Remote Learning Module for 27 March 2020

Lecture Notes for Fernando Espinoza's *The Nature of Science,* Chapter 2

We noted last time how Western science begin with the *physikoi* (or, natural philosophers) who hailed from Miletus in Greek-speaking Ionia. Known as the Milesians, these early thinkers began with a simple enough naturalistic question: What *archē* (or principle) serves to account for the phenomena of *change,* on the one hand, and *multiplicity,* on the other hand. We then met the figure of Anaximander, who held in the face of paradox that this *archē* must be something absolutely infinite—something he called *tó aperion* (or, the boundless—what has no boundaries, no border). Today we'll delve further into the logic of paradoxes, looking for the mind tools we can use to resolve them.

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(0) The Paradox of Origins. Let's first refresh ourselves with the puzzle that confronted Anaximander. Recall that he was well aware that he was facing a paradox (two incompatible beliefs that appear equally warranted). We seem to have good reasons for the following two incompatible beliefs: (a) the universe must have had a beginning in time, and (b) the universe must be eternal (can have had no beginning). The reason for (a) is that from an infinite past the present moment we call *now* would never arrive, yet here we are; the reason for (b) is that if there were a beginning of the universe, there must have been a time when there was nothing at all, but from nothing, nothing ever comes.

(1) Resolving Paradoxes. Resolving a paradox involves giving reasons. Typically, such reasons will fall into one of three basic categories. Thus, we can resolve a paradox if:

(a) We can show that the paradox follows from *false assumptions*.

(b) We can show that *only one* of the apparently incompatible beliefs is warranted.

(c) We can show that the two beliefs are *actually compatible*.

Failing to accomplish one of a, b, or c will leave the paradox unresolved. This puts us in a similar position to the one we find ourselves in when we say of a scientific model that while the evidence for it is positive, that evidence is defeasible, so that we are left with the judgement: Inconclusive. Let's look at some examples of all three of these ways of resolving paradoxes.

(2) False Assumptions. When you were young, and first becoming acquainted with the counting numbers, you may have assumed that there must be a largest number. If so, you will have generated a paradox: suppose you gave the name, "gillion," to the largest number; but by adding one to a gillion, you then had a new and larger number, so it would have appeared that a gillion is both the largest number and not the largest number. Your assumption (that there is a largest number) was false, and once you noticed this, the paradox was resolved.

Here's another; this one is a little trickier. It comes from the philosopher Bertrand Russell, and is known as the Barber Paradox. Let us assume that there is a small mining town in Tennessee in which only adult males are living with a peculiar arrangement: there is a barber there who shaves all and only those men who do not shave themselves. It's a small town, so at first, the task seems plausible. But let's ask: Who shaves the barber? Here's the paradox: if the barber shaves himself, then he does not shave himself (because in this town the barber shaves *all and only* those who do not shave themselves), but for the same reason, if the barber does not shave himself, he must shave himself. So we have a paradoxical barber. We resolve the paradox in the very same way we concluded that there cannot be a largest number: there simply is no such barber; our assumption was false.

(3) Only one of the two beliefs is warranted. Let's consider the paradox of origins again. Remember how it seemed that if there was a beginning of the universe, there would have to have been at time at which there was nothing at all. Yet, this is exactly what the model we call the Big Bang says of the universe. Is the Big Bang paradoxical? Well, not if we take the General Theory of Relativity fully into account, which is to say, if we understand the manifold, or coordinate system, in which we find the universe to be four-dimensional (three dimensions of space and one of time), then the Big Bang represents the coming into being of both time and space at once: in the same way that there is no such thing as space *outside* the universe, there is no time *before* the universe. On analogy: asking what happened *before* the Big Bang is like asking: What's north of the North Pole? The proper answer to this latter question isn't: Nothing. The proper answer is that the question makes no sense. You might as well be asking: Do green ideas sleep furiously? Another example: Darwin's simple answer to the chicken-and-egg question: the egg must have come first; it can't have been the chicken; rather, some non-chicken must have laid the first egg. All it takes to see this is to understand the mechanisms whereby mutations can lead eventually to speciation.

