Эпистемология и философия науки
2024. Т. 61. № 1. С. 202–222
УДК 167.7

Epistemology & Philosophy of Science
2024, vol. 61, no. 1, pp. 202–222
DOI: https://doi.org/10.5840/eps202461116

Carl G. Hempel: Thought Experiments between Methodological Monism and the Discovery/Justification Dichotomy

Marco Buzzoni – PhD in Philosophy, Professor. University of Macerata. 20 via Garibaldi, Macerata 62100, Italy; e-mail: marco.buzzoni@unimc.it

Hempel's account of thought experiments has been discussed only by a very few authors and, for the most part, with rather cursory remarks. Its importance, however, is not only historical, but also systematic theoretical, because it involves the distinction between discovery and justification, a main pillar of neopositivistic philosophy of science. Hempel raised the question whether thought experiments constitute a methodological component of scientific research or, on the contrary, are merely a heuristic-psychological device for obtaining and/or transmitting new ideas. While conceding a few exceptions in the natural sciences, he argued that thought experiments always have a heuristic character in the social sciences. There is however a fundamental tension in Hempel's conception of thought experiments, between the thesis of methodological monism and the neopositivistic dichotomy discovery/justification. On the one hand, on the basis of the unity of scientific method, Hempel admits a difference only in degree between the natural and the human sciences, but on the other hand, he draws a principled distinction between thought experiments of the human sciences (which have only a greater or lesser heuristic value) and those of the natural sciences (which may have also a cognitive-justificatory value). If one assumes the unity of method in the minimal sense in which no scientific knowledge can renounce intersubjective controllability, this tension can be removed either by rejecting the discovery/justification dichotomy or by interpreting it differently. Here, following the second path, two senses of the dichotomy are distinguished, one of which must be accepted, while the other rejected. This removes the internal tension in Hempel's conception of thought experiments and suggests the thesis that any plausible thought experiment, both in the natural and the human sciences, must already contain some justification, implicit or explicit, of the theoretical hypotheses that they formulate.

Keywords: Dichotomy discovery/justification, Hempel, Methodological monism, Human sciences vs. Natural sciences, Thought experiment

Карл Гемпель: мысленные эксперименты между методологическим монизмом и дихотомией открытия/обоснования

Марко Буззони – доктор философии, профессор. Университет Мачераты.

Подход Гемпеля к мысленным экспериментам обсуждался лишь очень немногими авторами и по большей части ограничивался довольно беглыми замечаниями. Однако его значение

© Marco Buzzoni, 2024

20 via Garibaldi, Мачерата
62100, Италия;
e-mail: marco.buzzoni@unimc.it

не только историческое, но и систематически теоретическое, поскольку оно включает в себя различие между открытием и обоснованием, что является основным столпом неопозитивистской философии науки. Гемпель поставил вопрос о том, являются ли мысленные эксперименты методологической составляющей научных исследований или, наоборот, являются лишь эвристически-психологическим приемом для получения и/или передачи новых идей. Допуская несколько исключений в естественных науках, он утверждал, что в социальных науках мысленные эксперименты всегда имеют эвристический характер. Однако в концепции мысленных экспериментов Гемпеля существует фундаментальное противоречие между тезисом методологического монизма и неопозитивистской дихотомией открытия/обоснования. С одной стороны, на основе единства научного метода Гемпель допускает различие лишь в степени между естественными и гуманитарными науками, но, с другой стороны, он проводит принципиальное различие между мысленными экспериментами гуманитарных наук (которые имеют лишь большую или меньшую эвристическую ценность) и естественных наук (которые могут иметь и познавательно-обосновательную ценность). Если предположить единство метода в минимальном смысле, при котором ни одно научное знание не может отказаться от интерсубъективной значимости, то это напряжение можно снять либо путем отказа от дихотомии открытия/обоснования, либо путем ее иной интерпретации. Здесь, следуя по второму пути, выделяются два смысла дихотомии, один из которых необходимо принять, а другой отвергнуть. Это снимает внутреннее напряжение в концепции мысленных экспериментов Гемпеля и предполагает тезис о том, что любой правдоподобный мысленный эксперимент, как в естественных, так и в гуманитарных науках, уже должен содержать некоторое обоснование, скрытое или явное, теоретических гипотез, которые они формулируют.

Ключевые слова: дихотомия открытия/обоснования, Гемпель, методологический монизм, гуманитарные науки против естественных наук, мысленный эксперимент

1. Introduction

As Suppe [2000] pointed out, Hempel [1965a] took up a line of thought that had already been present since 1936 in a work written with Paul Oppenheim.[1] According to Suppe, "[i]n the first approximation, this work can be viewed as an updated summary of key ideas in the *Typusbegriff.*" [Suppe, 2000, p. 210, fn. 34] Indeed, despite the fact that Hempel 1965a only makes a laconic reference "for further details" to the writing which

[1] Cf. [Hempel and Oppenheim, 1936]. [Hempel, 1965a] reproduces, with some stylistic revisions and minor modifications, the texts of [Hempel, 1952a; Hempel, 1964]. Since the small differences between [Hempel, 1952a; Hempel, 1964; Hempel, 1965a] are irrelevant for the purposes of this paper, I shall only quote from the most recent version provided by [Hempel, 1965a].

he co-authored with Paul Oppenheim, the more general purpose of this paper is essentially the same as that of the 1936 work: to clarify what kind of concepts need to be used to formulate controllable laws in psychology and medicine and, more generally, in the human sciences (cf. [Hempel & Oppenheim, 1936, p. v; Oppenheim, 1969, p. 1]).

While Suppe's claim is essentially correct, it is also somewhat reductive because Hempel 1965a explicitly introduced the new issue of thought experiment (henceforth TE). This issue should today be added to those "core issues in scientific methodology" which, as Wesley Salmon noted, were all already contained in *Aspects of Scientific Explanation* and which make this work the best introduction to logical empiricism [Salmon, 1999/2000, p. 318]. Hempel's paper constitutes one of the very few attempts to clarify the concept of TE before the 1990s, and this alone would be enough to make it difficult to justify why it did not receive the attention it deserved. Hempel's conception of TEs has only been discussed by very few authors and, for the most part, with rather cursory remarks (see, e.g., [Lazarsfeld, 1962; Sorensen, 1992, p. 47–48; Cohnitz, 1995, p. 54–55; Stäudner, 1998, p. 15; Kühne, 2005, p. 325–328, and Buzzoni, 2008a, p. 110–113; Betta and Swedbery, 2021, p. 150–151]).

