Overview

Intelligence

Robert J. Sternberg*

Intelligence is the ability to learn from past experience and, in general, to adapt to, shape, and select environments. Aspects of intelligence are measured by standardized tests of intelligence. Average raw (number-correct) scores on such tests vary across the life span and also across generations, as well as across ethnic and socioeconomic groups. Intelligence can be understood in part in terms of the biology of the brain—especially with regard to the functioning in the prefrontal cortex. Measured values correlate with brain size, at least within humans. The heritability coefficient (ratio of genetic to phenotypic variation) is between 0.4 and 0.8. But genes always express themselves through environment. Heritability varies as a function of a number of factors, including socioeconomic status and range of environments. Racial-group differences in measured intelligence have been reported, but race is a socially constructed rather than biological variable. As a result, these differences are difficult to interpret. Different cultures have different conceptions of the nature of intelligence, and also require different skills in order to express intelligence in the environment.

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INTELLIGENCE

Intelligence is one's ability to learn from experience and to adapt to, shape, and select environments. Adaptation refers to one's changing oneself to suit the environment; shaping refers to one's changing the environment to fit oneself; selection means the choosing of a new environment, often after adaptation and shaping have failed. Historically, studies of intelligence influencing modern conceptions date back to the early twentieth century. In this article, I discuss major issues facing the field of intelligence: theories of intelligence, biological bases of intelligence, heritability of intelligence, race differences in intelligence, and cultural bases of intelligence.

BACKGROUND CONTEXT

Sir Francis Galton is the first well-known theorist of intelligence. He proposed that intelligence could be understood in terms of elementary psychomotor abilities, such as pitch discrimination and strength of grip.[1] However, later theorists emphasized higher levels of information processing than did Galton in their search to understand intelligence.

Early in the twentieth century, Charles Spearman scientifically studied intelligence using a technique called 'factor analysis.' He proposed that intelligence could be analyzed into a general ability, pervading all intellectual tasks, and specific abilities, each one unique to a particular intellectual task.[2] Spearman's conceptualization of general ability, which is sometimes called '*g*,' continues to be influential today.

Modern intelligence testing originated with the work of Alfred Binet and Theodore Simon, who created the forerunner of the contemporary Stanford-Binet Intelligence Scales.[3] These researchers believed that the essence of intelligence was to be found in good judgment. The ideas of Binet and Simon were imported to the United States by Henry Goddard and by Lewis Terman, a professor at Stanford University. Terman devised what came to be called the Stanford-Binet Scales, measures that are still used today in revised form.[4] These tests measured skills such as vocabulary, arithmetical problem solving, interpretation of proverbs, and spatial visualization. Another important researcher in the early testing of intelligence was David Wechsler, who believed that intelligence is a critical skill in everyday adaptation

*Correspondence to: robert.sternberg@okstate.edu
Office of Academic Affairs, Whitehurst, Oklahoma State University, Stillwater, OK, USA

to the challenges we all face. His Wechsler Scales of Intelligence, in revised form, are today the most widely used tests of intelligence in the world.[5]

Wechsler's original scale differed from Binet's in three key respects. First, intelligence quotient (IQ) was computed on the basis of standard deviation units from the mean rather than mental age (or the age at which one is measured as functioning mentally). Second, roughly the same tests were used at each age levels within broad age ranges (e.g., child, adult). Third, beyond an overall IQ, the Wechsler tests also yielded separate scores for verbal and performance measures of intelligence. A typical verbal item might present a vocabulary or general-information item; a typical performance item might present a series of pictures telling a story that are presented out of order and that need to be reordered so that the temporal sequence is correct, or might ask a test-taker to reproduce a design using multicolored blocks.

