Intelligence

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Intelligence is the ability to learn from experience and to adapt to, shape, and select environments. Intelligence as measured by (raw scores on) conventional standardized tests varies across the lifespan, and also across generations. Intelligence can be understood in part in terms of the biology of the brain—especially with regard to the functioning in the prefrontal cortex—and also correlates with brain size, at least within humans. Studies of the effects of genes and environment suggest that the heritability coefficient (ratio of genetic to phenotypic variation) is between .4 and .8, although heritability varies as a function of socioeconomic status and other factors. Racial differences in measured intelligence have been observed, but race is a socially constructed rather than biological variable, so such differences are difficult to interpret.

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Intelligence is one's ability to learn from experience and to adapt to, shape, and select environments. Formal studies of intelligence date back to the early 20th century.

Background context

The modern study of intelligence is often dated back to the work of Charles Spearman, who scientifically studied intelligence and proposed that it could be understood in terms of a general ability that pervaded all intellectual tasks, and specific abilities that were unique to each particular intellectual task.[1] Modern testing of intelligence, however, dates back to the work of Alfred Binet and Theodore Simon, who proposed the forerunner of the modern Stanford-Binet Intelligence Scales.[2] The work of Binet and Simon was brought to the United States by Lewis Terman from Stanford University, who devised the Stanford-Binet Scales.[3] Another critical figure in the early testing of intelligence was David Wechsler, whose Wechsler Scales of Intelligence are today the most widely used in the world.[4] Wechsler's original scale differed from Binet's in that, in addition to an overall intelligence quotient (IQ), it also yielded separate scores for verbal and performance measures of intelligence. A typical verbal item might present a vocabulary item, whereas 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.
Binet and Wechsler succeeded in their measurements because they viewed intelligence as based in judgment

and good sense. However, before them, Francis Galton constructed tests of intelligence based on acuity of sensorimotor processing, such as visual, auditory, and tactile skills.[5] Although Galton is often credited as being the first to take a scientific approach to intelligence, his sensorimotor tests did not prove to be very predictive of scholastic performance or other kinds of meaningful cognitive performances.

Although some researchers believe intelligence to be highly stable,[6] IQ, at the least, can be quite variable. For example, it can vary both across the lifespan[7] 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 3 points every decade in many nations all through the 20th century.[8]

This article will discuss aspects of intelligence of contemporary importance: theories of intelligence, biological bases of intelligence, heritability of intelligence, and race differences in intelligence.

Theories of intelligence

There have been many and diverse theories of intelligence, which are reviewed in detail elsewhere.[9] Theories of intelligence have been of several kinds.[10] The most visible theories have been psychometric theories, which conceptualize intelligence in terms of a sort of "map" of the mind. Such theories specify the underlying structures posited to be fundamental to intelligence, based upon analyses of individual differences in subjects' performance on psychometric tests. The Cattell, Horn, Carroll (CHC) theory, described below, is such a theory. These theories have been the basis for most conventional tests of intelligence ("IQ tests"). A more recent type of theory is the systems theory, which attempts to characterize the system of structures and mechanisms of mind that comprise intelligence. Gardner's and Sternberg's theories, described below, are of this kind. A third kind of theory is the biologically based theory, which attempts to account for intelligence in terms of brain-based mechanisms. Different biological accounts are given their own section, immediately following this one.

CHC theory

The most widely accepted theory is a synthesis sometimes referred to as CHC theory, named after Cattell, Horn, and Carroll,[11] the authors of the original theories that have been synthesized. Carroll's theory itself is a synthesis of earlier psychometric theories of intelligence. The theory is based largely upon psychometric evidence—that is, factor-analytic studies that have sought to uncover sources of individual differences in performance on standardized tests of intelligence (and related constructs). The basic idea of CHC theory is that there are three strata of intelligence that are hierarchically related to each other. Stratum I includes narrow abilities, Stratum II, broad abilities, and Stratum III, general ability. For the purposes of this article, the most important abilities are general ability (Stratum III), also referred to as *g*, and fluid and crystallized ability (Stratum II), also referred to as *g-f* and *g-c*. General ability is an overarching ability that is theorized to be relevant to, and involved in, a very wide variety of cognitive tasks. It has been found to be correlated with performance on a very wide range of cognitive functions and life outcomes, such as income, job performance, and even health.[12] Fluid ability is one's ability to cope with novelty and to think rapidly and flexibly. Crystallized ability is one's general store of knowledge relevant to adaptation in one's life, including vocabulary and general information.

