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Partial reference, scientific realism and possible worlds

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ABSTRACT

Theories of partial reference have been developed in order to retrospectively interpret rather stubborn past scientific theories like Newtonian dynamics and the phlogiston theory in a realist way, i.e., as approximately true. This is done by allowing for a term to refer to more than one entity at the same time and by providing semantic structures that determine the truth values of sentences containing partially referring terms. Two versions of theories of partial reference will be presented, a conjunctive (by Hartry Field, 1973) and a disjunctive one (by Christina McLeish, 2006). In this paper, I will analyze them with regard to modal and epistemic aspects of those theories. It will be argued that a) theories of partial reference are (surprisingly) compatible with the rigidity of natural kind terms but face a weaker form of the so called "no-failures-of-reference-problem" and b) that the disjunctive account of partial reference suffers from a serious weakness: the impossibility of discriminating between descriptions that fix the reference of a term and those merely associated with it leads to the unacceptable result that past scientific theories containing such partially referring terms will come out as epistemically necessary, i.e., as a priori true.

1. What is partial reference?

Theories of partial reference were developed in order to defend scientific realism. In the following section, I will give a very brief introduction to the discussion of why theories of reference are considered at all when it comes to scientific realism. Following that, I will introduce two theories of partial reference in detail. The first one derives from Hartry Field (1973), the second one from Christina McLeish (2006).

One of the tenets of scientific realism is the presence of a constant progress in the sciences. Scientific theories do not exist in isolation, constructing their own worlds populated with different entities, but are related to each other in sometimes very subtle but still real ways: our theories improve continuously (they are converging on the truth). An intuitively plausible thesis would be to think that for a theory A to be better than a theory B, at least presupposes that A and B apply to one common domain. But this is what advocates of the pessimistic meta-induction maintain cannot be shown: past scientists were unable to formulate true statements because they used theoretical terms that do not refer. If there is no referential success, it is almost impossible to decide whether two theories apply to one common domain, as it is unclear what the theories are *about*. Without referential success it cannot even be shown that they apply to any domain at all. Hence there is no progress and realism fails.

The realist is now in a precarious position. On the one hand, she wants to admit that our current scientific theories are—if at all—the only true ones and that (most) past scientific theories are clearly false. On the other hand, she wants to serve the intuition that many past scientists contributed to the progress of scientific theorizing, despite the lack of an adequate language. One way out of this dilemma is to state that many past theories are false only in the sense that they are *approximately true*.[1] To argue for their approximate truth, many scientific realists argue for the necessity of searching for an adequate reconstruction of the superseded language, i.e., an interpretation that allows for the *referential success* of some of the key terms of the refuted theory. It is exactly this *semantic* version of scientific realism that is considered in this paper:

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that some statements of past scientists were true because they used terms that refer to existing entities.

For a long time realist philosophers assumed they had found an appealing answer to the pessimist in the causal theory of reference developed by Kripke and Putnam. The central tenet of the causal theory of reference, and semantic externalism, is to make referential success dependent on *matters of fact*: there are facts independent of the internal states of speakers that determine the denotation of certain terms (because we can refer to these facts in a causal way). This implies—and this is the crucial point—that two speakers are able to speak about the same entity (or matter, or physical quantity etc.), even if they are actually mistaken about the relevant properties. Even if two (or more) theories are wrong altogether, they can apply to the same domain: if the central terms are causally linked to the same entities. This provides the theoretical ground to further render some of their statements as approximately true (rather than just false).

However, it turns out that the (pure) causal theory of reference is rather implausible as a tool for the reconstruction of past (scientific) languages. This is so for the following reason: if a retrospective analysis of the terminology of a past scientific theory successfully determines an entity as the causal source of the introduction of a term, then this causal source will determine the referent of every single usage of the term. Thus, the term refers rigidly to the same entity or does not refer at all. The problem with this is that *usually* there is a certain phenomenon responsible for the introduction of a term. Hence it becomes very hard to justify referential *failure*. In the literature, this is often called the "no failures of reference problem" because the causal theory of reference seems to secure referential success too easily.[2] Even in the cases in which no determinate causal source for the usage of a given term can be identified, the causal theory of reference faces problems. Either the reference has to be totally denied or, if it is an interesting theory, extensive (and often contra- intuitive) analysis of the beliefs and intentions of the involved speakers are necessary. [3] This illustrates that the causal theory of reference needs modification. Theories of *partial reference* offer such refinements.