It is easy to find other reasons why this essay should not have been as neglected as it was. For instance, together with Popper [1959, App. XI], it seems to be one of the best candidates for that "traditional conception" of TEs to which, in a generic way, Thomas Kuhn alluded in his very important (but also initially neglected) essay on TEs, stating that according to the received view, TEs have the task of eliminating confusion and conceptual inconsistencies (cf. [Kuhn, 1964]). But in my opinion the most important reason why this essay should not be overlooked is that it addresses the problem of TEs in connection with the relationship between the context of discovery and the context of justification, one of the main pillars of logical empiricism and traditional epistemology. One of the main theses of this article is that Hempel's 1965 essay is the clearest expression, from the TE's perspective, of a fundamental tension in his understanding of the human sciences. On the one hand, he denies any difference in method between the natural sciences and the human sciences. On the other hand, however, in strong tension with this thesis, the separation between the context of discovery and the context of justification led him to downplay the importance of the human sciences to the point that what should have been a pure difference in degree became an essentially qualitative distinction between the TEs of the human sciences (which have only more or less heuristic value) and those of the natural sciences (which can also have, though rarely, a properly theoretical or cognitive-justificatory value).

The paper is organized as follows. In Section 2, after some references to the 1936 writing co-authored with Oppenheim, we shall reconstruct Hempel's account of TEs. We shall see that the old distinction

between the context of discovery and the context of justification is at the basis of Hempel's notion of TE. This leads to a twofold devaluation: both of the TEs in the human sciences (which ultimately have only intuitive-heuristic value) as compared to those in the natural sciences (which, albeit rarely, may possess a justificatory value) and of TEs in general as opposed to real experiments (henceforth REs). In Section 3 we shall see that the devaluation of TEs in the human sciences is in serious tension with the methodological monism, which admits a difference only in degree between the natural and human sciences. Finally, in the Section 4, we shall see that the main point of weakness of Hempel's account of TEs is the discovery/justification dichotomy itself, of which at least two main senses must be distinguished, one of which must be accepted, while the other rejected. By clarifying the ambiguity of this dichotomy, it will be possible to remove the internal tension in Hempel's account of TEs, though at the price of accepting the thesis – sketchily suggested at the end of the paper – that any *prima facie* plausible TE, no matter whether in the natural or human sciences, already contains some justification, implicit or explicit, of the theoretical hypotheses that it formulates.

2. Ideals Types and Thought Experiments: Weber and Hempel on "Imaginary Experiments"

As has been mentioned in the literature, and as we shall try to argue in more detail in this section, the distinction between the context of discovery and the context of justification is one of the fundamental reasons underlying Hempel's devaluation of TEs (cf. e.g. [Sorensen, 1992, p. 48; Cohnitz, 1995, p. 54–55; Kühne, 2005, p. 327–328; Buzzoni, 2008a, p. 110–113]). This distinction is already present in Hempel's early work and, passing through the famous essay on the concept of law in history [Hempel, 1942], reaches the essay devoted to the concept of TE, which is the subject of this paper.

In their 1936 writing, Hempel and Oppenheim distinguished "essentially only two fundamental forms of concept formation": "the classificatory form and the gradable form (*abstufbare Form*)" [Hempel and Oppenheim, 1936, p. 5]. Classical logic is able to provide classificatory concepts, whereas a theory of typological concepts requires modern symbolic logic. For example, any attempt to understand to which precise psychological type particular empirical personalities belong – with their variously nuanced and "graded" (*abgestuften*) properties – runs into very serious and ultimately insuperable difficulties (cf. [Ibid., p. 7]).

In Hempel and Oppenheim 1936, the distinction between "ideal types and empirical types" was considered of secondary importance because it was not a question of logic, but rather of psychology and heuristics

[Hempel and Oppenheim, 1936, p. 4–5]. In the essays of 1952a, 1964 and 1965a, on the contrary, the same need to provide a more comprehensive logic for the typological concepts of the human sciences leads Hempel to examine Weber's thought, who, according to Hempel, had, with the concept of the ideal type, obscurely intuited the need for "gradable" concepts, but had only managed to express this intuition negatively (they cannot be defined by *genus proximum* and *differentia specifica*) or in metaphorical language (cf. [Hempel, 1965a, p. 155–156]). Weber's "ideal type" is for Hempel a notion which lacks "clarity and rigor and thus call for further logical analysis" [Ibid., p. 157].

This is where TEs (or more precisely, as we shall see in a moment, "experiments-in-imagination") come into the picture, that is, in the context of a discussion of Max Weber's "ideal type" theory. Two problems are intertwined here, one philological-historical, relating to the expression used here to refer to TEs, and one conceptual-philosophical. After some brief clarifications concerning the first point, we will dwell on the second.

With regard to the first point, as noted by Betta and Swedbery [2021, p. 150–151], Weber had used the expression "gedankliches Experiment" to clarify some aspects of his own theory of ideal types. In Hempel and Oppenheim's 1936 writing, we find no expression referring to TE. The occurrence (since [1952a]) of "experiment-in-imagination", therefore, depends on the reading of Weber 1949 and 1947, works that Hempel explicitly cites. He quotes a passage in which Weber uses the term "imaginary experiment" (cf. [Hempel, 1965a, p. 162]), thus following the translation that had been provided in 1947 by A.M. Henderson and Talcott Parsons. In this passage Weber had noted that in attempting to confirm a historical interpretation, "[o]ften, unfortunately, there is available only the dangerous and uncertain procedure of the 'imaginary experiment' [*des 'gedanklichen Experiments'*] which consists in *thinking* away certain elements of a chain of motivation and working out the course of action which would then probably ensue, thus arriving at a causal judgment." ([Weber, 1922, p. 510]; Engl. Transl. by A.M. Henderson and T. Parsons in [Weber, 1947, p. 97]; the spacing of the original, lost in translation, has been restored here as italics). As an example of "imaginary experiments" provided with a high degree of controllability, Weber had cited Gresham's Law (according to which bad money will tend to drive good money out of circulation in the long run), in which "the cases are numerous enough so that verification can be considered established", adding, however, that in "very many cases" of historical interpretation there is no possibility of verification and the interpretation "must necessarily remain a 'hypothesis'" [Weber, 1922, p. 510; Engl. Transl., Weber, 1947, p. 98]; single inverted commas of the original restored). An intermediate case is represented according to Weber by the hypothesis of the causal significance of the Battle of Marathon for the development

of the cultural peculiarities of Greek and Western civilization, which "can only be directly verified by reference to the examples of the conduct of the Persians in cases where they were victorious, as in Jerusalem, Egypt, and Asia Minor, and even this verification must necessarily remain unsatisfactory in certain respects" [Weber, 1922, p. 511; Engl. Transl., Weber, 1947, p. 98]. In the 1965a essay (as in the corresponding earlier essays), in fact, Hempel's translation of "gedankliches Experiment" simply followed Henderson and Parsons', rendering this expression (as was not entirely uncommon at the time) with "imagined experiment" (as in the case just cited) or "experiment-in-imagination" or, again, without hyphens, "experiment in nimagination".

