Carnap's Unchanging Correspondence Rules —Summary—

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Abstract

The received view on the development of the correspondence rules in Carnap's philosophy of science is that at first, Carnap assumed the explicit definability of all theoretical terms in observational terms and later weakened this assumption. In the end, he conjectured that all observational terms can be explicitly defined in in theoretical terms, but not vice versa. I argue that from the very beginning, Carnap held this last view, albeit at times in contradiction to his professed position. To establish this point I argue that, first, Carnap's 'Über die Aufgabe der Physik' is a contribution to the philosophy of science of logical empiricism, contrary to Thomas Mohrmann and in agreement with Herbert Feigl. Second, Michael Friedman misinterprets the 'Aufgabe' with his claim that it describes a method to arrive at explicit definitions for theoretical terms.

1 Introduction

In his autobiography, Carnap (1963, § 9) describes how the explicit definability of all theoretical terms in observational terms, as it was claimed in *Der logische Aufbau der Welt*[1] (Carnap 1928), was successively weakened in later publications on the logical empiricists' conception of scientific theories. My point in the following will be that Carnap's final conception of the relation between theoretical and observational terms was already present in his earliest writings on the structure of scientific theories.

2 The explicit definability of observational terms

With respect to the interpretation of scientific terms, Carnap (1963, § 9) describes the development of logical empiricism as a gradual liberalization. According to the *Aufbau*, § 35, "the

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[1]The Logical Construction of the World

concepts of science are explicitly definable on the basis of observation concepts" (Carnap 1963, 59), but soon Carnap (1936, 1937) relaxes the demand. Instead, he suggests that new terms should be introduced by pairs of reduction sentences, that is, one necessary and one sufficient condition for the new term.

In the *Foundations of Logic and Mathematics* (1939), Carnap discusses two methods of constructing a scientific language. One starts with observable terms and introduces successively more abstract ones through reduction sentences. The other method starts with theoretical terms and introduces successively less abstract and finally observable ones. Here, Carnap states, "it seems at present" that explicit definitions of all terms are possible (206).

Philosophical Foundations of Physics: An Introduction to the Philosophy of Science (Carnap 1966) provides a glimpse at what Carnap considers core issues in the philosophy of science and his mature view on scientific theories. The two longest parts in the *Introduction*, about concept formation in the sciences and the structure of space, put a strong emphasis on the conventional elements in these constructions. The conventions are typically chosen, Carnap states, so that the resulting laws are as simple as possible. The third longest part, on the structure of scientific theories, relies on the bipartition of the vocabulary into an observational and a theoretical part and the connection of the two via correspondence rules. Carnap repeats the claim that the correspondence rules may consist of explicit definitions for all observational terms in theoretical terms, but not vice versa (234), and gives two examples for correspondence rules (233)

> "If there is an electromagnetic oscillation of a specified frequency, then there is a visible greenish-blue color of a certain hue". [. . .]
>
> "The temperature (measured by a thermometer, and therefore, an observable in the wider sense explained earlier) of a gas is proportional to the mean kinetic energy of its molecules".

In the next section, I will elucidate the relation of this view on correspondence rules to Carnap's earlier works.

3 The one-many relation between phenomenal and physical states

Feigl (1970, 3) cites Carnap's article 'Über die Aufgabe der Physik und die Anwendung des Grundsatzes der Einfachstheit'[2] as his first exposition of the logical empiricist's view of scientific theories. Mohrmann (2007, 159, n. 13) criticizes this classification:

> Feigl once went so far to trace back the essentials of the Logical Empiricist account of empirical theories to an early (pre-Vienna) paper of Carnap that may well be classified as belonging to his neo-Kantian period [. . .]. This stance betrays, to

[2] 'On the task of physics and the application of the principle of maximal simplicity'

> put it mildly, that Feigl did not pay too much attention to the amendments that had taken place since then.

Contrary to Mohrmann, there are good reasons to consider the 'Aufgabe' a contribution to logical empiricism's view of theories. For one, Mohrmann's claim of a discontinuity rests on the text's belonging to Carnap's neo-Kantian period, but even if Carnap wrote the article while holding neo-Kantian views, this does not mean that they are manifest in the article. When Carnap (1963, 4, 12) himself discusses the influence of Kant's views on his work, he mentions his doctoral dissertation (Carnap 1922) but not the 'Aufgabe'. As influences on the 'Aufgabe', Carnap rather lists Hugo Dingler, Poincaré, Hilbert, and Duhem (15, 77f).

Carnap also begins part II, § 13, of his autobiography, entitled 'The Theoretical Language', with the 'Aufgabe' and continues to *Logic & Mathematics*. Since each section of part II deals with "a certain problem or complex of problems" (Carnap 1963, 44), Carnap himself considers the 'Aufgabe' a starting point of the development that led to one of his core articles on scientific theories.

Furthermore, Carnap (1963, 15) summarizes the 'Aufgabe' already in the terminology of the *Introduction*:

> I imagined the ideal system of physics as consisting of three volumes: The first was to contain the basic physical laws, represented as a formal axiom system; the second to contain the phenomenal-physical dictionary, that is to say, the rules of correspondence between observable qualities and physical magnitudes; the third to contain descriptions of the physical state of the universe for two arbitrary time points. From these descriptions, together with the laws contained in the first volume, the state of the world for any other time-point would be deducible [. . .], and from this result, with the help of the rules of correspondence, the qualities could be derived which are observable at any position in space and time.

