

The Little Logic Book
Hardy, Ratzsch, Konyndyk De Young and Mellema
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Exercises for The Little Logic Book may be downloaded by the instructor as Word documents and then modified for distribution to students; or students may be instructed to download the exercises and then told which ones to answer. This is an exercise bank; it is not assumed that students will do all the exercises for any one chapter. Comments, questions or suggestions for Chapter Twelve of The Little Logic Book can be sent to logic@calvin.edu

Exercise Bank for Chapter Twelve:
Scientific Inference
(Posted June, 2014)

1.0 Basic Concepts

Define or identify the following:

- 1.1 Deductivism
- 1.2 Scientific realism
- 1.3 Scientific antirealism
- 1.4 Inductivism
- 1.5 Scientific theory
- 1.6 Hypothetico-deductivism
- 1.7 Underdetermination of theory by data
- 1.8 Falsificationism
- 1.9 Auxiliary theories
- 1.10 Methodological naturalism

2.0 Scientific Inference Basics

Indicate whether the following statements are true or false. Briefly explain your answer.

- 2.1 The empirical sciences prove their theories by deductive reasoning.
- 2.2 Once a scientific theory is proven, it's no longer just a theory.
- 2.3 Scientific theories are never proven, they are only more or less confirmed.
- 2.4 If science does not provide rigorous proof, then Christians can safely ignore science.
- 2.5 Typically, scientific theories are not based on simple observation.
- 2.6 For any data set, there are infinitely many possible explanatory theories compatible with that set.
- 2.7 A good theory is one that has been rigorously deduced from the data.
- 2.8 If a theory has always made true predictions, that shows that the theory is true.
- 2.9 No theory by itself makes any predictions whatever.
- 2.10 Scientific theories cannot be rigorously falsified.
- 2.11 One would think that certain values make scientific theories more likely to be true only on the basis of certain metaphysical views.
- 2.12 Even scientists themselves do not always agree on what constitutes good science.
- 2.13 It follows from the definition of science that science has nothing to do with religious belief.

3.0 Scientific Inference

- 3.1 In what ways are science and its results relevant to philosophy?
- 3.2 What did Aristotle mean by “induction”?
- 3.3 Why is simple observation an inadequate basis for the construction of scientific theories?
- 3.4 State at least two problems with the deductivist picture of scientific reasoning.
- 3.5 What is at issue in the debate between scientific realists and scientific antirealists?
- 3.6 Why does inductivism fail to work as an account of scientific reasoning?
- 3.7 Why is it that scientific theories cannot be conclusively proven true?
- 3.8 Why is it that scientific theories cannot be conclusively proven false?
- 3.9 Briefly explain how hypothetico-deductivism was supposed to keep human subjectivity out of science.
- 3.10 Name some of the factors besides a theory that are required in order to derive predictions by which that theory is to be tested.
- 3.11 Explain why scientists cannot avoid accepting and using epistemic values.
- 3.12 List some of the more important epistemic values employed by scientists.
- 3.13 Most people believe that scientific theories are more likely to be true if they exemplify such values as simplicity, accuracy, and the like. What are the underlying metaphysical bases for that belief? In the absence of such metaphysical bases, would we have any reason to think that those values had any connections to the truth? Why or why not?
- 3.14 What cautions must be kept in mind when applying epistemic values to theories?
- 3.15 What religious views have been employed to help us understand why science tracks the truth?

4.0 Some Cases to Think About

4.1 Science, Proof and Alternative Medicine

On July 9, 2013, Tom Ashcroft, NPR host of the show “On Point,” interviewed Dr. Paul A. Offit about the effectiveness of alternative medicine. Dr. Offit has just published a book highly critical of the alternative medicine industry entitled *Do You Believe in Magic: The Sense and Nonsense of Alternative Medicine*. Ashcroft commented that many people think that we would do well to listen to the ancient wisdom of eastern medicine. Maybe Dr. Offit was captive to the prejudices of the western medicine paradigm. Dr. Offit replied that he doesn’t put much stock in the distinction between eastern and western medicine. “To me,” he said, “it’s always about the scientific method. If you’re going to make a claim—a medical or scientific claim—you can prove that or not prove that in a scientific or medical study. So, that’s what I ask for here—just evidence.”

Dr. Offit’s view is very similar to a view published earlier in the *Journal of the American Medical Association* by P.B. Fontanarosa and G.D. Lundberg: “There is no alternative medicine. There is only scientifically proven, evidence-based medicine supported by solid data or unproven medicine, for which scientific evidence is lacking.” (JAMA 280 (1998): 1618-19.

Comment on Dr. Offit’s response to those who find some value in eastern medicine in light of the discussion of science and proof in the chapter on scientific inference. If you are sympathetic to his general view, how might you reformulate his point? If you are not sympathetic to his view, how would you criticize it?

