer than that heard by the lower-SES children.[22] The study also found a large difference in the number of encouraging comments made to children, compared with reprimands. The children of professional parents received six encouragements for every reprimand; the children of working-class parents received two encouragements per reprimand, and the children of unemployed African American mothers received two reprimands per encouragement.‡ An earlier intensive study of two working-class neighborhoods found similar results. White working-class parents held conversations with their young children. The child says something, the parent responds, and the child responds in turn. But black working-class parents were more likely to talk about their young children than engage in conversation with them.[23]

These findings are amplified by studies using the Home Observation for Measurement of the Environment (HOME). HOME researchers assess family environments for the amount of intel-

*The high heritability of cognitive ability, at least for some parts of the population, has led many to believe that finding specific genes that are responsible for normal variation would be easy and fruitful. So far, progress in finding the genetic locus for complex human traits has been extremely limited. Whereas 282 individual genes responsible for specific forms of mental retardation have been identified,[13] very little progress has been made finding the genes that contribute to normal variation.[14] A recent large study found only six genetic markers associated with cognitive ability, and the six markers considered together barely explained 1 percent of the variation in general cognitive ability.[15]

†To learn more, see "Equalizing Opportunity," by Richard Rothstein, in the Summer 2009 issue of *American Educator*, available at www.aft.org/pdfs/americaneducator/summer2009/equalizingopportunity.pdf.

‡To read more about this study, see "The Early Catastrophe," by Betty Hart and Todd R. Risley, in the Spring 2003 issue of *American Educator*, available at www.aft.org/pdfs/americaneducator/spring2003/TheEarlyCatastrophe.pdf.

lectual stimulation, as indicated by how much the parent talks to the child; how much access there is to books, magazines, newspapers, and computers; how much the parent reads to the child; how many learning experiences outside the home (trips to museums, visits to friends) there are; the degree of warmth versus punitiveness of parents' behavior toward the child; and so on.[24] These studies find marked differences between the social classes, and they find that the association between HOME scores and IQ scores is very substantial. A HOME score at the 84th percentile compared with the 50th percentile translates into a 9-point difference in IQ (which is roughly equivalent to IQ moving from the 50th percentile to the 73rd percentile). A 9-point difference in IQ characterizes, for example, the average difference between people with some college and people whose education stopped at high school or earlier.

It should be acknowledged that at present there is no way of knowing how much of the IQ advantage for children with excellent environments is due to the environments per se, and how much is due to the genes that parents creating those environments pass along to their children. It is almost surely the case, however, that a substantial fraction of the IQ advantage is due to the environments independent of the genes associated with them. This is because, as I noted earlier, we know that adoption into a higher-SES home adds around 12 points to the IQ of children born to lower-SES mothers.

Home environments are not the only possible factors to explain how environment affects IQ. Home environments are correlated with neighborhood, peer, and school environments. These likely are also important factors that are reflected in the adoption outcomes.

Group Differences in IQ

Two types of group differences in IQ have been exhaustively explored. These are the differences between males and females, and the differences between blacks and whites. Differences between Asians and Westerners have been less well explored, but a brief summary is provided. Little is known about Hispanic American[§] and American Indian IQs, other than that they are lower than those of white Americans and slightly higher than those of blacks, so those group differences are not explored here.

Sex Differences in Intelligence

The subtests of IQ tests are weighted so that males and females come out to the same average of 100 on the overall test score. But in fact, on the great majority of subtests, there really is little or no difference between males and females.[25]

Subtests that show a nontrivial difference between males and females include an advantage for females for verbal abilities such as fluency and memory for words. In almost all countries, females have been found to read more fluently and with greater understanding.[26] There are also large advantages favoring girls in writing ability. This difference is so marked that, on average, eighth-grade girls write at a level characteristic of eleventh-grade boys,[27] a difference that is reduced but not obliterated later in development.

There are very large sex differences favoring males in mental rotation, which is the ability to imagine what an object would look like if it were rotated.** Differences in this ability can be found as young as 3 months of age.[28] Such an early difference strongly indicates that sex difference in this ability has a biological basis. But there is also good evidence for the role of social learning. After being trained with computer games that required use of spatial visualization, there were relatively small differences in female and male college students' performance.[29]

Boys and girls don't differ much on tests of math achievement that measure what is typically taught in school.[30] On average, males have scored about 33 points higher than girls on the SATs over the last 25 years,[31] but that value can be misleading because many more females than males take the SATs.[32] (The higher the fraction of a group that takes a college-entrance test, the lower the expected average for the group because more people who are not highly talented are presumably taking the test.) With samples of highly gifted adolescents, three times as many boys as girls score 700 or more on the mathematics portion of the SATs.[33] This difference can't be explained by boys taking more math courses than girls, so there may be some biological basis to the finding that most students who score at the top in mathematics are male.

