Philosophy 3334: Philosophy of Biology
Fall 2023
Homework 6

Answers should be uploaded into Blackboard before 11:59pm on Sunday, Dec 3.

PREAMBLE: Imagine that we do a very large GWAS study and a gene has been identified that is 50 times more prevalent in obese individuals than non-obese individuals. Not everyone who has this gene is obese and some people have the gene and are not obese. Nevertheless, there is strong correlation.

1) Is this enough information to conclude that yes, this is a gene for obesity? What about the claim that this gene *causes* obesity? (Say whether you think this is the same question or two different questions). If you think this is not enough information, what additional information would you need to know?

It is natural to think that a gene *for* obesity is a gene that causes obesity. Discovering an association with a GWAS study is typically not enough information to know that that the gene is causing the phenotype in question – it could be a spurious correlation due to population stratification (like the case of the "chopsticks gene"). Harden or Sober would want evidence about whether there would be a difference in whether the person is obese if they had the gene vs. didn't in the same environmental circumstances. Understanding what the gene does in the body would be one of the ways we could learn this counterfactual information.

2) Here are three different hypothetical stories about what might be happening.

2a) In story one, it turns out that this gene affects how the body metabolizes food and creates body fat. So someone with this variant of the gene who has the exact same diet as someone with a different variant will end up with more body fat.

2b) In story two, it turns out that people with this variant of the gene do not feel satiated as quickly when they eat. In other words, they are hungrier more often. So as a matter of fact, when we compare the total amount of calories they consume, they simply eat more on average than people with a different variant of the gene. It is of course possible for them to simply eat less (meaning eat the same amount as other people), but they would be hungry all the time and this is very difficult and very unpleasant. But if they did, they would be at a more normal weight.

2c) In story three, it turns out that people with this variant of the gene have a taste for calorie dense foods like sugary drinks and desserts. These foods just taste especially good to them. It is not particularly difficult to avoid these foods and if they just have water instead of soda for example, they feel perfectly fine and their body reacts normally. However, as a matter of fact, people with this variant of the gene just tend to drink much more soda and eat more desserts than other people. But if

they ate the same diets as other people, they would have the same rates of obesity as others.

NOW: Write about genetic and environmental causation in the context of these three stories. In each of the three cases, explain how these genes would contribute to the overall calculation of H^2. Are the genes part of the genetic causes of obesity if we follow the logic of the heritability studies? It should help you to think about twin studies in these cases. Is the answer the same in all three cases or are there any important differences? Do you think that these genes really are causing obesity in these cases?

You could answer these questions by discussing the three cases separately (or in two groups) or you could write one 'overall' discussion; but if you do that, make sure to talk about any relevant differences between the cases.

A heritability study would indicate strong genetic causation in all three cases because Vg is a significant portion of Vp. In other words, some people are obese and some are not and there are significant genetic difference between these groups.

In the case of story a), it is genetic and not environmental. Switching genes would change the outcome, changes environments would not. In the case of 2b and 2c, again we have genetic causation (identical twins will be more similar than fraternal twins) but whether or not we have high Ve will depend on what environments we are looking at. If some environments just don't a lot of food or treats available, then those individuals will not be obese. But if we think of varying the environment as being raised in a different home, then this environmental variation will not matter.

How should we use the term 'cause' here? One answer is that the heritability studies are right. All three cases are cases of genetic causation. Harden would likely agree – in all three cases, the genes are causing something (lower metabolism or overeating) which itself causes obesity. A different possible answer would focus on how easy is it to control your weight. In cases like 2c we are much more likely to blame the obese individual and say that it was within their power to be not obese. That would lead some people to say therefore this is not a cause of genetic causation. But I say that whether or not the genes are causally relevant here is prior to (or at least independent of) what we want to say about praise and blame.

3) Briefly describe how realistic you think different aspects of these stories are. Which parts of the preamble and the three possible stories are consistent with what you know (or believe) about obesity and which are not? For this part you will not be graded on how accurate your answer is, but just whether you actually answer the question.

Polderman et al. (2015) is a meta-analysis of 2,748 publications of twin studies published between 1958 and 2012. One of the most frequent traits examined in these studies is obesity (and other traits collectively referred to as "weight

maintenance functions"). This meta analysis estimates the heritability of these traits at $H^2 = 0.48$.

A number of genes have been discovered which are associated with obesity and in fact there are genes of all three kinds. There are variants of the gene that codes for leptin (LEP) and there are leptin receptor genes (LEPR). There are also genes that affect hunger such as the gene for Prader-Willi syndrome. Genes also are responsible for variation in self-reported taste for sugar. But here, the 'normal' variant of the gene is one that makes us crave sugar. One genetic variant makes people *less* interested in eating sugary foods.

So the three narratives are all realistic (actually it is all three at the same time plus more). What is not realistic is that the gene makes it 50 times more likely that you are obese. Numbers are unclear here but perhaps 20% of adults in the US are obese so even a gene that basically guaranteed that you were obese could only make it at most 5 times more likely that you are obese (since so many people with the gene are obese). This can change slightly if we are looking at more stringent criteria like morbid obesity.