In the 'Aufgabe' itself, Carnap (1923, § I, all emphases removed, all translations are mine) also introduces his main point with a reference to Poincaré and Dingler, but not Kant:

> The main thesis of conventionalism, marshalled by Poincaré and continued by Dingler, says that the construction of physics needs stipulations that are subject to our choice. [. . .] But the choice of these stipulations shall not be arbitrary, but rather governed by specific principles, where in the end the principle of maximal simplicity decides.

The laws of physics can be chosen according to the principle of maximal simplicity, Carnap (1923, § III) states, because they are not completely determined by experience, very much as described in the *Introduction*. His examples of correspondence rules (99f) also strongly anticipate those in the *Introduction*:

> "To such a blue (designated, for example, according to the Ostwald color-system) corresponds a specific periodic movement of electrons (designated by the frequency)". [...] "To such a heat experience (system of designation missing) corresponds a specific average kinetic energy of some amount of electron-complexes (atoms or molecules)."

In the *Introduction*, Carnap only uses the concept of hue rather than the Ostwald color-system and a system of designation for heat.

Finally, as in the *Introduction*, the correspondence rules are such that any statement in observation terms can be described in theoretical terms, but not vice versa. Carnap (1923, 100) writes:

> The dictionary can be used in both directions: It serves both for the translation of a phenomenal fact into the corresponding physical one and conversely. It has to be noted, however, that the correlation is unique only in the second case; while, for two distinct reasons, a specific phenomenal content generally corresponds not to one specific physical fact alone but an infinite set of them.

Carnap's first reason for the lack of translatability into the physical language are the multiple microscopic realizations of physical macrostates in, for example, thermodynamics. His second reason is the perception threshold. This one-many relation between observational and physical facts occurs in three other works by Carnap (1924, 1926, 1928), including the *Aufbau*, § 136.

In modern terminology, this relation can be phrased syntactically or semantically. Carnap could not easily have made that distinction, since the concepts had not been developed yet. Syntactically, Carnap claims that every sentence in observational terms can be translated into a sentence in theoretical terms with the help of the correspondence rules but not vice versa. From the theory of definition it is known that then the correspondence rules entail an explicit definition for each observational term in theoretical terms, while the converse does not hold. Semantically, Carnap claims that a structure for the theoretical vocabulary can be expanded at most in one way to a model of the correspondence rules, while at least some structures for the observational vocabulary can be expanded to more than one model of the correspondence rules. This means that the correspondence rules do not entail an explicit definition for each theoretical term (according to Padoa's theorem), and that the correspondence rules do entail an explicit definition for each observational term (according to Beth's theorem) for correspondence rules in first order logic and (according to a theorem by Tarski (1935)) for a finite number of correspondence rules in higher order logic (cf. Leivant 1994, § 5.1). In other words, already in his very first publication on the structure of theories, Carnap claims that theoretical terms are interpreted through observational terms according to the second method described in *Logic & Mathematics*, although without the later qualification that explicit definability *seems* possible given the contemporary state of science. Of course, when he wrote the 'Aufgabe', definition theory and formal semantics were not yet developed enough to phrase this consequence so clearly. Nonetheless, this is what Carnap's position in the 'Aufgabe' entails. Carnap (1936, 168) knew of Tarski's theorem very soon, and so at least could have seen the relation then.

Contrary to this result, Friedman (1992, 21f) claims that in the 'Aufgabe', Carnap

> outlines a procedure for nonetheless approximating to a unique assignment of physical state-magnitudes by focusing on a small neighborhood of a given phenomenally characterized space-time point and working back and forth using the laws of physics (1923, pp. 102–03). The crucial point is that the laws of physics, together with an unambiguous determination of phenomenal qualities from physical state-magnitudes, provide a methodological procedure for narrowing down the ambiguity in the assignment of physical state-magnitudes [. . .].

I do not think that this is Carnap's claim. In the passage to which Friedman refers, Carnap relaxes the idealizing assumptions about the third volume of an ideal physics, the complete knowledge of two physical states of the world. Instead of the prediction of observations from the knowledge of the physical states, the task is then "to calculate from the observed state of a bounded area, namely our environment in space-time, the state of a different space-time area."

The method to come to predictions is given in the following passage:

> To a specific observation report belong indeed an infinite set of physical states of the area, and therefore a set of states of the same power for the future state under investigation [. . .]. But in many cases, retranslating this infinite set of physical states into perceptual contents results in a comparably small set of perceptual contents, which in advantageous cases form a continuous region of qualities (i. e., a domain of similar colors). [T]he aspiration is now [. . .] to narrow down the range of the one region of qualities as much as possible. [. . .] This holds for the prediction of *perceptual contents*, which is the only one demanded in practice. In contradistinction, science always stays infinitely far away from the unique prediction of physical states even for arbitrarily small time intervals.

So, contrary to Friedman's claim, Carnap does not give a method to uniquely determine physical states. Rather, he argues that in some cases, it is possible to predict that an observation in a small region of space-time will be in a small range of possible perceptual contents, but that in all cases, it is impossible to predict a physical state. As the last and the first sentence show, for Carnap it is impossible to describe a physical state in observational terms.

4 Conclusion

The structure of correspondence rules that Carnap presents in the 'Aufgabe' did not change much. Specifically, in contradiction to Friedman, Carnap describes a one-many relation between observational states and theoretical states that is still present in his last works on the structure of scientific theories. Carnap only phrases it in terms of the explicit definability of observational terms in theoretical terms.

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