These brief philological-historical considerations already introduce us to the properly philosophical problem of Hempel's account of TEs. Just as in the 1936 work co-written with Oppenheim, also at stake in Hempel 1965a is the possibility of introducing into the historical and social sciences general concepts (called "typological") that bear such similarity to those of the natural sciences that they can be considered scientific in the same fundamental sense as the latter.

This issue was ultimately similar to that addressed by Weber in the works just cited, but in Hempel, as emphasised in the proposition that closes the work, the discussion is explicitly intended as an in-depth and detailed contribution to "the logical unity of science" ([Hempel and Oppenheim, 1936, p. 124–125]; the original is in italics): for Hempel and Oppenheim, as for the logical empiricists, a "logical separation" between "natural sciences" and "the human sciences" is "impracticable" and the typological approach "does not establish a fundamental difference between psychology on the one hand and the so-called exact natural sciences on the other; rather, it is only a matter of differences in the state of development of conceptualization in the areas mentioned" [Ibid.]. As we have already anticipated, however, one reason for novelty lies in the fact that, through recourse to Weber's thought, in the last part of Hempel 1965a (as well as in the corresponding earlier versions) this thesis is extended to the use of TEs in the human and natural sciences.

To overcome the shortcomings of Weber's analysis, Hempel distinguishes three main types of typological concepts: classificatory, extreme and ideal types. Let us leave aside here the "classificatory" use of typological concepts, which construct types as classes and are inadequate to express gradable notions such as those of extravert and introvert personalities [Ibid., p. 157].

Let us mention only briefly the second kind of type concepts, the "extreme" ones. If the term *T* is an extreme type, an individual *a* cannot be said either to be *T* or to be *non-T*: "rather, *a* may be, so to speak, more or less *T*". "Extreme" concepts are well represented by the definition, based on the scratch test, of the purely comparative concept of hardness in mineralogy [Ibid., p. 159–160]. Although they are "gradable", they

only in the most favorable cases can lead us to "invariant relationships expressible in terms of mathematical functions" or to correlations such as "the proportionality, at constant temperature, of the specific electric and thermic conductivities of metals" [Hempel, 1965a, p. 160].

It is only the analysis of the third and final type of concepts – the "ideal types" – that lead Hempel to discuss the relationship between TEs of the human and the natural sciences. Hempel distinguished two ideal types of "imaginary experiments" (or "experiments-in-imagination"): "theoretical" and "intuitive" TEs. In "intuitive" TEs many assumptions and data are not made explicit, and the deductions are performed intuitively. "Theoretical" TEs, on the contrary, are based on "a set of explicitly stated general principles" – such as laws of nature – and they anticipate the outcome of REs "by deductive or probabilistic inferences from those principles in combination with suitable boundary conditions representing the relevant aspects of the imagined experimental situation" [Ibid., p. 164].

To illustrate "theoretical" TEs, Hempel gives the following example:

> The question what *would* happen *if,* say, the thread of a pendulum were infinitely thin and perfectly rigid and *if* the mass of the pendulum were concentrated in the free end point of the thread is answered here, not by "thinking away" those aspects of a physical pendulum that are at variance with this assumption and then trying to envisage the outcome, but by rigorous deduction from available theoretical principles. Imagination does not enter here; the experiment is imaginary only in the sense that the situation it refers to is not actually realized and may indeed be technically incapable of realization [Ibid., p. 165].

TEs usually fall somewhere in between these two ideal types. But most of them are closer to the intuitive side and therefore only have a heuristic value. For Hempel, in most cases, TEs are useful to make *discoveries* and, since they are restricted to the psychological and historical context of discovery, they do not *justify* scientific laws:

> Galileo's dialogues contain excellent examples of this procedure, which show how fruitful the method can be in suggesting general theoretical insights. But, of course, intuitive experiments-in-imagination are no substitute for the collection of empirical data by actual experimental or observational procedures. This is well illustrated by the numerous, intuitively quite plausible, imaginary experiments which have been adduced in an effort to refute the special theory of relativity; and as for imaginary experimentation in the social science, its outcome is liable to be affected by preconceived ideas, stereotypes, and other disturbing factors. <…> Such experiments, then, cannot provide evidence pertinent to the test of sociological hypotheses. At best, they can serve a heuristic function: they may *suggest* hypotheses, which must then be subjected, however, to appropriate objective tests [Hempel, 1965a, p. 165].

Here Hempel contrasts rather sharply the TEs of the natural sciences and those of the social sciences. Although he expresses some scepticism towards the TEs of the natural sciences, their difference in principle to those of the social sciences is well reflected in his claim that sociological TEs can only "serve a heuristic function", and this, moreover, only in the best case ("[a]t best").

It is clear enough that this clear-cut distinction takes up the dichotomy of the logical empiricists between the "context of discovery", in which the method of empathy can be of great help, but with only heuristic value, and the "context of justification", which has a logical-epistemological value and where the use of observation, experiment and logic enables the occurrence of general laws. In fact, according to Hempel, one can raise against Weber's doctrine of ideal types the same objection that both he and Popper will repeat so many times against any application of the method of empathy in the historical and social sciences (an objection, however, already raised by Weber himself against Dilthey):

> the subjective experience of empathic identification with a historical figure, and of an immediate - almost self-evidently certain - insight into his motivations, constitutes no knowledge, no scientific understanding at all, though it may be a guide in the search for explicit general hypotheses of the kind required for a systematic explanation [Hempel, 1965a, p. 161].

This was not a new point, since it is very similar to the one made in Hempel and Oppenheim 1936, where, on several occasions, the authors had stressed the distinction between the "logical form" of their analysis and an analysis connected with the "heuristics of the concept formation" (*Heuristik der Begriffsbildung*), mostly based on "'intuitive' estimations" [Hempel and Oppenheim, 1936, p. 83].

