

Nature vs. Nurture: Decoding the Origins of Who We Are

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June 16, 2026

RECOMMENDED CITATION

mohammad looti (2026). *Nature vs. Nurture: Decoding the Origins of Who We Are*. PSYCHOLOGICAL SCALES. Retrieved from <https://scales.arabpsychology.com/?p=38038>

The nature versus nurture debate concerns the relative importance of an individual's innate qualities ("nature," i.e. nativism, or innatism) versus personal experiences ("nurture," i.e. empiricism or behaviorism) in determining or causing individual differences in physical and behavioral traits.

"Nature versus nurture" in its modern sense was coined by the English Victorian polymath Francis Galton in discussion of the influence of heredity and environment on social advancement, although the terms had been contrasted previously, for example by Shakespeare (in his play, *The Tempest*: 4.1). Galton was influenced by the book *On the Origin of Species* written by his cousin, Charles Darwin. The concept embodied in the phrase has been criticized for its binary simplification of two tightly interwoven parameters, as for example an environment of wealth, education and social privilege are often historically passed to genetic offspring.

The view that humans acquire all or almost all their behavioral traits from "nurture" was termed by philosopher John Locke *tabula rasa* ("blank slate") and proposes that humans develop from only environmental influences. This question was once considered to be an appropriate division of developmental influences, but since both types of factors are known to play such interacting roles in development, most modern psychologists and anthropologists consider the question naive--representing an outdated state of knowledge.

In the social and political sciences, the nature versus nurture debate may be contrasted with the structure versus agency debate (i.e. socialization versus individual autonomy). For a discussion of nature versus nurture in language and other human universals, see also psychological nativism.

Scientific Approach

To disentangle the effects of genes and environment, behavioral geneticists perform adoption and twin studies. These seek to decompose the variance (differences) in a population into genetic and environmental components. This move from individuals to populations makes a critical difference in the way we think about nature and nurture. This difference is perhaps highlighted in the quote attributed to Psychologist Donald Hebb who is said to have once answered a journalist's question of "which, nature or nurture, contributes more to personality?" by asking in response, "Which contributes more to the area of a rectangle, its length or its width? For a particular rectangle, its area is indeed the product of its length and width. Moving to a population, however, this analogy masks the fact that there are many individuals, and that it is meaningful to talk about their differences. Thus if a game such as soccer defined the width of a playing field very tightly, but left the length unspecified, then differences in the area of the playing fields would be almost entirely due to differences in length."

Scientific approaches also seek to break down variance beyond these two categories of nature and nurture. Thus rather than "nurture", behavior geneticists distinguish shared family factors (i.e.,

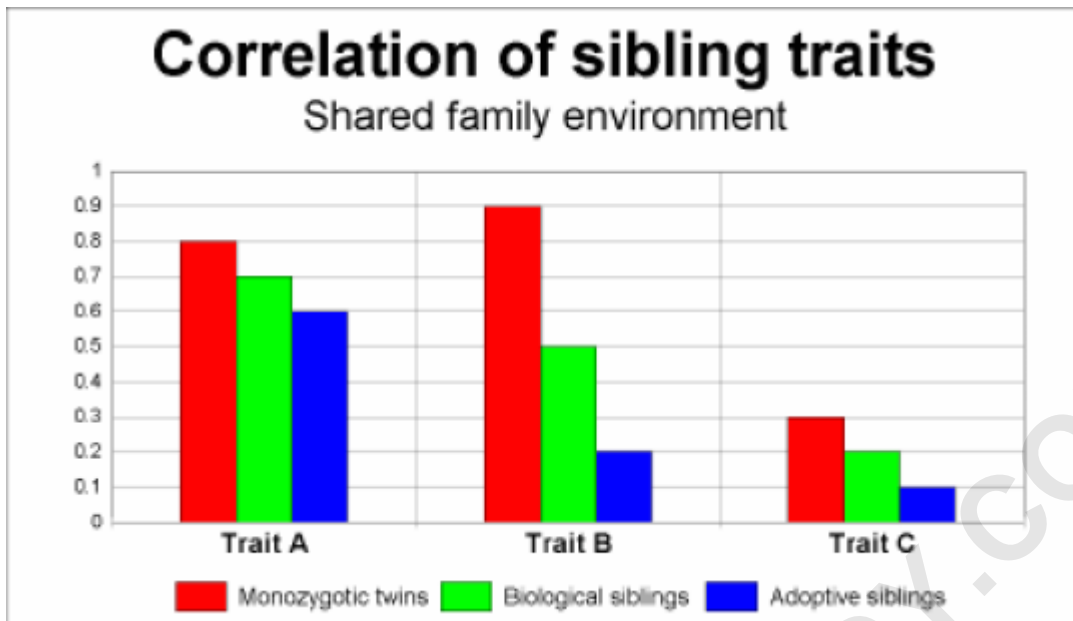
those shared by siblings, making them more similar) and nonshared factors (i.e., those that uniquely affect individuals, making siblings different). To express the portion of the variance due to the "nature" component, behavioral geneticists generally refer to the heritability of a trait.