Binet and Wechsler succeeded in the creation of their assessments because they both viewed intelligence as based on judgment and good common sense. However, as mentioned earlier before them, Francis Galton constructed tests of intelligence based on acuity of sensori-motor processing, such as visual, auditory, and tactile skills, which he administered to people at an exposition in London.[6] Although Galton is often credited as being the first to take a scientific approach to intelligence, his sensori-motor tests did not prove to be well predictive of school or other kinds of meaningful cognitive performances. Galton also believed that intelligence and especially genius-level intelligence could be ascribed in large part of hereditary factors.[7]

Although some researchers believe intelligence to be highly stable,[8] IQ, at the least, can be quite variable. For example, it can vary both across the life span[9] and across generations. Flynn has shown that average IQ, as measured by raw scores (number of items answered correctly on an intelligence test), increased about three points every decade in many nations during the entire twentieth century.[10]

THEORIES OF INTELLIGENCE

There have been numerous and varied theories of intelligence, which are discussed in detail elsewhere.[11] Theories of intelligence, which are of several kinds, have been proposed.[12] The most well-known theories have been psychometric ones, which view intelligence in terms of a 'map' of a person's mental functioning. These theories delineate the underlying mental structures asserted to be basic to intelligence, as derived from analyses of individual differences in individuals' performances on psychometric tests of intelligence. Cattell–Horn–Carroll (CHC) theory, described below, is an example of such theories.

Psychometric theories have provided the conceptual grounding for most conventional standardized tests of intelligence ('IQ tests'). More recently, systems theories have been proposed that attempt to characterize the structures and mechanisms of the mind that constitute intelligence. The theories of Gardner and Sternberg, described below, are systems theories. A third kind of theory is based on biology. It seeks to characterize intelligence in terms of mechanisms of the brain. Various biological accounts are given their own section, immediately following this one. A final kind of theory that we shall consider is the cultural theory, according to which intelligence can be understood only within the cultural framework in which it is embedded.

CHC Theory

The most widely accepted psychometric theory is CHC theory, which, as noted above, stands for 'Cattell, Horn, Carroll,'[13] the names of the creators of the theories that have been synthesized. Carroll's theory itself is a synthesis of earlier psychometric accounts of intelligence. The theory is based in large part upon psychometric data, i.e., factor-analytic studies that have sought to elucidate underlying bases of individual differences with respect to performance on standardized tests of intelligence (and related constructs). CHC theory proposes that there are three strata of intelligence, related to each other in a hierarchical fashion. Stratum I involves narrow abilities, Stratum II, broad abilities, and Stratum III, an overarching general ability. For the purposes of this article, the most important abilities are general ability (Stratum III), or *g*, as well as fluid and crystallized ability (Stratum II), also referred to as *g-f* and *g-c*, respectively. General ability is a very broad ability theorized to be relevant to and involved in a wide array of cognitive tasks. General ability has been found to be correlated with performance on a very wide range of cognitive functions and life outcomes, including income, job performance, and even health.[14] Fluid ability is one's ability to deal with novelty and to think rapidly and flexibly. Crystallized ability is one's store of general knowledge relevant to adaptation in one's life, including vocabulary and general information.

Gardner's Theory of Multiple Intelligences

Howard Gardner has contended that intelligence is not a single thing—that there exists no 'general intelligence' broadly defined—but rather that the construct of intelligence is multiple.[15] In other words, there are

'multiple intelligences.' These multiple intelligences include (1) linguistic—employed in reading a book; writing an article, a novel, or a play; and understanding spoken words; (2) mathematical—utilized in solving mathematical problems, in balancing a checkbook, in deducing a mathematical proof, and in the reasoning of symbolic logic; (3) spatial intelligence—used in navigating from one location to another, in deciphering a map, and in packing suitcases in the trunk of a car so that they all fit into a compact space; (4) musical intelligence—used in singing an aria, composing a concerto, playing a violin, or even in understanding and appreciating the structure of a musical composition; (5) bodily kinesthetic intelligence—involved in dancing, playing tennis, running a race, or throwing a javelin; (6) naturalist intelligence—employed in understanding often hidden patterns in nature; (7) interpersonal intelligence—used in interacting with other people, e.g., when we seek to understand other people's emotions, motives, or behavior; and (8) intrapersonal intelligence—used in understanding ourselves—for understanding who we are, what leads us to some decisions rather than others, and how we can change ourselves for the better. Gardner's theory is based upon diverse sources of evidence, including neuropsychological as well as psychometric evidence. However, empirical evidence in support of eight independent intelligences is lacking.