In sum, the distinction between the context of discovery and the context of justification - which was already present in Hempel's early work and, passing through the famous essay on the concept of law in history [Hempel, 1942], reaches the essay devoted to the concept of TE - pushed Hempel in the direction of drawing a qualitative difference between TEs in the natural sciences and those in the human sciences. Only in the latter case does Hempel recognise a purely heuristic function for TEs, on the basis of reasons that are in principle different from those which, according to Hempel, as a rule limit their value even in the natural sciences.

In the next section, we shall see that Hempel's assumption of the dichotomy between the "context of discovery" and the "context of justification" is in tension with Hempel's methodological monism, a tension which generates an oscillation, now towards the thesis of a difference in principle and now towards a difference in degree only between the TEs of the natural sciences and those of the human sciences.

3. Thought Experiments between Methodological Monism and the Discovery/Justification Dichotomy

As we saw in the previous section, the discovery/justification dichotomy is one of the fundamental reasons for Hempel's devaluation of thought experiments both as such, when compared to real experiments, and of thought experiments in the human sciences, when compared to those in the natural sciences. However, the fundamental thesis of methodological unity, which is typical of all positivism, old and new, and of which Hempel was one of the most decisive champions, is in tension with its devaluation of TEs in the human sciences and thus, ultimately, with the discovery/justification dichotomy that underlies it.

As already mentioned, in their 1936 writing Hempel and Oppenheim explicitly stated that their work was intended as a contribution to "the logical unity of science" (cf. [Hempel and Oppenheim, 1936, p. 125]; the original is in italics) The thesis of the unity of scientific method, starting with Auguste Comte's famous classification of the sciences, leads to the denial of any qualitative distinction between the human sciences and the natural sciences, admitting only a difference in degree. In line with this idea, Hempel and Oppenheim had considered the difference between the typological concepts of the human sciences and those of the natural sciences as a difference of degree only, as "differences in the state of development of conceptualisation".

This generates in Hempel's considerations concerning TEs a serious internal tension. Due to the influence of the dichotomy of the psychological-heuristic context of discovery vs. the logical-methodological context of justification, what according to the thesis of methodological monism should have been a pure difference of degree between the natural and human sciences, in the 1965a essay often takes on the features of a qualitative distinction. Not only, as we have seen, does Hempel claim in this paper that TEs in the human sciences, "[a]t best," "can serve a heuristic function," but he also adds a specific reason: "as for imaginary experimentation in the social sciences, its outcome is liable to be affected by preconceived ideas, stereotypes, and other disturbing factors" [Hempel, 1965a, p. 165]. Here "preconceived ideas, stereotypes, and other disturbing factors" appear as a principled reason that only concerns the human sciences, *as something that undermines the empirical controllability of the latter in a very peculiar way*. It is *prima facie* certainly a plausible thesis that TEs have less certain value than actual experiments, but this, according to the thesis of methodological monism, should apply equally to the natural and human sciences.

This tension between the thesis of methodological monism and the thesis of the almost inevitable inferiority of the TEs of the human sciences to those of the natural sciences can also be illuminated by considering the role played by idealization in the two cases. As Hempel himself rightly admits, the concept of idealization is intimately connected with TEs in both the natural and human sciences. But despite this admission (again required by the thesis of the unity of method across disciplines), he also strives to find a correspondence with the distinction already drawn between "theoretical" and "intuitive" TEs:

> In two important respects <…> idealizations in economics seem to me to differ from those of the natural sciences: first of all, they are intuitive rather than theoretical idealizations in the sense that the corresponding postulates are not deduced, as special cases, from a broader theory which covers also the non-rational and noneconomic factors affecting human conduct. <…> This takes us to the second point of difference: the class of concrete behavioral phenomena for which the idealized principles of economic theory are meant to constitute at least approximately correct generalizations is not always clearly specified" [Hempel, 1965a, p. 169–170].

Although on the one hand he warns that the previous two points of comparison should not be considered as indicating "an essential methodological difference between the two fields" [Ibid., p. 170], on the other hand he points out that, only in the human sciences, and particularly in the use of ideal types, a *ceteris paribus* clause is systematically used that would generally empty them of empirical content:

> it might seem that we may with assurance assert our typological hypothesis if only we qualify it by an appropriate *ceteris paribus* clause and thus give it the form: 'All other factors being equal or irrelevant, *Q* will be realized whenever *P* is realized'. Evidently, no empirical evidence can ever disconfirm a hypothesis of this form since an apparently unfavorable finding can always be attributed to a violation of the *ceteris paribus* clause by the interference of factors other than those specifically included in *P* [Ibid., p. 167].

In contrast, according to Hempel, this would not happen in the formulation of physical hypotheses, in which the *ceteris paribus* clause is never used:

> all the factors considered relevant are explicitly stated (as in Newton's law of gravitation or in Maxwell's laws) or are clearly understood (as in the familiar formulation of Galileo's law, which is understood to refer to free fall in a vacuum near the surface of the Earth); all other factors are asserted, by implication, to be irrelevant. Empirical test is therefore significant, and the discovery of discordant evidence requires appropriate revisions either by modifying the presumed functional connections

between the variables singled out as relevant, or by explicitly introducing new relevant variables [Hempel, 1965a, p. 167–168].

But this distinction does not rest on solid ground, as Hempel himself will later show, when, addressing the problem in the terms of "provisos" rather than "ceteris paribus clauses," he recognized that the problem arises with equal seriousness for the natural sciences as well ([Hempel, 1988, p. 244]; by the term "provisos" Hempel refers "to assumptions… which are essential, but generally unstated, presuppositions of theoretical inferences" [Ibid., p. 240; the original is in italics]. Indeed, as Suppe has shown, the problem of provisos remains unanswered throughout Hempel's production, from the 1936 writing he co-authored with Oppenheim until his latest works (cf. [Suppe, 2000]).

We may conclude that Hempel remains a prisoner of two mutually inconsistent assumptions. On the one hand, he supports the thesis of methodological unity, which allows him to posit a difference only in degree between the natural and human sciences. But on the other hand, when he has to clarify the nature and role of TEs in the human sciences, he resorts to the dichotomy between discovery and justification, relegating them to an inferior function, merely heuristic or didactic, devoid of any cognitive-justificatory value. Hempel ends up oscillating between the recognition of the scientific status of the human sciences and the old positivist prejudice about their mostly wanting, always suspect, testability.