With regard to the Big Five personality traits as well as adult IQ in the general U.S. population, the portion of the overall variance that can be attributed to shared family effects is often negligible. On the other hand, most traits are thought to be at least partially heritable. In this context, the "nature" component of the variance is generally thought to be more important than that ascribed to the influence of family upbringing.

In her Pulitzer Prize-nominated book *The Nurture Assumption*, author Judith Harris argues that "nurture," as traditionally defined in terms of family upbringing does not effectively explain the variance for most traits (such as adult IQ and the Big Five personality traits) in the general population of the United States. On the contrary, Harris suggests that either peer groups or random environmental factors (i.e., those that are independent of family upbringing) are more important than family environmental effects.

Although "nurture" has historically been referred to as the care given to children by the parents, with the mother playing a role of particular importance, this term is now regarded by some as any environmental (not genetic) factor in the contemporary nature versus nurture debate. Thus the definition of "nurture" has expanded to include influences on development arising from prenatal, parental, extended family, and peer experiences, and extending to influences such as media, marketing, and socio-economic status. Indeed, a substantial source of environmental input to human nature may arise from stochastic variations in prenatal development.

Heritability Estimates



This chart illustrates three patterns one might see when studying the influence of genes and environment on traits in individuals. Trait A shows a high sibling correlation, but little heritability (i.e. high shared environmental variance c^2 ; low heritability h^2). Trait B shows a high heritability since correlation of trait rises sharply with degree of genetic similarity. Trait C shows low heritability, but also low correlations generally; this means Trait C has a high nonshared environmental variance e^2 . In other words, the degree to which individuals display Trait C has little to do with either genes or broadly predictable environmental factors--roughly, the outcome approaches random for an individual. Notice also that even identical twins raised in a common family rarely show 100% trait correlation.

It is important to note that the term heritability refers only to the degree of genetic variation between people on a trait. It does not refer to the degree to which a trait of a particular individual is due to environmental or genetic factors. The traits of an individual are always a complex interweaving of both. For an individual, even strongly genetically influenced, or "obligate" traits, such as eye color, assume the inputs of a typical environment during ontogenetic development (e.g., certain ranges of temperatures, oxygen levels, etc.).

In contrast, the "heritability index" statistically quantifies the extent to which variation between individuals on a trait is due to variation in the genes those individuals carry. In animals where breeding and environments can be controlled experimentally, heritability can be determined relatively easily. Such experiments would be unethical for human research. This problem can be overcome by finding existing populations of humans that reflect the experimental setting the researcher wishes to create.

One way to determine the contribution of genes and environment to a trait is to study twins. In one

kind of study, identical twins reared apart are compared to randomly selected pairs of people. The twins share identical genes, but different family environments. In another kind of twin study, identical twins reared together (who share family environment and genes) are compared to fraternal twins reared together (who also share family environment but only share half their genes). Another condition that permits the disassociation of genes and environment is adoption. In one kind of adoption study, biological siblings reared together (who share the same family environment and half their genes) are compared to adoptive siblings (who share their family environment but none of their genes).

In many cases, it has been found that genes make a substantial contribution, including psychological traits such as intelligence and personality. > Yet heritability may differ in other circumstances, for instance environmental deprivation. Examples of low, medium, and high heritability traits include:

Low heritability Medium heritability High heritability
Specific language Weight Blood type
Specific religion Religiosity Eye color

Twin and adoption studies have their methodological limits. For example, both are limited to the range of environments and genes which they sample. Almost all of these studies are conducted in Western, first-world countries, and therefore cannot be extrapolated globally to include poorer, non-western populations. Additionally, both types of studies depend on particular assumptions, such as the equal environments assumption in the case of twin studies, and the lack of pre-adoptive effects in the case of adoption studies.

Interaction of Genes and Environment

Heritability refers to the origins of differences between people. Individual development, even of highly heritable traits, such as eye color, depends on a range of environmental factors, from the other genes in the organism, to physical variables such as temperature, oxygen levels etc. during its development or ontogenesis.