Gardner's theory of multiple intelligences

Gardner has argued that intelligence is not unitary—that there is no "general intelligence" broadly construed—but rather that it is multiple.[13] That is, there are "multiple intelligences." These multiple intelligences include: (i) linguistic—used in reading a book, writing a paper, a novel, or a poem, and understanding spoken words; (ii) mathematical—used in solving math problems, in balancing a checkbook, in solving a mathematical proof, and in logical reasoning; (iii) spatial intelligence—used in getting from one place to another, in reading a map, and in packing suitcases in the trunk of a car so that they all fit into a compact space; (iv) musical intelligence—used in singing a song, composing a sonata, playing a trumpet, or even appreciating the structure of a piece of music; (v) bodily-kinesthetic intelligence—used in dancing, playing basketball, running a mile, or throwing a javelin; (vi) naturalist intelligence—used in understanding patterns in nature; (vii) interpersonal intelligence—used in relating to other people, such as when we try to understand another person's behavior, motives, or emotions; and (viii) intrapersonal intelligence—used in understanding ourselves; the basis for understanding who we are, what makes us tick, and how we can change ourselves, given our existing constraints on our abilities and our interests. Gardner's theory is based upon a variety of sources of evidence, among them neuropsychological as well as psychometric evidence.

Sternberg's triarchic theory

Sternberg has proposed what he refers to as a "triarchic theory" of human intelligence.[14] The original version of the theory is triarchic in that it argues that intelligence comprises three sets of skills: creative, analytical, and practical. In its augmented version, it specifies the importance of wisdom-based skills as well. According to this theory, people are intelligent in their lives to the extent that they: (i) formulate and achieve goals that help them attain what they seek in life, given their cultural context; (ii) by capitalizing on their strengths and compensating for or correcting weaknesses; (iii) in order to adapt to, shape, and select environments; (iv) through a combination of essential skills. As mentioned above, the essential skills are: (i) creative skills to generate novel ideas; (ii) analytical skills in order to assure that the ideas are good ones; (iii) practical skills in order to implement their ideas and persuade others of their value; and (iv) wisdom-based skills in order to ensure that the ideas help to achieve a common good over the long as well as the short term through the infusion of positive ethical values.

The various aspects of the theory—analytical, creative, practical, wisdom—are measurable. Sternberg has shown that when they are measured, they improve prediction of both academic and nonacademic performance in university settings and reduce ethnic-group differences.[15] Teaching that incorporates the various aspects of intelligence increases academic performance relative to conventional teaching.[16] Sternberg has argued that intelligence is at least somewhat malleable throughout the lifespan.

Biological bases of intelligence

Biological approaches to intelligence directly examine the brain and its functioning.[17] Intelligence as measured by IQ tests appears to be localized, in part, in the prefrontal cortex (PFC) and across the neocortex. People with higher IQs show higher levels of functioning in the superior parietal, temporal, and occipital cortexes as well as in subcortical regions of the brain, especially the striatum.[18] Integration of functioning in the parietal and frontal lobes appears to be especially important.[19] Several different biological approaches have been used, most comparing biologically based measures to IQ.

Neural efficiency

Complex patterns of electrical activity in the brain as prompted by specific stimuli correlate with scores on IQ tests. In particular, speed of conduction of neural impulses may correlate with intelligence as measured by IQ tests.[20] Some investigators have suggested that this research supports a view that intelligence is based, at least in part, on neural efficiency.[21]

Additional support for neural efficiency as a measure of intelligence can be found from studies of how the brain metabolizes glucose during mental activities. Haier and his colleagues have found that higher intelligence correlates with reduced levels of glucose metabolism during problem-solving tasks.[22] Furthermore, Haier and colleagues found that cerebral efficiency increases as a result of learning a relatively complex task involving visuospatial manipulations (for example, in the computer game Tetris).[23] As a result of practice, individuals with higher IQ demonstrate 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 (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 24,25). These results are not consistent throughout the entire literature.