Sternberg's Triarchic Theory

Sternberg has offered a 'triarchic theory' of human intelligence,[16] later called in slightly revised form the 'theory of successful intelligence.' The original version of the theory is triarchic in that it holds that intelligence comprises three sets of skills: creative, analytical, and practical. In its augmented version, it includes wisdom-based skills as well. According to this theory, people are intelligent in their lives to the extent that they (1) formulate and seek to achieve goals that help them attain what they seek in life, given their environmental context; (2) recognize and capitalize on strengths and compensate for or correct weaknesses; (3) adapt to, shape, and select environments; (4) through a combination of (a) creative skills to generate novel ideas and adapt flexibly to novel environments; (b) analytical skills to ascertain whether theirs and others' are good ones; (c) practical skills to execute their ideas and persuade others of the value of those ideas; and (d) wisdom-based skills to ensure that their and others' ideas help to achieve a common good, over the long- as well as the short-terms, through the infusion of positive ethical values.

The main aspects of the theory—analytical, creative, practical, and wisdom-based thinking—are measurable. When these aspects of intelligence are measured, they can improve prediction of both academic (e.g., GPA) and nonacademic (meaningful extracurricular) performance in university settings and reduce levels of ethnic-group differences.[17] Teaching in school, if it incorporates the various aspects of intelligence, can increase academic performance relative to conventional teaching.[18] Sternberg also has asserted that intelligence is at least somewhat malleable throughout the lifespan.[19]

BIOLOGICAL BASES OF INTELLIGENCE

Biological approaches to intelligence evaluate the brain and its functioning.[20] Intelligence as measured by IQ tests appears to be localized, in part, in the parieto-frontal cortex, the prefrontal cortex (PFC), and, in general, across the neocortex. People with higher IQs show better functioning in the superior parietal, temporal, and occipital cortexes as well as in subcortical regions of the brain, especially the striatum.[21] Integration of neurological functioning in the parietal and frontal lobes appears to be especially important.[22] Several different biological approaches have been used. Most of these approaches compare biologically based measures to IQ.

Neural Efficiency

Various complex patterns of electrical activity in the brain as prompted by specific stimuli correlate with scores on tests of intelligence. In particular, speed of conduction of neural impulses may correlate with intelligence as measured by IQ tests.[23] Some investigators have suggested that this research supports a view that intelligence is based, at least in part, on neural efficiency, that is, the efficiency with which neural circuits operate in conducting impulses.[24]

Further support for neural efficiency as a possible measure of intelligence is available from studies of the manner in which the brain metabolizes glucose during mental activity. Richard Haier and his associates have discovered that higher levels of intelligence are related to reduced levels of glucose metabolism during a variety of problem-solving tasks.[25] Furthermore, Haier and associates discovered that cerebral efficiency increases as a result of learning in a relatively complex task involving visuo-spatial manipulations (as are involved in the computer game Tetris).[26] In highly practiced tasks, individuals with higher IQs show lower cerebral glucose metabolism overall. But they also show more specifically localized metabolism of

glucose. In most areas of their brains, persons with higher IQ show less glucose metabolism, but in selected areas of their brains (in particular, those that are novel or thought to be important to the task at hand), they show higher levels of glucose metabolism. Thus, people with higher IQ may have learned how to use their brains more efficiently (see Refs 22,23). These results are not consistent throughout the entire literature.

Researchers using electroencephalographic (EEG) methods have also noted a pattern of neural efficiency in intelligent individuals. Using EEG methods, Neubauer and colleagues noted that greatest neural efficiency was observed in the brain areas associated with the individual's greatest ability.[27]

Today, however, event-related potentials (ERPs) are used more widely than EEGs in the study of biological bases of intelligence. Research has examined the relation between intelligence test scores and P300. Quicker onset of P300 activity following stimulus presentation is associated with higher scores on intelligence tests.[28] However, the relation between P300 onset and IQ has not been consistent across studies.