There are a number of potential causes of sex differences in various abilities. Overall, female and male brains are similar in organization and structure, but closer inspection shows that most areas have some sex-based differences.[34] On average, the male brain is between 8 and 14 percent larger than the female brain, a difference that is comparable to the sex difference in the mass of other organs, like the heart[35] and kidneys.[36] But overall brain size probably does not account for differences in aspects of intelligence, because all areas of the brain are not equally important for cognitive functioning. In general, females have more gray matter and males have more white matter.[37] Moreover, different patterns of gray and white matter correlate with intelligence for males and females.[38] Some researchers have concluded that the very different brain designs of men and women somehow produce very similar intellectual performance.[39]

[§]Estimates of the Hispanic-white gap run from two-thirds the size of the black-white gap for IQ tests to only slightly less than the black-white gap for academic achievement as measured by the National Assessment of Educational Progress.

**To learn more about mental rotation and spatial abilities, read "Seeing Relationships," by Nora S. Newcombe, which begins on page 26 of this issue.

Steroidal hormones also play a role in intellectual ability. Prenatal hormones are critical to normal brain development, and both prenatal and postnatal hormones influence behavior, including cognition, in characteristically male versus female directions. It should be stressed that we are far from understanding the intricate interplay of hormones, brain structures, and intelligence.

Some public school districts have begun to segregate girls and boys based on the belief that they are so different intellectually that they need to be educated separately, a belief that stems from faulty extrapolations from research on sex differences in intelligence.[40] An extensive review conducted by the US Department of Education[41] found that the majority of studies comparing single-sex with coeducational schooling report either no difference or mixed results, and other reviews report a host of negative consequences associated with single-sex education, including increased sex-role stereotyping, which may harm both boys and girls.[42] The data from the research literature on intelligence and cognitive skills do not indicate that different learning environments for females and males are a good idea.

As with all group differences, average results say nothing about individual potential. The class poet may be a boy, and the calculus whiz may be a girl.

Black-White Differences in IQ

The Bell Curve encouraged the assumption that a significant portion of the 15-point IQ difference between blacks and whites that existed in the early 1990s might be due to genetics. The authors' treatment of the evidence on this question was biased in the extreme, devoting a great deal of space to the single study that gave significant support to the genetic interpretation, and devoting little space to the considerable amount of direct evidence indicating that the IQ difference is not due to genetics. This evidence stems from the fact that the "black" gene pool in the United States contains a large amount of European genes.[43] Almost all the research indicates no higher IQs for blacks with a significant degree of European heritage than for those with a lesser degree. One of the most telling studies is an adoption study examining the IQs of black and mixed-race children who were adopted early in infancy by middle-class black or white families.[44] When they were studied at age 8, the children who were of half-European origin had virtually the same average IQ as the children who were of exclusively black origin. Hence, European genes were of no advantage. But environment made a big difference. Children (both black and mixed-race) adopted by white families had IQs 13 points higher on average than those adopted by black families, indicating that there were marked differences in the environments of black and white families relevant to socialization for IQ—differences large enough to account for virtually the entire black-white gap in IQ at the time of the study. Tellingly, although Herrnstein and Murray were aware of the existence of this study (which we know because it appears in *The Bell Curve*'s references), they did not discuss the study at all.

The "evidence" by supporters of the genetic view that has received the most attention is the claim that, because brain size is related to IQ for both whites and blacks, and since blacks have smaller brains than whites, lower IQ for blacks is substantially genetic and mediated by brain size. But a within-group correlation does not establish that between-group differences have the same origin. Brain size differences between men and women are much greater than the race differences, yet men and women have the same average IQ. Brain size of full-term black and white infants is the same at birth,[45] and several postnatal factors known to reduce brain size are more common for blacks than for whites.[46] Such factors include chronic stress, which results in both smaller brain size[47] and suppressed generation of new nerve cells in various parts of the brain.[48] Finally, sheer brain size is a rather blunt measure of brain differences, which may be less predictive of IQ than measures of the size of particular regions or measures such as the ratio of gray matter to white matter.