(4) Both beliefs are compatible. Consider the apparently paradoxical claim: the sum of the interior angles of a triangle both do and do not equal 180º. We can easily resolve this paradox by noting that in flat space the interior angles do equal 180º, but do not in either parabolic or hyperbolic space. Here's another. It comes from one of the ancient Greek Sophists (rhetoricians or experts in public speaking—the ones Plato worried would undermine democracy by selling "unknown goods for the soul"). His name was Protagoras; his paradox was is often called the "Wind Argument." Protagoras asked his listeners to imagine two people walking along the sea shore, when one of them says, "It's rather chilly today," but the other responds, "Not at all, in fact, it's rather warm." Now, this would seem to imply that the wind is both hot and cold, both warm and chilly, which would seem to be incompatible states of affairs. Protagoras thought to resolve this paradox by asserting what we might call *relativism* about temperature. He did this by adopting a general principle of relativism about knowledge: each person is the measure of all things, he said, of those that are, that they are, and of those that are not, that they are not (yes, these Sophists were rather wordy, weren't they). In short, both beliefs are compatible: it's both warm and chilly, because temperature is relative to the individual, just as we often say, beauty is in the eye of the beholder.

(5) Unresolved Paradoxes. Here are two paradoxes that have resisted the efforts of mathematicians and logicians to resolve them satisfactorily.

The Berry Paradox: since the counting numbers are infinite, but the resources we have for naming them are finite, let us consider the following: “The least integer not nameable in fewer than nineteen syllables.” The sentence in quotation would seem to name some large number or other, but upon counting the syllables in this sentence, we find that this name has but eighteen syllables, so the least integer non nameable in fewer than nineteen syllables can be named in fewer than nineteen syllables; this is a contradiction.

The Grelling Paradox: this paradox has two parts. Here’s the first part: we can sort all the adjectives in natural languages like English, French, German, etc. into two categories:

(a) Adjectives that are instances of themselves, or describe themselves (some examples are “English,” which is, of course, an English word; “short,” which is a short word; and “polysyllabic,” which is a polysyllabic word). Let’s invent a new adjective for such words: *autological*, and let’s say it means “modifies itself.”

(b) Adjectives that are not instances of themselves, or do not describe or modify themselves (some examples might be “German,” which is not a German word; “long,” which is not a long word; and “monosyllabic,” which is not a monosyllabic word). Let’s invent a new adjective for such words: *heterological*, and let’s say it means “does not modify itself.”

Here’s the paradox proper: Let’s ask: is the adjective, “heterological” a self-modifier or a non-self-modifier (is “heterological” itself heterological or autological)? We are unfortunately left with the paradox that it is, if it isn’t, and it isn’t, if it is. If “heterological” were an instance of itself (if it were itself heterological), then it would be autological; but if it were autological (if it describes itself), then it must be heteroloical after all. Other than banning this adjective from our discourse, we have no resolution. But why ban it? After all, some adjectives are, and some are not, instances of themselves, as we saw in the first part of this paradox.

(6) Fallacies. Sometimes simple errors in reasoning can appear in the guise of paradoxes when they are in fact just bad reasoning. One example is called the “Gambler’s Fallacy,” which supposes that when flipping a fair coin, since the odds are 50/50, heads will soon follow tails. Why is this reasoning fallacious? Because it confuses *compensation* with *swamping*. Another way to see this is to note that the 50/50 ratio only obeys the law of averages for a fair coin at infinity. Since we’ll not ever flip a coin infinitely many times, the best we can do is rely on the law of large numbers: the more times we flip the coin, the closer the *overall ratio* will approach 50/50. The law of large numbers works by swamping, not compensation. There’s an underlying conceptual error in the fallacy too: thinking (falsely) that causes have memories.

(7) The Paradox of the Pop Quiz. Consider the following scenario.

Teacher: One day this week, class, I will give you a pop quiz *but* you will not it until that day.

Student A: It can’t be Friday, or we will know that Friday is pop quiz day.

Student B: But then it can't be Thursday either, since, having ruled out Friday, we will know on Thursday that it is pop quiz day.

Student C: But this reasoning goes for the rest of the week as well, so the pop quiz is impossible.

Teacher (on Wednesday): Good morning, students. Today is Wednesday; we shall now have a quiz.

Now, let's ask: What error in reasoning did all three of these students make?

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Next week, we'll turn our attention to another important *mind tool* devised by the ancient Greeks: the idea of *mathematical proof*. And we'll also consider the remaining material in Chapter 2, about the Origins of Accomplishing Tasks. Be well everyone, and remember: social distancing saves lives, which is presumably why we are still not in JUB 202 presently.