

## Remote Learning Module for 29 April 2020

Lecture Notes for Fernando Espinoza's *The Nature of Science*, Chapters 11 & 12

### — Einstein's Epistemology —

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Last time we turned our attention to the figure of Charles Darwin, whom we met early in our semester in Ron Giere's book, *Understanding Scientific Reasoning*. First, we reviewed some considerations about Darwin's role in the history of biology; then we briefly took stock of his biography; and finally, we examined the five theories he advanced in *On the Origin of Species*. Today, for our last day of the term, we'll take a short look at how the towering figure of Albert Einstein came to understand the relation between logic, mathematics, and science.

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Einstein had a lot to say about the “unreasonable effectiveness of math.” He once noted that “the amazing thing is that nature actually obeys our intuitions.” Many commentators have thought that Einstein changed his mind about the epistemic status of mathematical judgments between 1920 and 1933. In 1920, we find Einstein contending about physics, that the “justification for a physical concept lies exclusively in its clear and unambiguous relation to facts that can be experienced.” But in 1933, he writes: “The axiomatic basis of theoretical physics cannot be extracted from experience, but must be freely invented ... the creative principle resides in the mathematics.” Einstein's mature view was not, however, in direct conflict with his positivist proclivities in the earlier 1920 paper. Let's look a little further into his thinking, then.

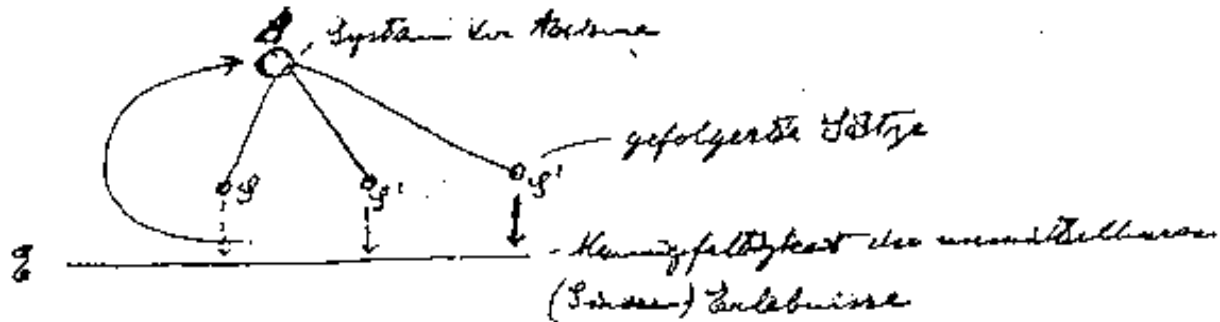
Einstein's mature epistemological views appear most clearly in his essays, “On the Method of Theoretical Physics” (1933), “Physics and Reality” (1936), and “Autobiographical Notes” (finished in 1946). The 1946 paper is of especial historical significance because it provides several important clues as to Einstein's own sense of intellectual lineage. For example, after articulating his general view as follows,

A proposition is correct if, within a logical system, it is deduced according to the accepted logical rules. A system has truth-content according to the certainty and completeness of its co-ordination-possibility to the totality of experience. A correct proposition borrows its “truth” from the truth-content of the system to which it belongs.

Einstein adds

A remark to the historical development. Hume saw clearly that certain concepts, as for example that of causality, cannot be deduced from the material of experience by logical methods. Kant, thoroughly convinced of the indispensability of certain concepts, took them—just as they are selected—to be the necessary premises of every kind of thinking and differentiated them from concepts of empirical origin. I am convinced, however, that this differentiation is erroneous, i.e., that it does not do justice to the problem in a natural way. All concepts, even those which are closest to experience, are from the point of view of logic freely chosen conventions, just as in the case with the concept of causality, with which this problematic concerned itself in the first instance.

The full flavor of Einstein’s neo-Kantian account of scientific reasoning is perhaps nowhere more clearly presented, however, than in a letter (written on 7 May 1952) to his longtime friend, Maruice Solovine. He says: “I view such matters schematically thus [Einstein’s drawing follows]



- (1) The *E* (experiences) are given to us [represented by the horizontal line along the bottom of the figure].
  - (2) *A* are the axioms, from which we draw consequences. Psychologically the *A* rest upon the *E*. There exists, however, no logical path from the *E* to the *A*, but only an intuitive (psychological) connection which is always “subject to revocation.”
  - (3) From the *A*, by a logical route, are deduced the particular assertions *S*, which deductions may lay claim to being correct.
  - (4) The *S* are referred to the *E* (test against experience). This procedure, to be exact, also belongs to the extra-logical (intuitive) sphere, because the relations between the concepts that appear in *S* and the experiences *E* are not of a logical nature.
- These relations of the *S* to the *E*, however, are (pragmatically) much less uncertain than the relations of the *A* to the *E*. . . . If such correspondence were not obtainable with great certainty (even if not logically graspable), the logical machinery would be without any value for the comprehension of reality (example, theology).
- The quintessence is the externally problematic connection between the world of ideas and that of experience.

In this account, we can see that, for Einstein, the logical machinery can be of value (physics) or not (theology). In this regard, Einstein reminds us that our models of the real world are just that—models. As for the Universe itself, well, it just goes on being whatever happens while we go about the business of building and testing our theories.

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Today is the last day of this remarkable semester. If you are enrolled in the MTeach Program, your Lesson Plans are due today. Everyone should have received final exam instructions on Monday; do be sure to return them via email on or before Friday, 1 May, if at all possible. If you have trouble meeting that due date, let me know. Be well everyone; stay safe, stay strong, and stay put. Let us continue to nurture our immune systems in the days and weeks ahead.