Brain Size and Intelligence

Brain size is associated with level of measured intelligence.[29] For humans, the reported correlations are generally modest but statistically significant. The finding is only correlational, so causal direction is not clear. Moreover, how efficiently information is processed in the brain is probably more important than the brain's size. For instance, on average, men have larger brains than women, but women have better connections across the corpus callosum between the two hemispheres. So it is not clear that one sex would have, on average, an advantage over the other.[30]

The correlation between brain size and intelligence does not hold across species.[31] Rather, the relationship appears to be between intelligence and brain size relative to the rough general size of the organism (also called level of encephalization).

GENETIC AND HERITABILITY STUDIES OF INTELLIGENCE

This section draws on collaborations with Elena Grigorenko, Kenneth Kidd, and Steven Stemler.[32,33] Various attempts have been made to identify genes that are critical to intelligence. To date, no genes have been conclusively identified and it appears unlikely that there will be any single crucial 'gene' for intelligence, or even any small number of relevant multiple genes.[34] Up to this time, researchers have conducted at least six genome-wide scans for genes contributing to intelligence and other aspects of cognition. The data deriving from these scans are inconsistent but there are definitely some partial overlaps in results. In particular, the data indicate genes relevant to intelligence in regions on chromosomes 2q (in four of six investigations), 6p (for five of six investigations), and 14q (for three of six investigations).[35] The overlap in investigations in identifying these regions suggests the existence of genes that might account for at least some of the variation in IQ. In addition, particular genes including *APOE*, *COMT*, and *BDNF* may play a part in the origins of intelligence (see Ref 20).

IQ QTL is a research project attempting to identify quantitative trait loci (QTL) responsible for genetic variation in intelligence.[36] The investigators have sought to identify QTLs linked to intelligence. But positive findings have generally failed to replicate or have generated weak signals that have not yet been convincingly replicated in independent samples.[37] Deary and his colleagues have suggested that 'there is still almost no replicated evidence concerning the individual genes, which have variants that contribute to intelligence differences.'[38] Recently, Davies and colleagues, in a study involving 3511 unrelated adults and almost 550,000 single nucleotide polymorphisms (SNPs), have found that genetic bases of intelligence are very widely distributed across genes rather than localized. They have estimated that 40% of the variation in crystallized intelligence and 51% of the variation in fluid intelligence is accounted for by linkage disequilibrium across genotyped common SNP markers and unknown causal variants.[39] Little is known of genetic markers for the broader aspects of intelligence discussed earlier in this article, as in the theories of Gardner and Sternberg.

Most attempts to investigate genes underlying intelligence have been indirect, through studies of heritability. But heritability is itself a troubled concept. Heritability (also referred to as h^2) is the ratio of genetic variation to total variation in an attribute (such as intelligence) *within* a given population. As a result, the coefficient of heritability says nothing with regard to sources of between-population variation. The coefficient of heritability further does not tell us the proportion of a trait that is genetic in absolute terms, but rather, the proportion of variation in a trait that is due to genetic variation *within a specific population*.

Variation in a trait within a given population is referred to as phenotypic variation; genetic variation in a given population is referred to as genotypic variation. Thus, heritability is a ratio of genotypic

variation to phenotypic variation. Complementary to heritability is environmentality, which is a ratio of environmental variation to phenotypical variation. Both heritability and environmentality are applicable only to populations, not to individuals. There is no way of estimating heritability for a particular individual, nor is the concept of heritability even meaningful for individuals.

Heritability is typically evaluated on a 0–1 scale, with a value of 0 signifying no heritability at all (i.e., no genetic variation underlying the trait) and a value of 1 indicating complete heritability (i.e., exclusively genetic variation in the trait). Heritability and environmentality add up to 1. Thus, if IQ has a heritability of 0.50 within a certain population, then 50% of the variation in scores on the attribute within that population is due (in theory) to genetic influences. This statement is completely different from the statement that 50% of the attribute is inherited. Similarly, if a trait has a heritability equaling 0.70, it does not mean that the trait is 70% genetic for any individual, but rather that 70% of the variation across individuals is genetic.