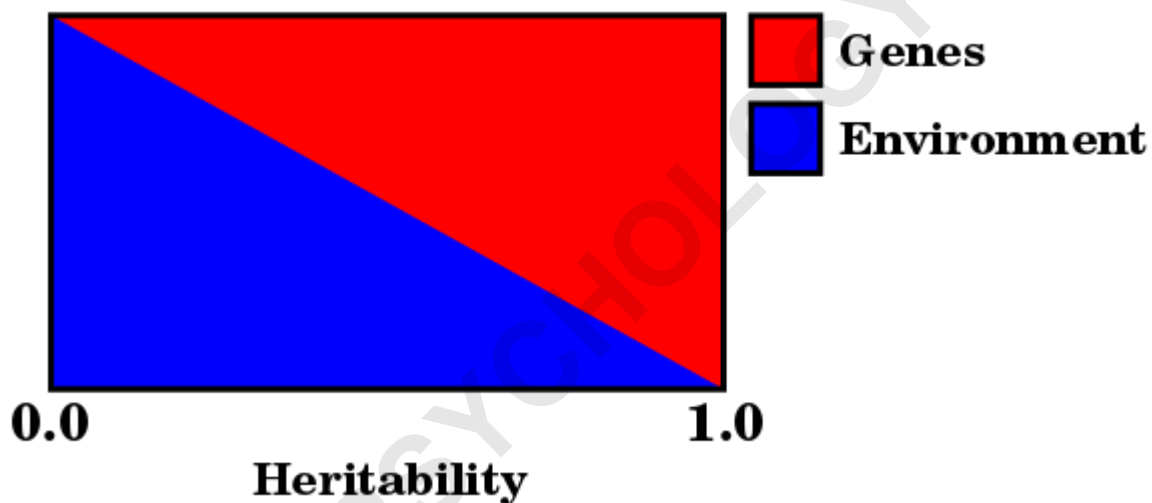
The variability of trait can be meaningfully spoken of as being due in certain proportions to genetic differences ("nature") , or environments ("nurture"). For highly penetrant Mendelian genetic disorders such as Huntington's disease virtually all the incidence of the disease is due to genetic differences. Huntington's animal models live much longer or shorter lives depending on how they are cared for.

At the other extreme, traits such as native language are environmentally determined: linguists have found that any child (if capable of learning a language at all) can learn any human language with equal facility. With virtually all biological and psychological traits, however, genes and environment

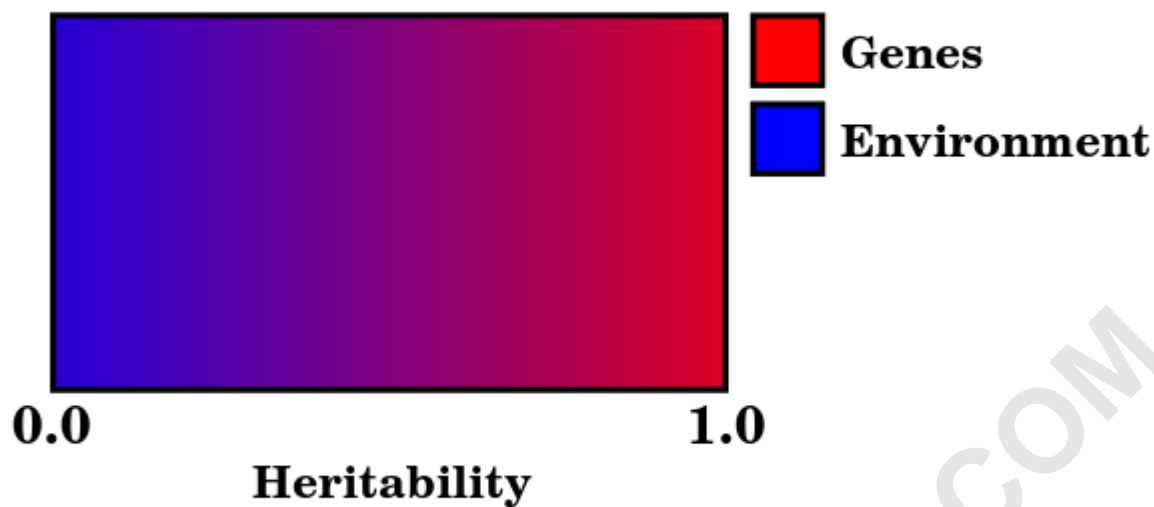
work in concert, communicating back and forth to create the individual.

