

$$R = h^2 S$$

- What h^2 is good for is predicting whether or not selection will be effective in changing the mean value of a trait in a population.
- R = response to selection (= difference between mean trait in parents and mean trait in offspring)
- S = selection differential (= difference between mean trait in general population and mean trait in population selected for breeding)

h^2 can be estimated as the slope of the linear correlation between parental and offspring phenotypes. Our class data for mean parental height (x-axis) vs. mean offspring height (y-axis) gives a value of 0.792 for h^2 , close to the accepted value of 0.7.

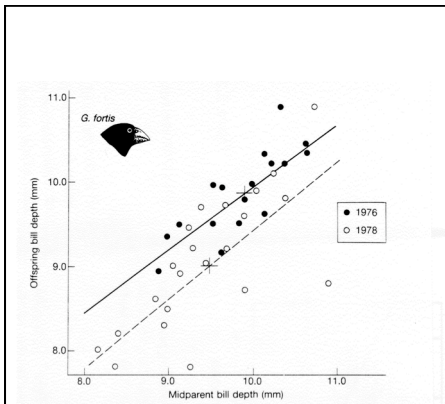
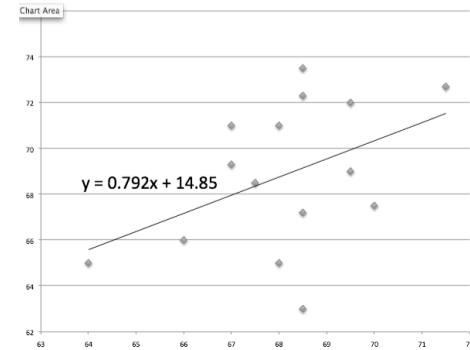


Figure 9.1 Parents with larger than average beaks produce offspring with larger than average beaks in *Geospiza fortis* on Daphne Major: beak size is inherited. From Grant (1986).

Graphing mean parent vs. mean offspring beak size in Galápagos finches gives straight lines with a slope of about 0.8, which is the narrow-sense heritability. The slope doesn't change from before a drought (1976) to after the drought (1978), suggesting that we are in fact measuring something genetic.



Heritability isn't fixed in a population or species; it can decrease with time. In a 1985 experiment selecting chickens for increased meat production, h^2 was 0.47 for the first four generations, and then slipped to 0.21–0.29. This reflects loss of variation, and the loss of the ability to improve further, as selection went on and on.

This explains why, within a single domestic dog breed, heritability of behavioral traits is low (between 0.09 and 0.24 for seven traits, in a 2002 study of German Shepherds). But when comparing *across* breeds, many behaviors are strongly inherited and have been selected for many years (herding behavior in sheepdogs, “soft mouth” in retrievers, etc.)



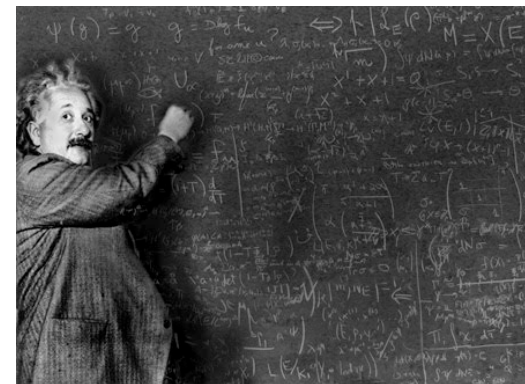
This is crucial! A trait may have low or no heritability and yet be inherited genetically. If German shepherds have very little genetic variation to begin with, and have been “taken about as far as they can go,” heritability of traits may be very low—and yet heritability may be high if you look at the total spectrum of dog breeds. Heritability is meaningless without reference to the population that it is measured in.



Traits can also change their heritability with individuals’ age. A large study of identical twins showed that “religiousness” has a heritability of 0.11-0.22 among 16-year-olds, but 0.30–0.45 among adults. The idea seems to be that for children, religious belief and practice are strongly determined by environment (i.e. by the parents). This is less strong in the case of mature adults.



The heritability of IQ also increases in adults compared to children—in adults it may be over 0.85. That might look like an argument in favor of Murray and Herrnstein in *The Bell Curve*. . .

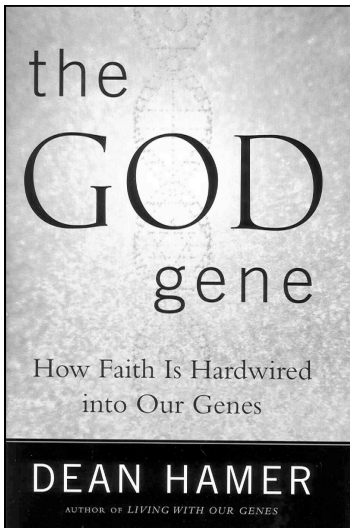




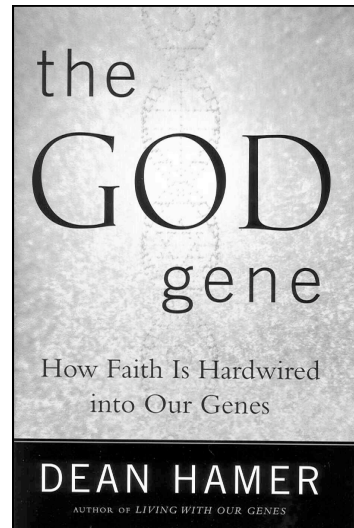
. . . BUT: just because a trait has high heritability says *nothing* about whether environment affects it! Imagine growing plants in two different environments: a very lush one and a very harsh one. Within both, plant height, say, might show high heritability — tall plants would have tall offspring. But the difference between populations would disappear if the environments were made the same.



The way to figure this out would be to raise both sets of plants in a “common garden experiment” under identical conditions. In fact, that is what we’d have to do in order to prove *The Bell Curve’s* argument—but that’s not really ethical.



Nor can we usually connect a specific gene to a quantitative trait, even one with significant heritability. The personality trait of “self-transcendence” (a measure of “spirituality”) is known to have a heritability of about 0.4. In 2004, Dean Hamer published *The God Gene*, arguing that alleles of the gene for the protein *vesicular monoamine transporter 2 (VMAT2)*, involved in neurotransmitter release, were correlated with a high degree of religious or spiritual behavior.



Unfortunately, VMAT2 accounts for about 1% of the variance in “self-transcendence”. . . Despite the book’s provocative title, faith is not “hardwired” into our genes, and we have yet to identify any individual genes with anything more than a very minor effect on human spirituality.