David J. Stump. *Conceptual Change and the Philosophy of Science: Alternative Interpretations of the A Priori*. Routledge 2015. 176 pp. $145.00 USD (Hardcover ISBN 9781138890138).

Some parts of the scientific edifice are so fixed that nobody dares to question them so long as there is some other less hardened part that can be challenged instead. Some may be tempted to grant such parts the status of a priori knowledge, yet the problem remains that scientific theories and concepts are fallible and dynamically in change. In his impressive and provocative book, David Stump considers these constitutive elements of science, those which are no longer considered a priori, yet play a pre-conditioning role for scientific practice. From the title, we might expect a discourse on conceptual change; however, this expectation is not fully satisfied, since the emphasis is on the sub-title, the a priori.

The book provides a long survey of theories of the constitutive elements of science (CES), from their first appearance to the writer's new and provocative claim. Modern understandings of a priori knowledge reach back to Kant, who considered such knowledge to be necessary and unrevisable. However, philosophers including Reichenbach, Pap and Friedman have promoted the idea of a dynamic (or pragmatic) and relativized a priori. On such accounts, some elements of our knowledge function as the precondition of any scientific enquiry; however, these elements lack the stability that Kant attached to a priori knowledge. Due to this major difference, Stump is more inclined to describe these elements as CES, not a priori. Stump's final claim in this book is that his account of CES can explain conceptual change through scientific revolutions.

After an important introduction which summarizes Stump's proposal, Chapter 2 reports a case of change in what had previously been thought to be a priori. The main goal is to show that geometry is reinvented by means of becoming a formal science. In this vein, Stump criticizes the standard accounts of the history of new geometry that link the development of geometry to the formation of mathematical logic and foundational issues of mathematics. For Stump, the motivation for formalization and the study of foundations of mathematics is the set-theoretical paradoxes, not the advent of non-Euclidean geometry. He does not, however, deny the significance of this historical understanding, which ultimately led to the conventional accounts of geometry (e.g., Poincaré).

In the third chapter, Stump identifies Poincaré's conventionalism as the starting point of the idea of a functional a priori. Poincaré's philosophy has been seen as an inconsistent mixture that combines a traditional fixed a priori in some arithmetic principles, with a conventional a priori in geometry and the physical sciences. However, Stump argues that Poincaré's philosophy is indeed consistent, despite some empirical and philosophical mistakes. Accordingly, there is an epistemological distinction between the conventionality of principles and conventionality of metric geometry, which can be drawn by means of the objects they refer to. Despite some objections to Poincaré, Stump is happy to accept Poincaré's insight that some empirical elements of science become conventionally true and are 'erected' into principles.

Still there is no sign of conceptual change and the survey of the dynamic a priori continues until Chapter 7. After Poincaré, the discussion continues with four well-known empiricist philosophers who have usually been considered as rejecting synthetic a priori knowledge: Schlick, Reichenbach, Carnap and Ayer. Reichenbach and Carnap are the more suitable cases for the author's aim in this book. Reichenbach draws a distinction between a sense of the a priori as necessary and permanent, and as a constituent object of knowledge. The distinction attracts Stump's attention, since it is a starting point to making them completely distinct. Although Reichenbach's opinion regarding

the nature of a priori knowledge changed through his interactions with Schlick, Stump believes that it is fair to call him the first to have *discovered* the dynamic nature of the a priori (77). Carnap, on the other hand, takes a reverse path, from a received idea of synthetic a priori to a dynamic account. He distinguished the logical and the physical parts of scientific language, where the former is analytic and conventional and the latter synthetic and empirical. Thus, following other scholars, Stump describes him as having 'made the most significant contribution to the development of…[a] relativized a priori' (82).

In Chapter 5, Stump tries to open up an alternative to logical empiricism's image of the a priori and prepare the stage for his account of CES. This chapter is, again, mostly written in a review format with few controversial contributions to the debate. The main focus is on three neo-Kantian philosophers—Cassirer, Lewis and Pap—who were aware of the weaknesses of the classical Kantian account of the a priori but still had some commitment to it.

Stump's reading of Cassirer is based on recent studies that interpret him as believing in two kinds of a priori, the first fixed and universal and the second historical. According to Cassirer, although there is some fixed knowledge—such as Group Theory—that enables our scientific enquiries, other parts that seem a priori are in fact functional, such as metric geometry. Believing in the latter kind of a priori made Cassirer an interesting figure in this book, and deserving of being called 'the grandfather of the dynamic a priori' (91). Lewis, similarly, divides a priori knowledge into three different areas, namely logic, propositions true by definition, and some basic principles in science, all of them more or less changeable in practical situations. Logical principles are the most robust element of the a priori, having nothing to say about the external world, yet they are not immune to change in case they fail pragmatic tests.