Now this tension can be removed by either abandoning one or the other of the theses that cause it or by reinterpreting these theses in such a way that they become mutually consistent. First of all, it does not seem that the thesis of methodological unity can be abandoned, at least if it is taken in the minimal sense of the requirement of empirical controllability in principle of any rational discourse, including that of the human sciences (note that this concession in no way precludes a critique of positivistic monism in other senses, a matter that is completely outside the limits of this paper). For this reason, in what follows, I shall focus on the dichotomy between discovery and justification, attempting to show that the tension I have insisted on in this section can be removed by carefully distinguishing two senses of the discovery/justification dichotomy, only one of which is acceptable, while the other must be rejected, because it would inevitably undermine intersubjective controllability in principle, a hardly dispensable trait of scientific knowledge.

But before taking a closer look at the discovery/justification dichotomy, in the last part of this section I shall briefly touch upon its implications for the relationship in general between TEs and the corresponding REs. We have seen so far that the dichotomy discovery/justification led Hempel 1965a to the devaluation of the TEs in the human sciences (which ultimately have only intuitive-heuristic value) as compared to those in the

natural sciences (which, albeit rarely, possess full "theoretical" value). As I shall try to show now, this same dichotomy also leads to Hempel's general devaluation of TEs, as compared to real ones.

Regarding the relationship between TE and RE, Sorensen rightly noted that Hempel's account suggests that those who believe that TEs justify and test hypotheses face a dilemma on the model of Hempel's "theoretician's dilemma" concerning the function of theoretical terms in science (cf. [Hempel, 1958]). The dilemma makes TEs either useless or devoid of empirical meaning: either TEs "can be checked through public experimentation", i.e., through their transformation into laboratory experiments, or they cannot. In the first case, they turn out to be "redundant or misleading"; in the second case, their results are in principle "unverifiable", and accordingly they are devoid of empirical meaning. Hempel's conception avoids the dilemma by placing all but a limiting case of TE outside the context of justification, that is, by relegating their study to the history and psychology of science [Sorensen, 1992, p. 48].

Hempel's conception escapes the above dilemma only at the price of making TEs irrelevant in the context of justification, admitting their scientifically relevant function in the context of discovery alone. One could attempt to defend Hempel's position by arguing that, properly understood, it does not make TEs irrelevant: the fact that they can help us discover scientific hypotheses allegedly proves their scientific importance, since the formulation of hypotheses is an essential aspect of scientific practice (cf. [Stäudner, 1998, p. 15]). But it is easy to see that this defence depends on the unconditional acceptance of the neopositivistic discovery/justification dichotomy that is at the basis of Hempel's account of TE and that, as we must now argue in detail, is hardly tenable for several reasons.

4. Two fundamental senses of the discovery/justification distinction and the relationship between real and thought experiment

As we have already noted, to overcome the internal tension in Hempel's conception of TEs, we need to undermine one of the two theses that generate it. And as we have also noted, the thesis of the unity of method cannot be abandoned, if it is taken in the minimal sense of the demand of empirical controllability in principle of any rational discourse. Therefore, we must challenge the other main premise of Hempel's tension and oscillation: the discovery/justification dichotomy. And it is to this problem that we shall turn our attention in the last part of the paper.

The distinction between the context of discovery and the context of justification is a point that unites Hempel not only with the other logical empiricists, but also with Popper (cf. [Popper, 1935, p. 4–6; Engl. transl., Popper, 1959, p. 8–9]). Hempel repeatedly uses the opposition between a "psychological" (or "pragmatic-psychological," or "subjective") and a "logical" (or "logic-systematic," or "objective," or "methodological") use of a concept to defend the nomological-deductive model (cf. e.g. [Hempel and Oppenheim, 1936, p. 91] and [Hempel, 1965, p. 258]) or to criticize numerous authors, such as Bridgman (cf. [Hempel, 1952b, p. 42]), Scriven (cf. Hempel, 1965, p. 413), Piaget (cf. [Ibid., p. 426]), Campbel (cf. [Ibid., p. 445]).

In general, logical empiricists and Popper used the distinction between the context of discovery and the context of justification to grant empirical science cognitive autonomy from its cultural and historical context (for historical details on the distinction between the "context of discovery" and the "context of justification", see [Schickore and Steinle (eds.), 2009], above all Part I and Part II, and [Buzzoni, 2015]). But this was precisely one of the main reasons why exponents of what I would call the "relativist turn" in the philosophy of science of the 1960s (notably Kuhn and Feyerabend) and proponents of the sociological turn (notably Bloor and Latour) since the 1980s have rejected the distinction in question. According to Kuhn and Feyerabend, for example, merely because they played an historical-causal role in the scientific process, *empirical-historical factors* such as scientists' prejudices and personal idiosyncrasies, aesthetic preferences, religious beliefs etc., are to be put on a par with more traditional *reasons* for maintaining or rejecting a theory, such as coherence, explanatory scope, unifying power, etc.[2]

This is one of the most serious objections that Kuhn, Feyerabend and other exponents of the relativist turn have pointed out against the discovery/justification dichotomy: if the invention of testable hypotheses is understood as heuristic in its most radical sense, that is, without any empirical or logical constraint, strictly speaking it *can be carried even by entirely non cognitive factors*. In other words, if TEs had only a heuristic value, they could be substituted by any other factor that might generate testable hypotheses in the scientist's mind (including, say, relaxing baths, which some scientists find especially conducive to new ideas).

We will see in a moment how one can escape this conclusion. First of all, however, I want to emphasise that this thesis is certainly unacceptable to Hempel. If he were to embrace the heuristic function of TE

[2] Cf. [Feyerabend, 1970, §14; Kuhn, 1962, p. 151–156]; for typical exponents of the sociological turn, see e.g. [Bloor, 1991, p. 36–37 and Knorr Cetina, 1992, p. 116]. For the choice of the term "relativistic turn," I must refer to [Buzzoni, 2008b, p. 106–107].

also in the very generic sense of anything that suggests a solution, the genericity of this sense would empty of meaning his distinction between different types of TE (intuitive and theoretical): this sense applies equally to the TEs of the human sciences and to those of the natural sciences. Actually, on reflection, it applies to any accidental event we may come across: it is a typical property of intelligence (intrinsically connected to "serendipity") that everything, even a purely accidental event, can acquire a heuristic value in this sense (I develop this point in [Buzzoni, forthcoming]). But if we do not intend TEs to have a heuristic value in this truistic sense, but rather in the sense that they point to a reason, as yet not entirely convincing or clear, for reaching a conclusion, one cannot deny them some value, even a minimal or provisional one, of justification, which can be increased as the discussion proceeds, even by resorting, if necessary, to actual experimentation. In this case, one cannot draw a qualitative distinction between, on the one hand, TEs that only provide a heuristic or intuitive insight and, on the other hand, TEs that can provide a scientific or systematic understanding, because their individual steps can be all inspected and checked in the light of primitive concepts, postulates and admitted general laws. In every field of knowledge and always, we find ourselves in a situation of partial understanding, and any TE that does not at least *prima facie* have some plausibility could not even be taken as a hypothesis. From this point of view, we must abandon the qualitative difference between the TEs of the humanities, which merely suggest how to expand our knowledge, and the TEs of the natural sciences, some of which can already be considered properly scientific and rigorous.