Thus, heritability is *not* the same as genetic influence. A trait could be highly dependent on genes and yet have relatively low heritability (or none at all), because heritability depends on the presence of individual differences. If there are no individual differences in a population, heritability is meaningless (because there is a 0 in the denominator of the ratio of genetic to total trait variation in a given population). For example, being born with two ears is 100% under genetic control in humans (with extremely rare exceptions of malformations not discussed here). Put another way, regardless of the environment into which a person is born, the individual will have two ears. But it is not meaningful to speak of the heritability of people's having two ears, because there are no individual differences in the trait. Heritability is not 1; rather, it is meaningless (because there is a 0 in the denominator of the ratio) and cannot sensibly be calculated.

Now consider a second complementary example, occupational status. This attribute has a statistically significant heritability coefficient,[40] but it is certainly not under direct genetic control. Clearly there is no gene or set of genes for occupational status. Rather, the effect is indirect and mediated by attributes such as intelligence, personality, and interpersonal attractiveness, which are all under some degree of genetic control. The effects of genes are thus, at best, indirect. Other attributes, such as divorce, may run in families, that is, show familiality, but again, they are also not under direct but rather under indirect genetic control.

Heritability has no fixed value for a given attribute such as intelligence. Although we may read about 'the heritability of IQ' (which, according to most theories, is not exactly the same as intelligence), there is no single fixed value of heritability that represents some true, constant value for the heritability of IQ or anything else. Heritability is dependent on numerous factors, but the most important single factor is the range of environments. Because heritability represents a proportion of variation, its value will depend on the amount of variation. As Herrnstein pointed out, if there were no variation at all in the environments in which people lived, heritability would be 1, because there would be no other source of variation. If there is wide variation in environments, however, heritability is likely to decrease.

In speaking of heritability, we must remember that genes always operate within environment contexts. All genetic effects occur within a reaction range. As a result, environment will likely have differential effects on the same genetic structure. The reaction range is the range of phenotypes (observable effects of genes) that a given genotype (latent structure of genes) for any particular attribute can produce, given the interaction of environment with that genotype. For example, genotype determines a reaction range for the possible heights a particular person can attain, but other factors, such as diseases, childhood nutrition, and the like may affect the adult height that is attained. Furthermore, if different genotypes respond differently to environmental variation, heritability will differ depending on the mean and variance of relevant factors in the environment.[41] Thus, the statistic is not a fixed, constant value. There exist no purely genetic effects on behavior, as would be demonstrated dramatically if a child were raised in a small closet with no stimulation. No genotype would allow an individual's intelligence to flourish in such an environment. Genes thus express themselves through covariation and interaction with the environment. Because the value of a given heritability statistic is relevant only under existing circumstances, the statistic does not and cannot address the modifiability of a trait. A trait could have a high level of heritability and nevertheless be highly modifiable.

The heritability of intelligence is typically estimated as between 0.4 and 0.8.[42] The value typically depends on the method used to estimate heritability, such as studies of degrees of relatedness (e.g., identical vs fraternal twins or identical twins reared apart). The studies are hard to interpret, in part because their assumptions are not always met. For example, identical twins reared apart are not randomly assigned to environments so that one cannot

cleanly separate genetic from environmental variation. Matters are complicated by the fact that heritability estimates vary across populations.

Heritability also varies as a function of socioeconomic status (SES). Turkheimer and his colleagues have found that heritability is very substantially higher in higher SES families than in lower SES families. In particular, at the lowest levels of SES, shared environment accounted for almost all of the variation in IQs, whereas at the highest levels shared environment accounted for practically no variation.[43]

In sum, heritability estimates do not explain in any meaningful sense genetic regulation of human behavior. Furthermore, they do not provide accurate estimates of the strength of the genetic regulation. Rather, genes act within the context of environments and their effects must be understood within these contexts.

RACIAL DIFFERENCES IN INTELLIGENCE

This section draws on collaborations with Elena Grigorenko, Kenneth Kidd, and Steven Stemler.[32,33] Where does race fit into the genetic pattern we have been discussing above? In fact, it does not fit at all. Race is largely a socially constructed concept, not a biological one. It is a result of people's desire to classify. People seem to be natural classifiers: They try to find order in the natural world. This proclivity may reflect, in part, what Gardner has referred to as 'naturalistic intelligence,' as discussed earlier. Any set of observations of course can be categorized in multiple ways. People impose categorization and classification schemes that make sense to them and, in some cases, that favor their particular, often nonscientific, goals.

