

Philosophy 3334: Philosophy of Biology
 Fall 2023
 Homework 5

Answers should be uploaded into Blackboard before 11:59pm on Tuesday, Nov 21.

1) Let's assume a farmer has two genetic varieties (G_1 and G_2) of the same type of pumpkin. They plant them in four different fields ($E_1 - E_4$) where each field has one of two different types of soil (S_1 or S_2). Then one field of each type of soil is fertilized and the other is not. One hundred of each type of pumpkin are planted in each field. The average mass in kilograms of each type of plant in each field is given in the chart below:

	G_1	G_2
$E_1 (S_1 + F)$	4	12
$E_2 (S_1 \text{ without } F)$	2	8
$E_3 (S_2 + F)$	8	8
$E_4 (S_2 \text{ without } F)$	2	4

From this information, calculate each of the following quantities (and show your work):

V_p – overall phenotypic variance

V_g – overall genotypic variance

V_e – overall environmental variance

V_{gxe} – overall variance due to the interaction of genetic and environmental factors (called I in Sober). NOTE: In this case, because there are the same number of each type of plant in each type of environment the covariance between genotype and environment $Cov(g,e) = 0$ so you do not need to worry about this term.

H^2 - broad score heritability (h^2 in Sober)

2) Now let's use the data from problem 1 to ask about causation. Calculate the following:

2a) The average mass of a pumpkin in fertilized soil.

2b) The average mass of a pumpkin in non-fertilized soil.

2c) The average mass of a pumpkin in soil type 1.

2d) The average mass of a pumpkin in soil type 2.

2e) Harden doesn't actually give a definition of causation in her book, but she does say on page 108, "All" that is required to assert that you have identified a cause is to demonstrate evidence that the average outcome for a group of people *would have been different* if they had experienced **X** instead of **Not-X**. – According to this, do you think Harden would say that the fertilizer causes the pumpkins to be larger? What

about being in soil type 1? Carefully explain your answers. Do you think this is correctly capturing causation here? What would happen if almost all of the pumpkins of this type in the wild were G_1 and G_2 was a rare mutant type? Would this change the answer at all? Should it?

3) On page 121 Harden says, “Even as I write this, I hear a chorus singing out a familiar objection: ‘Heritability estimates are specific to a population.’ ”

Imagine that the farmer does the exact calculation you did in problem #1 and says, “Now I have learned something interesting about pumpkins. I have learned that the heritability of size in these pumpkins is xxx [your answer]. That is really interesting and valuable information.” Now a critic comes along and says, “Who cares? This is worthless information. Don’t you know that heritability estimates are specific to a population?”

Explain this objection. What is the critic trying to tell the farmer here?

4) Some traits in humans seem to be highly heritable – for example, height is around $H^2 = .8$ as is schizophrenia. To many people this suggests that your genes almost completely determine your height and similarly, nothing we do will affect whether or not a child will develop schizophrenia later in life. This would seem even more powerful if the trait had a heritability value of .95 or even 1. But actually, this is incorrect.

4a) Explain how this high value for heritability is consistent with the claim that a new, different environment might affect phenotypes.

4b) Give an example where this has happened in the past (or for fun, describe an example (realistic sounding or not) of an alteration like this that could happen in the future).

4c) Explain how things actually happening in the environment right now could still be causally influencing these traits.

5) One common kind of twin study involves comparing how similar the phenotypes of identical twins are to how similar the phenotypes of fraternal twins are. The standard methodology assumes what is often called the “equal environments assumption.”

5a) Explain what this assumption means.

5b) Explain why it is almost certainly false.

5c) Explain how this assumption matters to the calculation of heritability (either formally or informally) and what the effects are if it is false.