But if in this sense, as we shall see more clearly later on, the discovery/justification distinction proves to be untenable, in another sense it is certainly unavoidable. The indiscriminate rejection of this distinction by the authors of the relativistic and sociological turn is the typical case where the baby had been thrown out with the bathwater. The baby was here the minimal sense, which I shall call *reflexive-transcendental*, in which reason is irreducible to empirical, particular causal factors, namely as an expression of its claim to represent, in principle, things as they really are (no matter how far this can succeed). Although a countless number of physical, biological, psychological, sociological, and, generally, contingent or accidental factors influence and limit human reason, the irreducibility of this latter, at least in an important sense, cannot be denied without denying all possibility of meaningful thinking or talking. Any claim to reduce reason to causal factors, necessarily presupposing its own truth, is irreducible to the causal factors to which, contradictorily, it grants a determining power over itself. In fact, to assert any empirical fact is to assert, implicitly, the distinction in principle between reason and facts, without which there would be neither one's own asserting nor one's own denying.

At least in this sense the distinction between the contexts of justification and discovery is constitutive of reason and cannot be denied without contradiction, since it is affirmed by the very act of negating it. However, it is necessary to distinguish at least one other sense, which has already emerged in some of the previous considerations and which I shall call *genetic-methodological*, which is the opposite complementary of the reflexive-transcendental just seen, a sense in which this distinction must be rejected.

In fact, if the general claim of representing things as they are is not to remain devoid of any particular content and cognitive function, it must be realized by means of concrete methodological procedures which make it possible to reconstruct, to re-appropriate and to evaluate in the first person the reasons why a particular truth-claim should be accepted. In other words, the truth-claim of our discourses tends by its very nature to translate (in principle without residue) into particular methods (or techniques). Not only the logical empiricists, Popper and Lakatos, but also the exponents of the sociological turn, failed to clearly identify this sense, in which a genetic-methodological attitude is decisive for justification. To test the truth value of a statement, in principle we must always adopt a genetic and historical-reconstructive attitude and retrace the main methodological steps taken by those who first achieved a certain result through those steps. Pythagoras's Theorem can be used in a practical way without recalling the procedural steps of its demonstration. But if someone challenged its validity, we ought to test it by retracing in the first person the procedural steps that led to that theorem being asserted. By doing this, we *justify* a theory by historically reconstructing the context of its *discovery*. In this sense, context of discovery and context of justification are one and the same thing (for a more detailed justification of this thesis, see [Buzzoni, 2008a, ch. 1, §§4–7, and 2015].

Now this unity and distinction between a reflexive-transcendental and a genetic-methodological sense of reason casts some light, at the same time, on the relationship between heuristic and justificatory role of TEs and on the relationship between REs and TEs. This is certainly not the place to take up here the account I have developed elsewhere, at once reflexive-transcendental and genetic-methodological (or operational), concerning the relationship between TE and REs (cf. [Buzzoni 2008a]). But the link briefly illustrated above between two senses – one reflexive-transcendental, the other genetic-methodological – of the distinction discovery/justification readily suggests the general thesis, according to which there is a relationship of unity and distinction between thought and real experiments: all TEs are in principle translatable into real experiments, and all REs can in principle be regarded as realisations of TEs.

This entails, among other things, that Hempel's devaluation of TE must be abandoned, both in the human sciences and in the natural

sciences. This thesis must be replaced by a relationship of unity and distinction of real and TE, according to which neither would be what it is outside their mutual relationship. On the one hand, despite their conditioned empirical power, TEs are very important in science for the following reasons: (1) at the most fundamental (transcendental) level, without TEs there would not be REs because no RE would be possible without a previous mental project, which expresses in potentially operational (i.e. experimental) terms the theoretical questions we address to nature; in this sense, far from being superfluous, TEs are the *condition of the possibility* of real ones. As such, their value is not merely heuristic, but intrinsic, and they are a constitutive, indispensable aspect of REs; (2) TEs, to the extent that they are based on well-established scientific facts and laws of nature, even if they are not realized or we decide not to realize them, can support fresh scientific claims and, at least provisionally, "inductively extend our knowledge" (cf. [Buzzoni, 2008a, p. 96]). On the other hand, entirely in line with Hempel's demand for empirical controllability, this explains easily both the undeniable similarities that TEs have with REs (certainly more significant than those with relaxing baths) and their essential connection to real experiments, which Hempel rightly cared about: without already realized TEs there would be no reliable empirical laws on which new TEs can base their anticipated answers to new questions. To sum up, they are complementary in a typical Kantian sense: (empirical) TEs without REs are empty; REs without TEs are blind (cf. [Buzzoni, 2018]).

This perspective allows us to understand from a broader context and in a deeper way the strengths and weaknesses we have already highlighted in Hempel's account.

First of all, our distinction of two senses of the relation between discovery and justification leads almost directly to grasping a twofold motive of truth in the dilemma constructed by Sorensen. In the perspective we have sketched, this dilemma could be briefly summarized by saying that while according to its first horn thought experiments would lose their (reflexive-transcendental) autonomy, in the second one they would lose their empirical (in the sense of genetic-methodological) controllability. Reconsidered in light of the distinction between the reflexive-transcendental and genetic-methodological senses of the discovery/justification dichotomy, the "theoretician's dilemma" (which Hempel rightly rejected, though not for the reasons given here) is easily resolved: just as the reflexive-transcendental truth claim of our discourses tends by its very nature to translate into particular methods (or techniques), similarly the theoretical assumptions contained in TEs must be translatable (in principle without residue) into the technical-practical realization of a RE (for a detailed argument, see [Buzzoni, 2008a]). Unfortunately, Hempel's radically empiricist perspective excludes this answer and is therefore unable to justify any autonomy of TEs with respect to REs. Only from an even reflexive-transcendental perspective is it possible to translate a theoretical

truth-value into a technical-operational content without denying the irreducibility of TEs to REs.