If one looks at geographic patterns in the distribution of traits, one will find numerous and diverse attributes that correlate with geography. In general, nearby populations tend to be more similar and geographically distant populations tend to be more dissimilar. This pattern is similar to common ideas of socially defined races but is more complex.[44] An adaptation, such as heterozygosity for sickle-cell anemia, may be adaptive in one place (Africa) and maladaptive in another (the United States). Similarly, preferences for food with high fat content might have been adaptive in times of food scarcity, but today can lead to obesity.

Over the millennia, people who migrated changed both as a result of chance factors and as a result of adaptation to their environments in various ways. What is 'good,' from an evolutionary point of view would depend on the adaptations that needed to be made in a given time and place. For example, our ancestors in Africa were in all likelihood dark-skinned because dark skin provided superior protection against the particular challenges of the African environments in which they lived, most notably, the challenges of ultraviolet and other harmful forms of radiation. Socially constructed judgments as to how to classify people are typically offered on the basis of factors that have no relation to the original reasons that people came to look one way or another.

There is nothing special about skin color that gives it unique status to serve as a basis for differentiating humans into so-called races. Any two groups of people that differ in one way are likely to differ in a cluster of ways. For example, as observed by Marks, geneticists have discovered that 54% of people who have designated themselves as Hebrew priests, many of whom have the surname Cohen, have a certain pattern of two genes on the Y chromosome.[45] In contrast, only 33% of Jews who do not view themselves as priests have this pattern. But no one sensibly can claim a 'race' exclusively of Jewish priests.

Some have argued that the environmental challenges faced by peoples who migrated to Northern climates were greater than those faced by people who remained in Southern climates, and that this difference in challenges might have led to higher intelligence of those who went northward.[46] However, others might argue the reverse. A serious challenge of tropical climates is combating tropical diseases in order to survive; the challenges of fighting such diseases are greater in the tropics than they are further north. Indeed, children in some southern regions acquire from an early age specialized knowledge, not acquired further north, of natural herbal medicines that can be used to combat tropical illnesses.[47] To the extent that warmer climates encourage greater aggression,[48] learning how to compete successfully so as to survive in such more aggressive environments also might promote intellectual development. Post hoc evolutionary arguments made in the absence of fossils at times can have the character of 'just so' stories created to support, in retrospect, whatever point one might wish to make about present-day people.

Differences in socially constructed races derive in large part from geographic dispersions that occurred in the distant past, beginning roughly 100,000 years ago but continuing until roughly 3000 years ago in some areas. Observable skin color, a consequence of such dispersions, correlates well with many people's folk taxonomies, but only poorly with actual genetic differences. For example, the amount of genetic variation in Africa is enormous—much greater than

in the rest of the world.[49] In contrast, the amount of phenotypic variation (difference in appearance) in Africa is comparable but no greater than in the rest of the world. The phenotypic differences are nevertheless worthy of note. As an example, in Africa, one can find both very tall Masai and very short Pygmies. The latter probably gained an adaptive advantage as a result of their shortness for movement through dense vegetation in forests.[50] Yet, many people, including scientists, may lump together all these Africans as 'the same,' even though they differ more genetically from each other, in many cases, than they do from those who look very different.

How people are labeled racially is largely a function of social status. In the United States, black people historically have had lower social status than white people, so supposed admixtures of blood determine degrees of 'blackness.' In the United States, having any blackness makes one socially black in some degree. Black is what is called in linguistics the 'marked' term. So one can be light black, or medium-skinned, or dark black; socially, one is still black. Even if one of mixed parentage inherited none of the obvious physical features of blackness, one would still be classified socially as black, although one might pass for white.[50] Where black people are of higher social status, degrees of whiteness may all be seen as departures from true blackness.