The black middle class has grown substantially in recent decades. Since socialization for cognitive skills differs by socioeconomic status, we could reasonably expect that IQ differences between blacks and whites have gotten smaller. And indeed they

have. The best estimates we have indicate that blacks narrowed their IQ gap with whites by 5.5 points between 1972 and 2002.[49] Changes in academic performance, as measured by the National Assessment of Educational Progress, show comparable gains from the early 1970s to 2008 (averaging over reading and mathematics and over 9-, 13-, and 17-year-olds).[50] Analyzing a wide variety of tests of academic achievement, one researcher found that 50 years ago, the black-white gap was more than 1.5 times (in standard deviation terms) the SES gap.[51] Today, the SES gap is nearly twice as large as the black-white gap.

Stereotype Threat

Our understanding of group differences in intellectual ability is furthered by the very large literature on psychological reactions to negative stereotypes. In an influential 1995 article, Claude Steele, now with Stanford University, and Joshua Aronson, now with New York University, argued that when aware of widespread stereotypes that impugn a group's intelligence (e.g., "Black people are stupid," "Girls can't do math," etc.), test takers frequently experience the threat of devaluation—by themselves, by others, or by both.[52] The resulting arousal and anxiety can impair executive functioning on complex tasks such as standardized aptitude tests. Steele and Aronson called this response "stereotype threat," and demonstrated in a series of experiments that black test takers scored considerably better—sometimes far better—on intellectual tests when the test was presented in a manner that downplayed

ability evaluation or downplayed the relevance of race. Since 1995, some 200 replications of the effect have been published, extending the findings to women and mathematics abilities, Latinos and verbal abilities, elderly individuals and short-term memory abilities, low-income students and verbal abilities, and a number of nonacademic domains as well.[53]

A recent review of stereotype-threat research indicated that women's math performance and black students' verbal performance are suppressed, on average, by an amount equal to the difference between the 50th percentile and the 60th percentile.

The stereotype-threat concept has led to a variety of simple educational interventions conducted in schools and colleges that have substantially raised the overall academic achievement of black students[54] and the mathematics achievement of girls.[55] Some of the interventions seem remarkably minor on the surface yet produce substantial gains in academic achievement. For example, simple efforts at persuading minority students that their intelligence is, to a substantial extent, under their control have nontrivial effects on academic performance.[56] A series of classroom exercises over several hours helping junior high students assess what they need to do to achieve their life goals resulted in significant improvement in GPA and reduction in the likelihood of subsequent dropout.[57]

Simple efforts at persuading minority students that their intelligence is, to a substantial extent, under their control have nontrivial effects on academic performance.

Asian-White Differences in IQ

The academic achievements and high occupational profiles of many Chinese and Japanese Americans have inspired speculation about genetic superiority of Asians.[58] James Flynn (the researcher behind the Flynn effect discussed earlier) analyzed schooling and career data for the high school graduating class of 1966. That large sample, which is nationally representative, included a substantial number of Asian Americans.[59] The Asian Americans had about the same average IQ as white Americans (actually, slightly lower) but scored 33 points higher on the SAT than white Americans. SAT scores may reflect motivational differences, such as taking more and higher-level math courses, to a greater degree than do IQ tests. The Asian Americans also exceeded the white Americans in career achievement in later life. Remarkably, Chinese Americans in the class of 1966 ultimately attained occupations of a professional, managerial, or technical nature at a rate 62 percent higher than white Americans. The picture that results is that Asian Americans capitalize on a given level of intellectual ability much better than do European Americans.

Another important study also indicates that Asian achievement has less to do with IQ than with cultural factors. This longitudinal study[60] found that children in Taiwan and Japan had IQ scores slightly lower than those of American children at the beginning of first grade. By the end of the fifth grade, the IQ difference had disappeared, but the math skills of the Asian children were light years ahead of the American children. On a scale where the Americans scored at the 50th percentile, the Taiwanese scored at the 84th percentile and the Japanese scored at the 91st percentile.

There is reason to believe that math teaching in Taiwan, Japan, and some other parts of Asia is superior to math teaching in the United States, but some of the achievement differences are almost surely due to cultural factors. East Asians are members of cultures having a Confucian background. A characteristic belief in those cultures is that intelligence is primarily a matter of hard work.[61] Confucian families exert far more influence on their children than do most families of European culture.[62] They can demand of their children excellence in education and preparation for high-status careers and expect their children to try to comply.

