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The Predictive Power of Successful Scientific Theories: An Explanatory Study on Their Substantive Ontologies through Theoretical Change

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Abstract : Debates on realism in science concern two different questions: (I) whether the unobservable entities posited by theories can be known; and (II) whether any knowledge we have of them is objective or not. Question (I) arises from the doubt that since observation is the basis of all our factual knowledge, unobservable entities cannot be known. Question (II) arises from the doubt that since scientific representations are inextricably laden with the subjective, idiosyncratic, and a priori features of human cognition and scientific practice, they cannot convey any reliable information on how their objects are in themselves. A way of understanding scientific realism (SR) is through three lines of inquiry: ontological, semantic, and epistemological. Ontologically, scientific realism asserts the existence of a world independent of human mind. Semantically, scientific realism assumes that theoretical claims about reality show truth values and, thus, should be construed literally. Epistemologically, scientific realism believes that theoretical claims offer us knowledge of the world. Nowadays, the literature on scientific realism has proceeded rather far beyond the realism versus antirealism debate. This stance represents a middle-ground position between the two according to which science can attain justified true beliefs concerning relational facts about the unobservable realm but cannot attain justified true beliefs concerning the intrinsic nature of any objects occupying that realm. That is, the structural content of scientific theories about the unobservable can be known, but facts about the intrinsic nature of the entities that figure as place-holders in those structures cannot be known. There are two possible versions of SR: Epistemological Structural Realism (ESR) and Ontic Structural Realism (OSR). On ESR, an agnostic stance is preserved with respect to the natures of unobservable entities, but the possibility of knowing the relations obtaining between those entities is affirmed. OSR includes the rather striking claim that when it comes to the unobservables theorized about within fundamental physics, relations exist, but objects do not. Focusing on ESR, questions arise concerning its ability to explain the empirical success of a theory. Empirical success certainly involves predictive success, and predictive success implies a theory's power to make accurate predictions. But a theory's power to make any predictions at all seems to derive precisely from its core axioms or laws concerning unobservable entities and mechanisms, and not simply the sort of structural relations often expressed in equations. The specific challenge to ESR concerns its ability to explain the explanatory and predictive power of successful theories without appealing to their substantive ontologies, which are often not preserved by their successors. The response to this challenge will depend on the various and subtle different versions of ESR and OSR stances, which show a sort of progression through eliminativist OSR to moderate OSR of gradual increase in the ontological status accorded to objects. Knowing the relations between unobserved entities is methodologically identical to assert that these relations between unobserved entities exist.

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