Second, the rejection of the distinction between the context of discovery and the context of justification in the sense we have called genetic-methodological is instead entirely in line with Hempel's claim that not even the human sciences can derogate as scientific disciplines from the fundamental principle of empirical controllability (cf. e.g. [Hempel, 1965a, p. 170]). Hempel was not wrong to demand the empirical controllability of TEs in the human sciences, a controllability that cannot be challenged without calling into question both their status as sciences and the high degree of predictability of many human actions and thoughts (just think of the accuracy with which exit polls predict the likely result of elections). His error consisted rather in drawing a difference between the humanities and the natural sciences which runs perfectly parallel to that between the context of discovery and the context of justification, thus reducing the difference to one in principle between the psychological-heuristic and the logical-methodological side of scientific research.

Hempel shares Popper's view that philosophy of science must investigate the "logic-systematic" or "methodological" function of scientific theorizing because there is no logico-rational explanation of the moment of scientific discovery: "Scientific hypotheses and theories <…> are not mechanically inferred from observed "facts": *They are invented by an exercise of creative imagination*" [Hempel, 1966, p. 32]. In the light of the considerations developed in this paper, we can also express Hempel's main error by saying that his way of understanding the opposition between a mechanical inference and the creativity of human imagination, though in one sense obvious and undeniable, in no way considers the possibility of a creative imagination that is capable of justifying the methodical steps by which it reaches its results, a possibility which eludes the false alternative in which Hempel, Popper and the logical empiricists were caught.

5. Conclusion

The importance of Hempel's account of TEs is not only historical, but also systematic theoretical, since it involves the relationship between the context of discovery and the context of justification, which was a main pillar of neopositivistic philosophy of science. Hempel, while conceding a few exceptions in the natural sciences, argued that TEs always have a heuristic character in the human sciences. As already noted in the literature and as shown more in detail in Section 2, Hempel is led to this conclusion by his advocacy, though with different expressions,

of the traditional dichotomy between the context of discovery and the context of justification. The devaluation of the human sciences involved by this dichotomy, as argued in Section 3, is in tension with the methodological monism – another main tenet of neopositivistic philosophy of science. This tension emerges more clearly than elsewhere in Hempel's account of TEs, where Hempel remains a prisoner of two mutually inconsistent assumptions. On the one hand, he assumes the thesis of the unity of scientific method, which allows a difference only in degree between the natural and human sciences. But on the other hand, when comparing nature and role of TEs in the human and natural sciences, he resorts to the dichotomy between discovery and justification, and yields to the temptation of relegating human sciences to an inferior role, merely heuristic or didactic, devoid of any cognitive-justificatory value.

This tension can be removed only by either abandoning one or the other of the theses in question or by reinterpreting them in such a way that they become mutually consistent. The thesis of methodological unity ought not be abandoned, provided that it is taken in the minimal sense of the demand of empirical controllability in principle of any rational discourse. Therefore, in Section 4, I focused on the dichotomy discovery/justification and showed that the tension in question should be removed by carefully distinguishing two senses of this dichotomy, one of which must be accepted, while the other rejected. This eliminates the internal tension in Hempel's account of TEs and casts some light on the relationship between heuristic and justificatory role of TEs: all plausible thought experiments, both in the natural and the human sciences, must already contain some justification, implicit or explicit, of the theoretical hypotheses that they formulate. Moreover, as only sketchily mentioned at the end of the paper, this suggests that Hempel's devaluation of TEs must be abandoned both in the human sciences and in the natural sciences. Neither TE nor RE would be what they are outside their mutual relationship: they are complementary in a typical Kantian sense: (empirical) TEs without REs are empty; REs without TEs are blind.

References

Betta and Swedbery, 2021 – Betta, M. and Swedbery, R. "On Thought Experiments in Sociology and the Power of Thinking", in: Leiulfsrud, H. and Sohlberg, P. (eds.) *Constructing Social Research Objects*. Leiden: Brill, 2021, pp. 142–164.

Bloor, 1991 – Bloor, D. *Knowledge and Social Imagery*, 2nd ed. London: Routledge and Kegan Paul, 1991.

Buzzoni, 2008a – Buzzoni, M. *Thought Experiment in the Natural Sciences. An Operational and Reflexive-Trascendental Conception.* Würzburg: Königshausen+Neumann, 2008.

Buzzoni, 2008b – Buzzoni, M. *Filosofia della scienza*. Brescia: La Scuola, 2008.

Buzzoni, 2015 – Buzzoni, M. "The Practice Turn in Philosophy of Science: The Discovery/Justification Distinction, and the Social Dimension of Scientific Objectivity", in: E. Agazzi and G. Heinzmann (eds.) *The Practical Turn in Philosophy of Science*. Milan: Angeli, 2015, pp. 81–111.

Buzzoni, 2018 – Buzzoni, M. "Kantian Accounts of Thought Experiments", in: J.R. Brown, Y. Fehige, M. Stuart (eds.). *The Routledge Companion to Thought Experiments*, New York: Routledge, 2018, pp. 327–341.

Buzzoni, forthcoming – Buzzoni, M. *Serendipity, Creativity, and Method in Scientific Research*. Forthcoming.

Cohnitz, 1995 – Cohnitz, D. *Gedankenexperimente in der Philosophie*. Paderborn: Mentis, 1995.

Fetzer, 2000 – Fetzer, J.H. (ed.) *Science, Explanation, and Rationality*. Oxford: Oxford University Press, 2000.

Fetzer, 2001 – Fetzer, J.H. (ed.) *The Philosophy of Carl G. Hempel. Studies in Science, Explanation, and Rationality*. Oxford: Oxford University Press, 2001.

Feyerabend, 1970 – Feyerabend, P.K. "Against Method: Outline of an Anarchistic Theory of Knowledge", in: M. Radner & S. Winokur (eds.) *Analyses of Theories and Methods of Physics and Psychology, Minnesota Studies in the Philosophy of Science, IV*. Minneapolis: University of Minnesota Press, 1970, pp. 17–130.

Hempel and Oppenheim, 1936 – Hempel, C.G. and Oppenheim, P. *Der Typusbegriff im Lichte der Neuen Logik. Wissenschaftstheoretische Untersuchungen zur Konstitutionsforschung und Psychologie.* Leiden: Sijthoff, 1936.

