

# Theories: Tools versus models<sup>☆</sup>

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## Abstract

In “The Toolbox of Science” (1995) together with Towfic Shomar we advocated a form of instrumentalism about scientific theories. We separately developed this view further in a number of subsequent works. Steven French, James Ladyman, Otavio Bueno and Newton Da Costa (FLBD) have since written at least eight papers and a book criticising our work. Here we defend ourselves. First we explain what we mean in denying that models derive from theory—and why their failure to do so should be lamented. Second we defend our use of the London model of superconductivity as an example. Third we point out both advantages and weaknesses of FLBD’s techniques in comparison to traditional Anglophone versions of the semantic conception. Fourth we show that FLBD’s version of the semantic conception has not been applied to our case study. We conclude by raising doubts about FLBD’s overall project.

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## 1. Introduction

In 1994 the two of us together with Towfic Shomar wrote a brief position paper, “The Toolbox of Science”,<sup>1</sup> advocating an instrumentalist view of theory: a good theory is not

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<sup>1</sup>Cartwright, Shomar, & Suárez (1995); this paper is hereafter referred to as “The Toolbox”, or following French & Ladyman (1997) as “CSS”.

primarily a collection of models (nor of claims) that cover the phenomena in its domain. When it comes to models of phenomena, theory is rather a tool for their construction.

The bulk of “The Toolbox” is an example from early attempts to understand superconductivity—a model by Fritz and Heinz London. The example was further developed by one of us, who described its epistemological implications in greater detail (Suárez, 1995, 1997, 1999). Previous models had successfully treated the resistanceless flow characteristic of superconductivity but they were stymied by the discovery of the Meissner effect—the expulsion of electromagnetic flux when superconducting materials pass the critical temperature. The Londons deployed electromagnetic theory, taking the old models that treated superconductors as ferromagnets and shifting the analogy to think of superconductors as diamagnets. They borrowed equations from the old model—just enough to keep resistanceless flow—but left behind those from which the borrowed equations were originally derived, added features in accord with the new analogy, and at last accounted for both resistanceless flow and the Meissner effect in a single treatment. Here was an exciting piece of scientific advance, a powerful new model that could do what could not be done within the old models. Theory served to help construct the new model but the model, and the accompanying claims about superconductivity and its sources, were not already there contained in the theory—perhaps only in some highly abstract form—waiting to be extracted.

Steven French and his collaborators, James Ladyman, Otávio Bueno and Newton Da Costa (hereafter FLBD) have since published at least eight papers and one book containing attacks on our claims and comments on this case study, which includes two extended discussions in this journal (French & Ladyman, 1997, 1998, 1999; Bueno, 1997; Da Costa & French, 2000, 2003; Ladyman, 1998, 2002, pp. 257–260; French, 1999; Bueno, French, & Ladyman, 2002). For our defence we turn in part to FLBD themselves. What they say about the case is consistent with our account and in particular shares the features that matter for our argument. Moreover their own development of the semantic conception of theories—if it were to do what is advertised for it—shows one way that theories can function as tools.

What is at stake in our case study is a kind of piecemeal borrowing from an old model of superconductivity to the new London model; borrowing that takes some assumptions but leaves others behind. FLBD claim that our description of the early model—or of classical electromagnetic theory into which it fits—as a “tool” for the construction of the new model is mistaken, and that their alternative in terms of partial relations fits the case study much better. We shall argue that, contrary to what FLBD say, our description is correct; and that moreover there is no reason to think the partial relations approach, if it could be successfully applied, would contradict our description. But we shall also argue that the partial structures approach has not, after all, been applied to this case study and that there seems no straightforward way to apply it to do the jobs demanded.

In Section 2 we explain and defend our main doctrine in “The Toolbox”, namely that successful model building is generally non-theory driven. Section 3 reviews the specific case of the London model and finds nothing in FLBD’s account that contradicts our own. Section 4 describes FLBD’s account of the relations among models in terms of partial structures and points out that this is in principle not incompatible with our instrumentalism. However, in Section 5 we show that the FLBD approach has not been applied to the relevant features of the case study, contrary to what they claim. In Section 6,

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