The case for the modifiability of intelligence could scarcely be clearer. People's intelligence is greatly affected by prenatal and immediate postnatal factors; by home environments; by education, including early childhood education; and by changes in the larger culture. How smart we and our children are as individuals, and how smart we are as a society, is under our control to a marked degree.

Interventions

A huge range of interventions have substantial effects on IQ and academic achievement. Of greatest importance to educators, there is clear evidence that school affects intelligence, that better schools produce better effects, and that the caliber of the individual teacher is of great importance.

Education and Other Environmental Interventions

School has a massive effect on IQ.[63] Tragic circumstances in which children are deprived of school for an extended period of time show deficits in IQ equivalent to dropping from the 50th percentile to the 2nd percentile.

Children actually lose IQ points and academic skills over the summer.[64] But this seasonal change in intellectual skills, as we might expect given the different home environments of children of different social classes, is much greater for lower-SES children. Indeed, the knowledge and skills of children in the upper fifth in family SES actually increase over the summer,[65] an effect that is likely due to higher-SES children experiencing intellectually enriched activities during the summer. This effect is so marked that by late elementary school it may be the primary cause of the achievement gap between lower- and higher-SES children.[66]

So schools make a difference to intelligence. And some schools—and some teachers—make more of a difference than others.

The best prekindergarten programs for lower-SES children

Self-Regulation and Schooling

What is it about school and preschool that enhances intelligence and academic abilities? Content knowledge (e.g., learning about climate in different places in the world) and procedural knowledge (e.g., sorting shapes) are of course important, but increasingly scientists are recognizing the importance of developing self-regulatory skills and other noncognitive traits as requisite for high-level intellectual functioning.[1] Self-regulatory skills include behaviors such as being able to wait in line, inhibiting the desire to call out in class, and persevering at a task that may be boring or difficult. There are many terms in the research literature for the general idea that people can recognize, alter, and maintain changes in their behaviors and moods in ways that advance cognitive performance. These terms include self-discipline,[2] the ability to delay gratification,[3] and self-regulated learning.[4]

A classic study of self-regulation found that 4-year-old children who delayed the immediate gratification of eating one marshmallow so that they would be allowed to eat two marshmallows later scored higher on the SAT they took for college entrance more than a decade later.[5] A study with similar implications was conducted with eighth-grade students at a magnet public school.[6] Students were given envelopes that contained $1. They could either spend the dollar or exchange the envelope for one containing $2 the following week. In addition, students were rated on numerous other measures of self-discipline. The authors reported that scores on a composite measure of self-discipline predicted academic performance and learning gains over the academic year in which the study was conducted and did so better than IQ tests. Similar studies with college students at Ivy League schools, students at a military academy, and spelling bee participants found that self-discipline and ability to delay gratification predicted success across a variety of academic measures.[7]

There is evidence that self-control, or at any rate some set of noncognitive motivational factors, contributes not only to life outcomes but to IQ scores themselves. A team of researchers has shown in a meta-analysis of more than 40 samples that incentives for good test performance improve IQ scores by about 10 points.[8] For samples for which the average baseline IQ was less than 100, the gain due to incentives was about 14 points. The lower the baseline IQ, the greater the gain due to incentives, and the larger the incentives offered, the larger the IQ gain. The investigators also examined the correlates of assessed test-taking motivation (based on refusal to attempt parts of the test, responding rapidly with "I don't know" answers, etc.) for a group of middle school boys. IQ predicted academic outcomes in adolescence and total years of education by the age of 24. So did the nonintellective traits, though to a lesser degree. Nonintellective traits predicted nonacademic outcomes—criminal convictions and employment in adulthood—as well as IQ did. –R.E.N.

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have a substantial effect on IQ, but this typically fades by late elementary school, perhaps because children's environments do not remain enriched. However, there are two studies that provide exceptions to the rule that prekindergarten programs have little effect on later IQ. In both, children moved into average or above-average elementary schools following the prekindergarten interventions. On average, children in one of the programs[67] had IQs 10 points higher than those of controls when they were adolescents. Children in the other program had IQs 4.5 points higher than those of controls when they were 21 years old.[68]

Whether or not high-quality preschool programs have sustained IQ effects, their effects on academic achievement and life outcomes of lower-SES children can be very substantial. The gains are particularly marked for intensive programs with parent-education components, such as the HighScope Perry Preschool Program[69] and the Abecedarian Project.[70] By adulthood, individuals who had participated in such programs were about half as likely as individuals in a control group to have repeated a grade in school or to have been assigned to special education classes, and they were about a third more likely to have completed high school, to have attended college, and even to own their own home. The discrepancy between school achievement effects and IQ effects is sufficiently great as to suggest that the achievement effects are produced more by social and emotional changes such as greater self-control and perseverance than by intellectual gains per se.[71] (For more on these factors, see the sidebar above.)