Studies 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.[24]

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 typically has been associated with higher intelligence test scores.[25] The relation between P300 onset and IQ has not been consistent, however, and depends in part on the intelligence test utilized.

Brain size and intelligence

Some investigators have examined the relationship between brain size and intelligence.[26] For humans, the statistical relationship is modest but significant. Obviously, the finding is only correlational: greater brain size may cause greater intelligence, greater intelligence may cause greater brain size, or both may be dependent on some third factor. Moreover, how efficiently the brain is used is probably more important than its size. For example, on average, men have larger brains than women, but women have better connections, through the corpus callosum, between the two hemispheres. So it is not clear which sex would have, on average, an advantage—probably neither.[27]

The relationship between brain size and intelligence does not hold across species.[28] Rather, there seems to be a relationship between intelligence and brain size relative to the rough general size of the organism (level of encephalization).

Genetic and heritability studies of intelligence

Although numerous attempts have been made to identify genes that are critical to intelligence,[29,30] no single gene has been conclusively identified, and it looks as though there will be no "gene" for intelligence to be found.[31] So far, investigators have conducted at least six genome-wide scans for genes contributing to intelligence and other aspects of cognition. The data from these scans vary, but there are definitely some partial overlaps. In particular, the data suggest genes related to intelligence in regions on chromosomes 2q (in four of six of the investigations), 6p (for five of the six investigations), and 14q (for three of the six investigations).[32] 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 (QTLs) responsible for genetic variation in intelligence.[33] The investigators have sought to identify QTLs linked to intelligence. But positive findings have generally failed to replicate, or generated weak signals that have not yet been convincingly replicated in independent samples.[34] Deary and his colleagues have found that "there is still almost no replicated evidence concerning the individual genes, which have variants that contribute to intelligence differences."[35] 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.[36] 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*.

Observable 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 phenotypic 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 to 1 scale, with a value of 0 signifying no heritability at all (ie, no genetic variation underlying the trait) and a value of 1 indicating complete heritability (ie, exclusively genetic variation in the trait). Heritability and environmentality add up to 1. Thus, if IQ has a heritability of .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 .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 tantamount to genetic influence. A trait could be highly influenced by genes and yet have low heritability (or none at all). This is because heritability depends on the existence of individual differences. If there are no individual differences, there is no meaningful heritability (because there is a 0 in the denominator of the ratio of genetic to total trait variation in a given population). As an example, being born with two eyes is 100% under genetic control (with extremely rare exceptions of malformations not discussed here). Put another way, regardless of the environment into which a person is born, the person will have two eyes. But it is not meaningful to speak of the heritability of people's having two eyes, 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 be sensibly calculated.

Now consider a second complementary example, occupational status. This attribute has a statistically significant heritability coefficient,[37] 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 that themselves are under some degree of genetic control. The effects of genes thus are, at best, indirect. Other attributes, such as divorce, may run in families—that is, show familiality—but again, they also are 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 (all observable effects) 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.[38] 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 statistic pertains to correlations, whereas modifiability pertains to mean effects. For example, height has a heritability of over .90. Yet height also is highly modifiable, as shown by the fact that average heights have risen substantially over the past several generations.

The heritability of intelligence is typically estimated as between .4 and .8.[39] The value typically depends on the method used to estimate heritability, such as studies of degrees of relatedness (eg, 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 one cannot cleanly separate genetic from environmental variation.