The first theory of partial reference was set out by Hartry Field.[4] He developed a broad account on which the reference of certain terms is indeterminate because those terms refer to different entities *at the same time*. The crucial point in his account is the thesis that this referential indetermination does not necessarily imply that the truth value of a sentence containing these terms is also indeterminate. Although a term can partially refer to more than one entity and is hence referentially indeterminate, a sentence containing this term can still be determinately true or false.

According to Field, the reference of many past scientific terms is indeterminate because there is no *matter of the fact* that could determine what they denote or what their extension is. His prime example is the replacement of Newtonian dynamics by the special theory of relativity, especially by the substitution of the term "mass". Field argues that in Newtonian dynamics there is no determinate answer to what the term "mass" denotes because two different but totally equal interpretations are available.[5] He formulates them in the following way[6]:

(R) Newton's word "mass" denoted relativistic mass, i.e., it denoted *total energy*/c^2 (c = speed of light).
(P) Newton's word "mass" denoted proper mass, i.e., it denoted *non-kinetic energy*/c^2.

The crucial point in Field's argumentation now rests on the observation that it is not decidable whether (R) or (P) is correct: there are no facts of the matter as to whether Newton meant relativistic mass, or proper mass when he uttered the word "mass". Hence, "mass" out of Newton's mouth is referentially indeterminate. But this does not imply that "mass" did not have a denotation.

There are simply two possible referents, which *both* fulfill the criteria of being the denotation of "mass."

We should briefly take a look at Field's argument for why (R) and (P) are equally plausible. For this it is necessary to consider two central tenets of Newtonian dynamics[7]:

(M) Momentum = mass × velocity
(F) For any two frames of reference, mass with respect to frame 2 = mass with respect to frame 1.

According to theory of relativity the *conjunction* of (M) and (F) cannot be correct as it implies that the momentum of a particle (divided by its velocity) does not depend on a given frame of reference. But the theory of relativity conveys the opposite: the momentum of a particle (divided by its velocity) may vary between two frames of reference. Hence, Newton was wrong in believing both (M) and (F). What does this tell us? If (R) and (P) are the most plausible interpretations of Newton's usage of the term "mass", then all we can do is to identify the conjunction of (M) and (P) as false. But we cannot decide which of the single conjuncts is true and which is false because (R) and (P) are equally justified (simply because (M) and (F) are equally important for Newtonian dynamics). According to Field, this implies that there are no facts of the matter regarding what the term "mass" denotes when Newton uttered it.[8]

The given situation is as follows: it is not plausible to render one of the referential hypotheses—(R) or (P)—as true and the other as false because this is perfectly indeterminate. If Field is right and every other alternative to (R) and (P) fails, then there is no coherent way to explain what Newton was referring to when he said "mass". But if we still want to maintain that Newton sometimes uttered *true* statements when he was using the term "mass"—and also that he was determinately wrong in some cases—then these truth values cannot be explained over his referential success, because what Newton was referring to is indeterminate. The burden of proof now clearly lies on the realist side: if she wants to maintain that Newton sometimes uttered true statements, she presupposes that there are sentences that have determinate truth values although they contain referentially indeterminate terms. But this claim contradicts the standard account of referential semantics. In order to explain this discrepancy, the realist needs a semantics that deals appropriately with referential indeterminacy. Here the theory of partial reference comes into play.

Field suggests establishing relations of partial reference to dissolve the discrepancy between truth values and referential indeterminacy: he states that Newton's "mass" partially referred to relativistic mass *and* partially referred to proper mass. "Mass" partially referred to both physical quantities but it did not denote one of them determinately. According to this view, singular terms can denote more than one entity and theoretical terms like "mass" can denote more than one physical quantity. With these assumptions at hand, Field formulates a new referential hypothesis about Newton[9]:

(PR) Newton's "mass" partially denoted proper mass and partially denoted relativistic mass (and did not partially denote anything else).

This implies that there are two physical quantities, which both have an impact on the truth values of Newton's utterances containing the term "mass". Let us take a closer look at the following[10]:

(S1) Mass is independent of the frame of reference.