Whatever the route to educational and life outcomes, there is no question that high-quality early childhood education pays off. Economists have estimated return on the dollar for these programs to be on the order of 4-to-1 up to 8-to-1.*

Quality of teaching in kindergarten also has a measurable impact

on academic success and life outcomes. One group of researchers[72] examined data from a significant study, Project STAR, in Tennessee. They found that students who had been randomly assigned to small kindergarten classes were more likely to subsequently attend college, attend a higher-ranked college, and have better life outcomes in a number of respects. Students who had more-experienced teachers had higher earnings as adults, as did students for whom the quality of teaching, as measured by test scores, was higher. Academic gains due to having more-experienced, superior teachers faded in later grades, but noncognitive gains persisted, much as for the pre-elementary interventions just discussed. In fact, having a kindergarten teacher at the 60th percentile of educational effectiveness rather than the 50th percentile was found to be worth $1,000 per year in income. Multiplied by the 20 or so children in the average class and the 30 or so years of a teacher's career, the benefit of a superior kindergarten teacher adds up to hundreds of thousands of dollars in economic gain for society as a whole.

Similarly, first-grade teaching quality has a significant impact on academic achievement in later grades. For instance, one study[73] found that children who were at risk for poor elementary school performance by virtue of relatively low SES had achievement scores equivalent to 15 percentile points higher if their first-grade teacher was one whose teaching quality was considered by researchers observing the classes to be in the top third as opposed to the bottom third. Indeed, the performance of the children with the better teachers was not significantly worse than that of children with well-educated parents. So, how did these better teachers differ from the others? In three-hour observations of each class, teachers were rated for their instructional and emotional support. According to the researchers, "high-quality instructional support in this study was observed when teachers made frequent and effective use of literacy instruction, evaluative feedback, instructional conversations, and encouragement of child responsibility."[74] And in classrooms they rated high in emotional support, "teachers were aware of and responsive to individual students' needs, offered effective and proactive behavior management, and created a positive classroom climate in which teachers and students enjoyed each other and their time in the classroom."[75] Quality of emotional support contributed to children's achievement independent of quality of instructional support.

Researchers with the Consortium on Chicago School Research have also found instructional and emotional support to be critical to effective teaching. In a study of sixth- through eighth-grade students, they found that the combination of academic pressure (which included rigorous content and high expectations for student performance) and social support (from teachers, peers, and parents) had a very strong impact on achievement. In reading, students in classrooms that were high in pressure and support gained almost two grade-level equivalents; in math, they gained more than two grade-level equivalents.[76]

Helping all children reach their full IQ potential will require a wide range of health care, social services, economic, family, neighborhood, and school interventions.

Of course, this does not mean that teachers alone should be expected to close the IQ and achievement gaps. There is a significant body of research on how to foster high-quality teaching. That research is beyond the scope of this article, but it includes quality leadership, rigorous curriculum, collaborative school environment, ongoing professional development, parent and community partnerships, and more.† In addition, many interventions in elementary school that do not directly address the quality of teaching, including lengthened school day, decreased class size, and interactive computer programs, have been found to markedly affect academic skills.[77]

For policymakers, the evidence on the importance of schooling and the evidence on the importance of socioeconomic status and the home environment are equally important. IQ and achievement gaps begin not just at home, but in the womb. Helping all children reach their full IQ potential will require a wide range of health care, social services, economic, family, neighborhood, and school interventions.‡ ☐

(Endnotes on page 38)

*To learn more, see "The Economics of Inequality," by James J. Heckman, in the Spring 2011 issue of *American Educator*, available at www.aft.org/pdfs/americaneducator/spring2011/Heckman.pdf.

†See, for example, "Teacher Performance in the Context of Truly Disadvantaged Schools in Chicago," by Elaine Allensworth, in the Fall 2011 issue of *Voices in Urban Education*, available at www.annenberginstitute.org/VUE/wp-content/pdf/VUE31_Allensworth.pdf. Also see "Learning to Teach Nothing in Particular," by David K. Cohen, in the Winter 2010–2011 issue of *American Educator*, available at www.aft.org/pdfs/americaneducator/winter1011/Cohen.pdf.

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Increasing IQ

(Continued from page 19)

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