The concept of race serves a social, not a biological, purpose. Different kinds of parentage have, depending on the time and place, given rise to racial labeling, as, e.g., in the 'Aryan race,' the 'German race,' the 'Jewish race,' or whatever. In Apartheid South Africa of the past, the races were Bantu (Black African), colored (including people of perceived mixed descent), Indian/Asian, and white. In contemporary North American society, we mix together the black and colored 'races,' somehow believing, as noted above, that if someone has any degree of non-whiteness, it puts that individual into the black category. Hitler designated as a member of the 'Jewish race' anyone who had supposed Jewish blood, which could date back to one's great-grandparents. In the United States today, tribal membership in certain American Indian tribes depends on lineage defined by the tribe as 'American Indian.'

Nisbett reviewed published studies exploring sources of differences in intelligence and other cognitive abilities between people socially identified as white and black.[51] These studies have used a variety of designs. For example, one design (as used by Scarr and Weinberg) involved examining socially black children adopted by socially white parents. Of seven published studies he located, six supported primarily environmental interpretations of group differences, and only one study, with equivocal results, did not.[52] The Scarr and Weinberg study showed that IQs of adopted children are more similar to those of their biological mothers than to those of their adopted mothers. But this finding has no clear racial implications.

The black–white difference in IQ in the United States was about 1 standard deviation (15 points of IQ) in the twentieth century,[53] although in recent years it appears to be decreasing[42] and so it is unclear where it will go.

CULTURAL BASES OF INTELLIGENCE

Different cultures have different conceptions of what intelligence is and how it manifests itself in everyday life.

Whereas in Western culture, verbal fluency is admired, in contrast, the Wolof tribe in Africa views people of higher social class and distinction as speaking less.[54] This difference between the Wolof and Western notions suggests the usefulness of looking at African notions of intelligence as a possible contrast to U.S. notions.

Similar emphasis on social aspects of intelligence has been found as well among two other African groups—the Songhay of Mali and the Samia of Kenya.[55] The Yoruba, another African tribe, emphasizes the importance of depth—of listening rather than just talking—to intelligence, and of being able to see all aspects of an issue and of being able to place the issue in its proper overall context.[56]

Studies in Africa in fact provide yet another window on the substantial differences in conceptions of intelligence across cultures. In Africa, conceptions of intelligence revolve largely around skills that help to facilitate and maintain harmonious and stable intergroup relations; intragroup relations are probably equally important and at times more important.[57] For example, Chewa adults in Zambia emphasize social responsibilities, cooperativeness, and obedience as important to intelligence; intelligent children are expected to be respectful of adults.[58] Kenyan parents also emphasize responsible participation in family and social life as important aspects of intelligence.[59] In Zimbabwe, one word for intelligence, *ngware*, actually means to be prudent and cautious, particularly in social relationships. Among the Baoule, service to the family and community and politeness toward and respect for elders are seen as key to intelligence.[60] In Zimbabwe, conceptions of intelligence are also represented by *njere* (in the Shona language) and *ukaliphile* (in the Ndebele language).[61] The terms

refer to behavior that is deliberate, socially responsible, positive public-spirited, and altruistic.[62] They also mean 'wise,' indicating that, as in Taiwanese Chinese culture, wisdom and intelligence are seen as closely related. Behavior is considered intelligent to the extent it benefits the community as a whole.[63]

In a study of Kenyan conceptions of intelligence, it was found that there are four distinct terms constituting conceptions of intelligence among rural Kenyans—*rieko* (knowledge and skills), *luoro* (respect), *winjo* (comprehension of how to handle real-life problems), *paro* (initiative)—with only the first directly referring to knowledge-based skills (including but not limited to the academic).[64]

The emphasis on the social aspects of intelligence is not limited to African cultures. Notions of intelligence in many Asian cultures also emphasize the social aspect of intelligence more than does the conventional Western or IQ-based notion.[65]

In China, the Confucian perspective emphasizes the characteristic of benevolence and of doing what is right.[66] As in the Western notion, the intelligent person spends a great deal of effort in learning, enjoys learning, and persists in life-long learning with a great deal of enthusiasm. The Taoist tradition, in contrast, emphasizes the importance of humility, freedom from conventional standards of judgment, and full knowledge of oneself as well as of external conditions.

