What is heritability?

Heritability is a measure of how well differences in people’s genes account for differences in their traits. Traits can include characteristics such as height, eye color, and [intelligence](https://ghr.nlm.nih.gov/primer/traits/intelligence), as well as disorders like [schizophrenia](https://ghr.nlm.nih.gov/condition/schizophrenia) and [autism spectrum disorder](https://ghr.nlm.nih.gov/condition/autism-spectrum-disorder). In scientific terms, heritability is a statistical concept (represented as h²) that describes how much of the variation in a given trait can be attributed to genetic variation. An estimate of the heritability of a trait is specific to one population in one environment, and it can change over time as circumstances change.

Heritability estimates range from zero to one. A heritability close to zero indicates that almost all of the variability in a trait among people is due to environmental factors, with very little influence from genetic differences. Characteristics such as religion, language spoken, and political preference have a heritability of zero because they are not under genetic control. A heritability close to one indicates that almost all of the variability in a trait comes from genetic differences, with very little contribution from environmental factors. Many disorders that are caused by mutations in single genes, such as [phenylketonuria](https://ghr.nlm.nih.gov/condition/phenylketonuria) (PKU), have high heritability. Most complex traits in people, such as intelligence and [multifactorial diseases](https://ghr.nlm.nih.gov/primer/mutationsanddisorders/complexdisorders), have a heritability somewhere in the middle, suggesting that their variability is due to a combination of genetic and environmental factors.

Heritability has historically been estimated from studies of twins. Identical twins have almost no differences in their DNA, while fraternal twins share, on average, 50 percent of their DNA. If a trait appears to be more similar in identical twins than in fraternal twins (when they were raised together in the same environment), genetic factors likely play an important role in determining that trait. By comparing a trait in identical twins versus fraternal twins, researchers can calculate an estimate of its heritability.

Heritability can be difficult to understand, so there are many misconceptions about what it can and cannot tell us about a given trait:

* Heritability does not indicate what proportion of a trait is determined by genes and what proportion is determined by environment. So, a heritability of 0.7 does not mean that a trait is 70% caused by genetic factors; it means than 70% of the variability in the trait in a population is due to genetic differences among people.
* Knowing the heritability of a trait does not provide information about which genes or environmental influences are involved, or how important they are in determining the trait.
* Heritable is not the same as [familial](https://ghr.nlm.nih.gov/primer/inheritance/runsinfamily). A trait is described as familial if it is shared by members of a family. Traits can appear in families for many reasons in addition to genetics, such as similarities in lifestyle and environment. For example, the language that is spoken tends to be shared in families, but it has no genetic contribution and so is not heritable.
* Heritability does not give any information about how easy or difficult it is to change a trait. For example, hair color is a trait with high heritability, but it is very easy to change with dye.

If heritability provides such limited information, why do researchers study it? Heritability is of particular interest in understanding traits that are very complex with many contributing factors. Heritability can give initial clues as to the relative influences of “nature” (genetics) and “nurture” (environment) on complex traits, and it can give researchers a place to start teasing apart the factors that influence these traits.

**Scientific articles for further reading**

Moore DS, Shenk D. The heritability fallacy. Wiley Interdiscip Rev Cogn Sci. 2017 Jan;8(1-2). doi: 10.1002/wcs.1400. Epub 2016 Dec 1. Review. PubMed: [27906501](https://www.ncbi.nlm.nih.gov/pubmed/27906501).

Tenesa A, Haley CS. The heritability of human disease: estimation, uses and abuses. Nat Rev Genet. 2013 Feb;14(2):139-49. doi: 10.1038/nrg3377. Review. PubMed: [23329114](https://www.ncbi.nlm.nih.gov/pubmed/23329114).