At a molecular level, genes interact with signals from other genes and from the environment. While there are many thousands of single-gene-locus traits, so-called complex traits are due to the additive effects of many (often hundreds) of small gene effects. A good example of this is height, where variance appears to be spread across many hundreds of loci .

Extreme genetic or environmental conditions can predominate in rare circumstances --if a child is born mute due to a genetic mutation, it will not learn to speak any language regardless of the environment; similarly, someone who is practically certain to eventually develop Huntington's disease according to their genotype may die in an unrelated accident (an environmental event) long before the disease will manifest itself.



The "two buckets" view of heritability.



More realistic "homogenous mudpie" view of heritability.

Steven Pinker (2004) likewise described several examples:

concrete behavioral traits that patently depend on content provided by the home or culture--which language one speaks, which religion one practices, which political party one supports--are not heritable at all. But traits that reflect the underlying talents and temperaments--how proficient with language a person is, how religious, how liberal or conservative--are partially heritable.

When traits are determined by a complex interaction of genotype and environment it is possible to measure the heritability of a trait within a population. However, many non-scientists who encounter a report of a trait having a certain percentage heritability imagine non-interactive, additive contributions of genes and environment to the trait. As an analogy, some laypeople may think of the degree of a trait being made up of two "buckets," genes and environment, each able to hold a certain capacity of the trait. But even for intermediate heritabilities, a trait is always shaped by both genetic dispositions and the environments in which people develop, merely with greater and lesser plasticities associated with these heritability measures.

Heritability measures always refer to the degree of variation between individuals in a population. These statistics cannot be applied at the level of the individual. It is incorrect to say that since the heritability index of personality is about 0.6, you got 60% of your personality from your parents and 40% from the environment. To help to understand this, imagine that all humans were genetic clones. The heritability index for all traits would be zero (all variability between clonal individuals must be due to environmental factors). And, contrary to erroneous interpretations of the heritability index, as societies become more egalitarian (everyone has more similar experiences) the heritability index goes up (as environments become more similar, variability between individuals is

due more to genetic factors).

Some have pointed out that environmental inputs affect the expression of genes (see the article on epigenetics). This is one explanation of how environment can influence the extent to which a genetic disposition will actually manifest. The interactions of genes with environment, called gene-environment interactions, are another component of the nature-nurture debate. A classic example of gene-environment interaction is the ability of a diet low in the amino acid phenylalanine to partially suppress the genetic disease phenylketonuria. Yet another complication to the nature-nurture debate is the existence of gene-environment correlations. These correlations indicate that individuals with certain genotypes are more likely to find themselves in certain environments. Thus, it appears that genes can shape (the selection or creation of) environments. Even using experiments like those described above, it can be very difficult to determine convincingly the relative contribution of genes and environment.

Obligate vs. Facultative Adaptations

Traits may be considered likely to be adaptations (such as the umbilical cord), byproducts of adaptations (the belly button) or due to random variation (convex or concave belly button shape). Within the class of adaptations, an alternative to contrasting nature and nurture focusses on "obligate vs. facultative" adaptations. This distinction asks whether an adaptation is obligate (robust in the face of typical environmental variation) or facultative (sensitive to typical environmental variation). The rewarding sweet taste of sugar and the pain of bodily damage are obligate psychological adaptations -- typical environmental variability during development does not much affect their operation. On the other hand, facultative adaptations are somewhat like "if-then" statements. An example is suggested to be adult attachment style. If attachment is sensitive to early childhood experience, then as adults, the propensity to develop close, trusting bonds with others is conditional on whether early childhood caregivers could be trusted to provide reliable assistance and attention. Buss proposes also that the adaptation of skin to tan on exposure to sunlight is an example of a facultative adaptation.

Advanced Techniques

The power of quantitative studies of heritable traits has been expanded by the development of new techniques. Developmental genetic analysis examines the effects of genes over the course of a human lifespan. For example, early studies of intelligence, which mostly examined young children, found that heritability measures 40-50%. Subsequent developmental genetic analyses found that variance attributable to additive environmental effects is less apparent in older individuals, with estimated heritability of IQ being higher than that in adulthood.

Another advanced technique, multivariate genetic analysis, examines the genetic contribution to several traits that vary together. For example, multivariate genetic analysis has demonstrated that

the genetic determinants of all specific cognitive abilities (e.g., memory, spatial reasoning, processing speed) overlap greatly, such that the genes associated with any specific cognitive ability will affect all others. Similarly, multivariate genetic analysis has found that genes that affect scholastic achievement completely overlap with the genes that affect cognitive ability.