4.2 Overeating and Obesity

“Are we fat because we overeat, or do we overeat because we’re fat?” This is the subtitle of an article that recently appeared *New York Times* Sunday Review section (May 18, 2014). A strong correlation between overeating and obesity has, of course, long been recognized. And for many years it just seemed obvious that overeating is the cause of obesity. But now some nutritional scientists are wondering if it’s not the other way around.

In the chapter on informal fallacies we warned against assuming the direction of causality, given some strong correlation. To determine the causal relation between two strongly correlated factors, we need a good causal theory, a good explanation of the correlation. We discussed what counts as a good explanation in the chapter on explanation. But sometimes we have competing explanations, in this case explanations that oppose each other on the issue of the direction of the causal relation. That brings us to the issue of deciding between competing explanations, of making an inference to the best explanation.

Here are the two competing theories.

The traditional theory: “For most of the last century, our understanding of the cause of obesity has been based on immutable physical law. Specifically, it’s the first law of thermodynamics, which dictates that energy can be neither created nor destroyed. When it comes to body weight, this means that calorie intake minus calorie expenditure equals calories stored. Surrounded by tempting foods, we overeat, consuming more calories than we can burn off, and the excess is deposited as fat. The simple solution is to exert will power and eat less.” (NYT Sunday Review, 1)

Here’s the alternative theory: “the more calories we lock away in fat tissue, the fewer there are circulating in the bloodstream to satisfy the body’s requirements. If we look at it this way, it’s a distribution problem: We have an abundance of calories, but they’re in the wrong place. As a result, the body needs to increase its intake. We get hungrier because we are getting fatter.” (Sunday Review, 6)

OK. But why are Americans getting fatter (obesity rates are three times what they were in the 1960s) if not simply through overeating; why are more calories being stored as fat? Many factors, say the proponents of the alternative theory, but chief among them is the increase in the insulin hormone brought about by highly processed foods. “We know that excess insulin treatment for diabetes causes weight gain, and insulin deficiency causes weight loss.” [This is an example of concomitant variation described in the chapter on Mill’s Methods.] “By this way of thinking, the increasing amount and processing of carbohydrates in the American diet has increased insulin levels, put fat cells into storage overdrive and elicited obesity-promoting biological responses [like overeating] in a large number of people.” (Sunday Review, 6)

So there are the two theories. We might wonder: Which one is better? Will experimental evidence incline us to one of them? Which one is more empirically adequate?

Here is one study cited in the article: “A recent study . . . examined 21 overweight and obese young adults after they had lost 10 to 15 percent of their body weight, on diets ranging from low fat to low carbohydrate. Despite consuming the same number of calories on each diet, subjects burned about 325 more calories per day on the low carbohydrate than on the low fat diet.”

Another study: “Rats fed a diet with rapidly digesting (called high “glycemic index”) carbohydrates [as are typically found in highly processed food] gained 71 percent more fat than their counterparts, who ate more calories over all, though in the form of slowing digesting carbohydrate.”

Yet there are other studies: “Several prominent clinical trials reported no difference in weight loss when comparing diets purportedly differing in protein, carbohydrate and fat.” However, say the author of the article, “these trial had a major limitations; at the end, subjects reported that they had not met the targets of complying with the prescribed diets. We wouldn’t discard a potentially lifesaving cancer treatment based on negative findings, if the research subjects didn’t take the drug as intended.” (Sunday Review, 6)

If the alternative theory is correct, we would focus less on calorie quantity and more on diet quality, reducing the amount of processed carbohydrates that trigger the insulin response. But to date the evidence seems inconclusive.

In this assignment comment on the empirical adequacy of the two theories given the experimental evidence cited above. Does the evidence favor one theory over the other? Is some or all inconclusive? Why should we think that rat experiments have any relevance for the study of human obesity? What kind of reason does the author give for not tossing out the alternative theory on the basis of several clinical trials that showed no difference in weight loss over varied diets? If the experiments and trials that might support the alternative theory have been poorly designed or executed, what kind of experiments and trials would be more helpful, more likely to provide stronger evidence one way or the other?

4.3 Science and Scripture

The Christian community once believed that Scripture (the Bible, in this case) taught that the earth was stationary and that the sun moved around the earth. After all, Psalm 104 states that God “set the earth on its foundations, so that it should never be moved”; and the sun, says Psalm 19, “runs its course with joy. Its rising is from the end of the heavens, and its circuit to the end of them.” But as scientific evidence accumulated in favor of the idea that the earth goes around the sun, the church eventually changed its views about what the Bible actually taught and concluded that in some cases scientific theories can even help us better understand what Scripture intends to teach, that it can give us some insight into how to interpret some parts of Scripture. But Christians currently disagree very strongly over whether evolutionary theory fits that category. What do you think, and why?

4.3 Your Shot at Fame

General Relativity and Quantum Mechanics have been known for decades to be mathematically inconsistent with each other in some applications. Up to this point, no one really knows how to reconcile them fully. Using the materials included in this logic text, demonstrate how that tension can be resolved. Show your work, then send it to the Nobel Prize committee in Oslo.