The figure who has the strongest influence on Stump in this debate is Arthur Pap. Pap has the most explicit ideas on the functional account of the a priori, as is clear from his roots in pragmatism and neo-Kantian thought. Pap asserts that some empirical knowledge can be erected into a priori knowledge depending on context. A functional a priori, for Pap, is neither empirical nor known intuitionally or analytically. For example, Newtonian principles, which are neither empirical nor true by definition, hardened after a while and became constituent parts of further scientific research.

In Chapter 6, Stump takes Newton's Laws as a famous case of knowledge with an unstable epistemological status. He shows that they were first proposed as empirical generalizations but later become CES in a way that, without them, the laws of gravitation and other parts of mechanics could not work. Stump's idea of changing epistemic status differs from the one defended by Quine (becoming the hard core of the web of beliefs), because in Stump's account CES are not only hardened but act as pre-conditions of other statements; without them, other scientific statements cannot be understood. Quine believed that the core knowledge is entrenched and consists of statements that have been around for long time, accepted by everyone in the community. Neither of these conditions are accepted by CES theorists.

Stump's main contribution to the conceptual change debate starts in chapter 7, where he finds the roots of a CES theory in Kuhn and Hacking. After a short introduction to Kuhn's argument in *Structure*, Stump shows that Kuhn's notion of paradigm, the system which enables scientists to study and conduct their experiments, has close connections with an account of CES. It is when some of the CES change that scientific revolutions take place. Stump argues that the elements of a Kuhnian paradigm, such as methods, aims, ontology, lexicon and so on, 'are functionally a priori in the sense of

being necessary preconditions' (140). In a general way, Stump defines (fundamental) conceptual change in science as a change in the epistemological status of CES (the ones which are preconditions to scientific practice) (132).

Stump ends his book by giving a framework for what he has done throughout the book. He focuses on an important consequence of a CES theory, which is an explanation of conceptual change in scientific revolutions. Conceptual change occurs when 'there is a change in what had been taken to be a priori knowledge' (166). In other words, conceptual change takes place because the fundamental elements of science, which enable scientific practice, change. These fundamental elements can be interpreted as a priori knowledge, as Kant did for example, or as constitutive elements, the view which Stump himself advocates.

There are, however, two areas in which Stump needs to provide more information. First, it is not clear what conceptual change means for Stump. Stump seems committed to the following statement:

(S) Conceptual change occurs when fundamental principles of science or CES change.

When these hardened (a priori) elements of science change, the framework and practice of concepts experience substantive change that leads to conceptual change. It seems clear that change in CES leads to conceptual change; yet still (S) seems incomplete. Conceptual change, as I understand it, includes changes in single concepts due to minor changes or incremental progress in science; it is not the case that conceptual change occurs only in scientific revolutions or in the course of major scientific change. Thus, CES change cannot be used as a complete explanation of conceptual change. Stump's usage of conceptual change applies better to what Davidson (1973) called conceptual scheme change, in which the justification of a group of concepts is called into question. However, Stump argues that in the course of change, what is called into question is not the truthfulness of a statement, but the very existence or comprehensibility of a statement. Thus, his usage seems even more general than Davidson's.

Second, it is not quite clear what is being referred to in the notion of the constitutive *elements* of science. It is supposed that these elements are of knowledge-kind (traditionally defined as justified true beliefs). This is because Stump substitutes CES with Kantian a priori knowledge. Another idea, however, is that these elements are of paradigm-kind. He emphasizes that 'the elements of paradigm—methods, aims, ontology, lexicon and so on' are functionally a priori (140). The reasons for this interpretation are first that he reads Kuhn as a CES theorist; and second, when he explains Newtonian revolutions, he points out that what changes from Aristotelian to Newtonian physics is the question of whether constant movement or stability requires explanation. I am quite dubious that such questions are of the knowledge-kind. Another difficulty for the nature of these elements relates to the previous concern. Conceptual change includes cases in which nothing changes except the values and aims of scientists—Brigandt (2006) reports some such cases (e.g., gene and homology). Again, goals are not of knowledge-kind. Therefore, the burden is on Stump to clarify what he means by constitutive *elements*.

Overall, this book presents a complete survey of the history of the functional a priori, or CES, in a concise way. It is recommended reading for researchers who are interested in novel pragmatic approaches to traditional accounts of a priori knowledge. They will find much that is fruitful therein.

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