Extremes analysis, examines the link between normal and pathological traits. For example, it is hypothesized that a given behavioral disorder may represent an extreme of a continuous distribution of a normal behavior and hence an extreme of a continuous distribution of genetic and environmental variation. Depression, phobias, and reading disabilities have been examined in this context.

For a few highly heritable traits, some studies have identified loci associated with variance in that trait in some individuals. For example, research groups have identified loci that are associated with schizophrenia (Harrison and Owen, 2003) in subsets of patients with that diagnosis.

IQ Debate

Evidence suggests that family environmental factors may have an effect upon childhood IQ, accounting for up to a quarter of the variance. On the other hand, by late adolescence this correlation disappears, such that adoptive siblings are no more similar in IQ than strangers.

Moreover, adoption studies indicate that, by adulthood, adoptive siblings are no more similar in IQ than strangers (IQ correlation near zero), while full siblings show an IQ correlation of 0.6. Twin studies reinforce this pattern: monozygotic (identical) twins raised separately are highly similar in IQ (0.74), more so than dizygotic (fraternal) twins raised together (0.6) and much more than adoptive siblings (~0.0).

Personality Traits

Personality is a frequently cited example of a heritable trait that has been studied in twins and adoptions. Identical twins reared apart are far more similar in personality than randomly selected pairs of people. Likewise, identical twins are more similar than fraternal twins. Also, biological siblings are more similar in personality than adoptive siblings. Each observation suggests that personality is heritable to a certain extent. However, these same study designs allow for the examination of environment as well as genes. Adoption studies also directly measure the strength of shared family effects. Adopted siblings share only family environment. Most adoption studies indicate that by adulthood the personalities of adopted siblings are little or no more similar than random pairs of strangers. This would mean that shared family effects on personality are zero by adulthood. As is the case with personality, non-shared environmental effects are often found to out-weigh shared environmental effects. That is, environmental effects that are typically thought to be life-shaping (such as family life) may have less of an impact than non-shared effects, which are

harder to identify. One possible source of non-shared effects is the environment of pre-natal development. Random variations in the genetic program of development may be a substantial source of non-shared environment. These results suggest that "nurture" may not be the predominant factor in "environment."

Genomics

With the advent of genomic sequencing, it has become possible to search for and identify specific gene polymorphisms that affect traits such as IQ and personality. These techniques work by tracking the association of differences in a trait of interest with differences in specific molecular markers or functional variants. An example of a visible human traits for which the precise genetic basis of differences are relatively well known is eye color. For traits with many genes affecting the outcome, a smaller portion of the variance is currently understood: For instance for height known gene variants account for around 5-10% of height variance at present.

Philosophical Difficulties

Philosophical questions regarding nature and nurture include the question of the nature of the trait itself, questions of determinism, and whether the question is well posed.

As well as asking if a trait such as IQ is heritable, one can ask what it is about "intelligence" that is being inherited. Similarly, if in a broad set of environments genes account for almost all observed variation in a trait then this raises the notion of genetic determinism and or biological determinism, and the level of analysis which is appropriate for the trait. Finally, as early as 1951, Calvin Hall suggested that discussion opposing nature and nurture was fruitless. Environments may be able to be varied in ways that affect development: This would alter the heritability of the character changes, too. Conversely, if the genetic composition of a population changes, then heritability may also change.

The example of phenylketonuria (PKU) is informative. Untreated, this is a completely penetrant genetic disorder causing brain damage and progressive mental retardation. PKU can be treated by the elimination of phenylalanine from the diet. Hence, a character (PKU) that used to have a virtually perfect heritability is not heritable any more if modern medicine is available (the actual allele causing PKU would still be inherited, but the phenotype PKU would not be expressed anymore). It is useful then to think of what is inherited as a mechanism for breaking down phenylalanine. Separately from this we can consider whether the organism has other mechanisms (for instance a drug that breakdown this amino acid) or does not need the mechanism (due to dietary exclusion).

Similarly, within, say, an inbred strain of mice, no genetic variation is present and every character will have a zero heritability. If the complications of gene-environment interactions and correlations

(see above) are added, then it appears to many that heritability, the epitome of the nature-nurture opposition, is "a station passed."

A related concept is the view that the idea that either nature or nurture explains a creature's behavior is an example of the single cause fallacy.

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