

Psychology 3102: Introduction to Behavioral Genetics (Carey)
Problem Set: Heritability and Environmentability

Two basic equations are required to calculate heritability and environmentability. The first equation is

$$h^2 + e^2 = 1$$

where h^2 is the heritability and e^2 is the environmentability. This equation simply states that the total variance is composed of two sources, the genes and the environment. The proportion of variance due to the genes is h^2 and the proportion of variance due to the environment is e^2 . The second equation is

$$\text{corr}(\text{relative 1, relative 2}) = h^2 + e^2 = 1$$

This equation states that the correlation between two types of relatives (e.g., MZ twins, or mothers and offspring, or siblings) equals the genetic correlation between these two types of relatives () times the heritability (h^2) plus the environmental correlation between the two types of relatives () times the environmentability (e^2). One requires two different correlation coefficients to solve for the unknowns in these equations. For example, one can solve for them with the correlation coefficients for MZ twins and DZ twins. One could also solve for them with the correlation coefficient between biological mothers and their adopted-away offspring and the correlation coefficient between biological mothers and the offspring that they raise.

1. Solve for h^2 , e^2 and when the correlation for siblings raised apart is .23 and the correlation for siblings raised together is .28.
2. Solve for h^2 , e^2 and when the correlation for biological parents and adopted-away offspring .18 and the correlation between adoptive mothers and their adoptive offspring is .15.
3. Solve for h^2 , e^2 and when the correlation for half-siblings raised in the same household is .22 and the correlation for half siblings raised in different households is .12.
4. In a Finnish study of alcohol use among male twins, the researchers studied two phenotypes. One was "density", or a measure of the frequency and regularity with which one drinks alcohol. The second was "amount" or a measure of the amount of alcohol that an individual would drink whenever he was drinking. The researchers reported the following correlations for MZ and DZ twins on the two phenotypes:

Phenotype	MZ Correlation	DZ Correlation
Density	.61	.32
Amount	.38	.11

For each of the two phenotypes, calculate the heritability, the environmentability, and the correlation between the environments of twins.

5. In the same study, the researchers reported the following correlations for a vocabulary test and an arithmetic test.

Phenotype	MZ Correlation	DZ Correlation
Vocabulary	.75	.51
Arithmetic	.73	.55

For each of the two phenotypes, calculate the heritability, the environmentability, and the correlation between the environments of twins.

6. In what ways are the two cognitive phenotypes similar and in what ways are they different from the two alcohol-related phenotypes in terms of heritability and environmentability?

7. Suppose the correlation between an adoptive mother and her adopted child is .02 and suppose the observed correlation between biological mother and own child reared together is .20. What is the heritability and environmentability of the trait? What is the effect of the parental environment on the trait? What would you predict the correlation between the birth mother and her adopted away offspring to be?

8. The correlation between genetically unrelated adoptive siblings raised in the same household is .25 [that is, the parents adopt 2 genetically unrelated children]. The correlation between identical twins raised apart since birth is .45. What would you predict the correlation to be for the following types of relatives:

- 8.a) biological siblings raised apart from birth
- 8.b) biological siblings raised together in the same household?
- 8.c) identical twins reared together?
- 8.d) biological parent and adopted away offspring

9. One large twin study was the National Merit twin study. One personality measure in this study was social dominance. People high on this trait like to assume positions of leadership and be the center of attention. People low on the trait prefer to remain in the background. The researchers obtained the following correlations for male and female twins:

MZ Males	.57		MZ Females	.49
DZ Males	.12		DZ Females	.36

From these data what would you conclude about possible sex differences in terms of the genetic effect on social dominance, the environmental effect on social dominance, and the effect of correlated twin environments on social dominance?

10. Bouchard & McGue (1990) reported twin correlations for the California Psychological Inventory (CPI) Socialization scale. This scale is a good predictor of juvenile delinquency and other antisocial behavior. The correlation for 45 pairs of identical twins raised apart was .53 and the correlation for 26 pairs of fraternal twins raised apart was .39.

- 10.a) Can you obtain two different estimates of h^2 from these correlations?
- 10.b) Why do you think these estimates do not agree with each other?