Matters are complicated by the fact that heritability estimates vary across populations. For example, estimates of the heritability of IQ in twin studies carried out in the former Soviet Union tended to be higher than they were in comparable studies conducted within the United States.[40] This observation made sense in terms of our discussion above. Environmental variation in Russia under the Soviet regime was relatively constrained; most people lived in roughly comparable environments. As a result, heritability estimates were higher. Most of the IQ heritability studies up to today have been carried out in nations within the developed world. Relatively little information exists regarding the heritability of IQ in the developing world, although what evidence there is suggests moderate heritability in these nations as well.[41]

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.[42]

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

Where does race fit into the genetic pattern we have been discussing above? (See refs 29,30; this section draws on collaborations with Elena Grigorenko, Kenneth Kidd, and Steven Stemler). In fact, it does not fit at all. Race is 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.[43] A characteristic that is adaptive in one place, such as heterozygosity for sickle-cell anemia, may be adaptive in one place (Africa) and maladaptive in another (the US). Similarly, preferences for food with high fat content might have been adaptive in times of food scarcity, but today can lead to obesity.

One could select any of a number of traits that are associated with geographic patterns and find correlations with other related traits. But such associations do not imply causation. Yet, some people have looked at differences in socially defined races as somehow causative of group differences in IQ. Sometimes, people make the inferences they do to justify existing social stratifications or to create new ones.

Over the millennia, peoples 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.[44] In contrast, only 33% of Jews who do not view themselves as priests have this pattern. What conclusion is to be drawn? The correct conclusion is that different groups of people will differ in various respects. The authors of the study, however, concluded that one could infer a genetic Jewish priestly line dating back to the Biblical Aaron.[45] Other bases for differentiation could be chosen as well, including girth. For better but often for worse, people will often draw conclusions that go well beyond the data, as when they take a correlation to imply causation or when they construe a genetic variation as having implications for a line of Jewish priests. There may indeed be a causal link, but there is no current genetic evidence to support it.

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. The point is not that people in warmer climates did indeed develop higher levels of intelligence, but rather, that one could create speculative arguments supporting greater intellectual growth in such climates, as has been done to support the notion that there was greater intellectual growth as a result of challenges up north. 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 degree of blackness makes one socially black to 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.[51] Where black people are of higher social status, degrees of whiteness may all be seen as departures from true blackness. In that instance, "white" becomes the linguistically marked term.

When we consider racial differences in intelligence, we need to remember that 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, for example, in the "Aryan race," the "German race," the "Jewish race," etc. 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 one standard deviation (15 points of IQ) in the 20th century,[53] although in recent years it has appeared to be decreasing[39]; future developments are unclear.

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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Inteligencia

La inteligencia es la capacidad para aprender de la experiencia y adaptarse a los ambientes, configurándolos y seleccionándolos. La inteligencia se mide con pruebas convencionales estandarizadas (con puntajes brutos) que varían a lo largo de la vida y también a través de las generaciones. La inteligencia se puede comprender en parte desde la biología del cerebro –especialmente en relación con el funcionamiento de la corteza prefrontal- y también, al menos entre los humanos, se correlaciona con el tamaño cerebral. Los estudios acerca de los efectos de los genes y del ambiente sugieren que el coeficiente de heredabilidad (relación entre la genética y la variación fenotípica) es entre 0,4 y 0,8 aunque la herencia varía en función del nivel socioeconómico y otros factores. En la medición de la inteligencia se han observado diferencias raciales; pero la raza más que una variable biológica está construida socialmente, por lo que las diferencias son difíciles de interpretar.

L'intelligence

L'intelligence est l'aptitude à apprendre de l'expérience et à s'adapter, se modeler et choisir son environnement. L'intelligence mesurée par des tests standardisés conventionnels (scores bruts) varie au cours de la vie et aussi parmi les générations. L'intelligence peut être comprise en partie en termes de biologie cérébrale –en particulier dépendant du fonctionnement du cortex préfrontal- et aussi selon la taille du cerveau, au moins chez les humains. Des études sur les effets des gènes et de l'environnement suggèrent que le coefficient d'héritabilité (rapport de la variation génétique sur la variation phénotypique) se situe entre 0,4 et 0,8, bien que l'héritabilité varie en fonction de l'état socio-économique et d'autres facteurs. Même s'il a été observé des différences raciales dans l'intelligence mesurée, la race est une variable socialement construite plutôt que biologique, et de telles différences sont donc difficiles à interpréter.

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