Other investigators have directly examined the language that people use when describing what is 'intelligent.'[67] They explicitly compared the concepts of intelligence of Chinese graduates from Chinese-language versus English-language schools in Hong Kong. They found that both groups considered nonverbal reasoning skills as the most relevant skill for measuring intelligence. Verbal reasoning and social skills came next, and then numerical skill. Memory was seen as least important. The Chinese-language-schooled group, however, tended to rate verbal skills as less important than did the English-language-schooled group. Moreover, in an earlier study, Chen and colleagues found that Chinese students viewed memory for facts as important for intelligence, whereas Australian students viewed these skills as of only trivial importance.[68]

The difference between Eastern and Western conceptions of intelligence may persist even in the present day. Contemporary Taiwanese Chinese conceptions of intelligence show five factors underlying these conceptions: (1) a general cognitive factor, much like the g factor in conventional Western tests; (2) interpersonal intelligence (i.e., social competence); (3) intrapersonal intelligence; (4) intellectual self-assertion; and (5) intellectual self-effacement.[69] In a related study but with different results, Chen found three factors underlying Chinese conceptualizations of intelligence: nonverbal reasoning ability, verbal reasoning ability, and rote memory.[70] The difference may be due to different subpopulations of Chinese, differences in methodology, or differences in when the studies were done.

The factors uncovered in Taiwan differ substantially from those identified in U.S. people's conceptions of intelligence by Sternberg and his colleagues—(a) practical problem solving, (b) verbal ability, and (c) social competence[71]—although in both cases, people's implicit theories of intelligence seem to go quite far beyond what conventional psychometric intelligence tests measure. Of course, comparing the Chen to the Sternberg et al. study simultaneously varies both language and culture.

Intelligence is viewed as being of great importance in many Western cultures as well as some other cultures. This emphasis is not shared throughout the world. In Japan, e.g., people rarely refer to an individual's level of intelligence at all.[72] Rather, there is much more emphasis on a person's motivation and diligence. Success is viewed as much more dependent on motivation than it is on intelligence. When participants are given a task followed by success or failure feedback, Japanese students are more likely than American students to attribute success to effort, good luck, or various situational factors, whereas the Americans are more likely to attribute their success to their ability. In contrast, the Japanese students are likely to attribute failure to lack of effort, and the Americans to lack of ability.[73] Nevertheless, Japanese people do have a conception of intelligence. Factors emerging from a study of implicit theories were active social competence, processing efficiency, and receptive social competence.[74] None of the factors were considered to be innate.

It is important to realize, again, that there is no one overall U.S. conception of intelligence. Indeed, different ethnic groups in San Jose, California, had rather different conceptions of what it means to be intelligent.[75] For example, Latino parents of schoolchildren tended to emphasize the importance of social-competence skills in their conceptions of intelligence, whereas Asian parents tended rather heavily to emphasize the importance of cognitive skills. Anglo parents also more emphasized cognitive skills. Teachers, representing the dominant culture, more emphasized cognitive- than social-competence skills. The rank order of children of various groups' performance (including subgroups within the Latino and Asian groups) could be perfectly predicted by the extent to which their parents shared the teachers'

conception of intelligence. In other words, teachers tended to reward those children who were socialized into a view of intelligence that happened to correspond to the teachers' own.

These varying conceptions of what it means to be smart suggest that in one culture might, in another culture, be viewed as irrelevant. Many cultures around the world emphasize social and practical skills much more in their definitions of intelligence than do Western cultures. In these cultures, socially skilled individuals might be viewed as intelligent, whereas cognitively skilled individuals might be passed over simply because Western schooling is hard to find or even nonexistent. Even in Western culture, after schooling, social and practical skills probably play at least as important of a role as, if not a more important role than, cognitive ones. If we ignore social and practical skills, we risk having definitions only poorly connected to the world in which we live.

CONCLUSION

Researchers generally agree that intelligence involves abilities to learn and adapt to changing environment. They also agree that many intellectual abilities tend to be positively correlated, although they disagree as to just how wide ranging these abilities are. Beyond that, the consensus seems to diminish. At one time, intelligence research consisted primarily of statistical analyses of individual differences in scores on intelligence tests. Today, in addition to such psychometric research, intelligence is also being studied by cognitive psychologists, neuroscientists, cultural psychologists, and many others.

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