Hempel, 1952a – Hempel, C.G. "Problems of Concept and Theory Formation in the Social Sciences", in: *Science, Language, and Human Rights, American Philosophical Association, Eastern Division*, vol. 1 (Papers for the symposia held at the annual meeting, at the College of the City of New York, Dec. 29–31). Philadelphia (Penn.): University of Pennsylvania Press, 1952, pp. 65–86.

Hempel, 1952b – Hempel, C.G. *Fundamentals of Concept Formation in Empirical Science*. Chicago & London: The University of Chicago Press, 1952.

Hempel, 1958 – Hempel, C.G. "The Theoretician's Dilemma", in: H. Feigl, M. Scriven & G. Maxwell (eds.) *Minnesota Studies in the Philosophy of Science, vol. II.* Minneapolis (also reprinted in Hempel 1965): University of Minnesota Press, 1958, pp. 37–98.

Hempel, 1964 – Hempel, C.G. "Typological Methods in the Social Sciences", in: H. Albert (ed.) *Theorie and Realität: ausgewählte Aufsätze zur Wissenschaftslehre der Sozialwissenschaften. Die Einheit der Gesellschaftswissenschaften.* Tubingen: Mohr, 1964, pp. 191–208.

Hempel, 1965 – Hempel, C.G. *Aspects of Scientific Explanation and Other Essays in the Philosophy of Science*. New York/Toronto: The Free Press, 1965.

Hempel, 1965a – Hempel, C.G. "Typological Methods in the Natural and the Social Sciences", in: *Aspects of Scientific Explanation and Other Essays in the Philosophy of Science*. New York/Toronto: The Free Press, 1965, pp. 155–171.

Hempel, 1966 – Hempel, C.G. "Recent Problems of Induction", in: R.G. Colodny (ed.) *Mind and Cosmos*. Pittsburgh: University of Pittsburgh Press, 1966, pp. 112–134. (Repr. and quoted from J.H. Fetzer (ed.) The Philosophy of Carl G. Hempel. Studies in Science, Explanation, and Rationality. Oxford: Oxford University Press, 2001, pp. 29–48.)

Hempel, 1988 – Hempel, C.G. "Limits of a Deductive Construal of the Function of Scientific Theories", in: E. Ullmann-Margalit (ed.) *Science in Reflection, The Israel Colloquium*, vol. 3. Dordrecht: Kluwer, 1988, pp. 1–15. (Repr. and quoted from J.H. Fetzer (ed.) The Philosophy of Carl G. Hempel. Studies in Science, Explanation, and Rationality. Oxford: Oxford University Press, 2001, pp. 237–249.)

Knorr Cetina, 1992 – Knorr Cetina, K.D. "The Couch, the Cathedral, and the Laboratory: On the Relationship between Experiment and Laboratory in Science", in: A. Pickering (ed.) *Science as Practice and Culture.* Chicago: University of Chicago Press, 1992, pp. 113–138.

Kuhn, 1962 – Kuhn, T.S. *The Structure of Scientific Revolutions.* Chicago: University of Chicago Press, 1962 (quotations are from the second edition, 1970).

Kuhn, 1964 – Kuhn, T.S. "A Function for Thought Experiments", in: R. Taton et I.B. Cohen (dir.), *L'aventure de la science.* Mélanges Alexandre Koyré, vol. II. Paris: Hermann, 1964, pp. 307–337. Repr. in: T.S. Kuhn. *The Essential Tension: Selected Studies in Scientific Tradition and Change*. Chicago (Ill.): University of Chicago Press, 1977, pp. 240–265.

Kühne, 2005 – Kühne, U. *Die Methode des Gedankenexperiments*. Frankfurt a.M.: Suhrkamp, 2005.

Lazarsfeld, 1962 – Lazarsfeld, P.F. "Philosophy of Science and Empirical Social Research", in: E. Nagel, P. Suppes, A. Tarski (eds.) *Logic, Methodology and Philosophy of Science. Proceedings of the 1960 International Congress Edited by Stanford Philosophy of Science and Empirical – Social Research.* Stanford (California): Stanford University Press, 1962, pp. 463–473.

Oppenheim, 1969 – Oppenheim, P. *Reminiscences of Peter*, in: N. Rescher (ed.) Essays in Honor of Carl G. Hempel. A Tribute on the Occasion of his Sixty-Fifth Birthday. Dordrecht: Reidel, 1969, pp. 1–4.

Popper, 1935 – Popper, K.R. *Logik der Forschung.* Wien: Springer, 1935.

Popper, 1959 – Popper, K.R. *The Logic of Scientific Discovery*. London: Hutchinson, 1959.

Rescher, 1969 – Rescher, N. (ed.) *Essays in Honor of Carl G. Hempel. A Tribute on the Occasion of his Sixty-Fifth Birthday*. Dordrecht: Reidel, 1969.

Salmon, 1999/2000 – Salmon, W.C. "Epilogue. The Spirit of Logical Empiricism: Carl G. Hempel's Role in Twentieth-Century Philosophy of Science", *Philosophy of Science,* 1999, vol. 66, pp. 333–350. Repr. from J.H. Fetzer (ed.) Science, Explanation, and Rationality. Oxford: Oxford University Press, 2000, pp. 308–324.

Schickore and Steinle, 2006 – Schickore, J. and Steinle, F. (eds.) *Revisiting Discovery and Justification: Historical and Philosophical Perspectives on the Context Distinction.* Dordrecht: Springer, 2006.

Sorensen, 1992 – Sorensen, R.A. *Thought Experiments.* London/Oxford: Oxford University Press, 1992.

Stäudner, 1998 – Stäudner, F. *Virtuelle Erfahrung. Eine Untersuchung über den Erkenntniswert von Gedankenexperimenten und Computersimulationen in den Naturwissenschaften*. Diss. Friedrich-Schiller-Universität, Erlangen, 1998.

Suppe, 2000 – Suppe, F. "Hempel and the Problem of Provisos", in: J.H. Fetzer (ed.) *Science, Explanation, and Rationality*. Oxford: Oxford University Press, 2000, ch. 8, pp. 186–213.

Weber, 1922 – Weber, M. *Wirtschaft und Gesellschaft. Grundriss der verstehenden Soziologie*. Tübingen: Mohr, 1922.

Weber, 1947 – Weber, M. *The Theory of Social and Economic Organization*, Engl. trans. by A.M. Henderson and T. Parsons. New York: Oxford University Press, 1947, pp. 87–423.

Weber, 1949 – Weber, M. *On the Methodology of the Social Sciences*, trans. and ed. E.A. Shils and H.A. Finch. New York: The Free Press of Glencoe, 1949.