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Confirmation Holism and Underdetermination in Quine's Thought

Holismo confirmacional e subdeterminação no pensamento de Quine

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Abstract
Quine is frequently acknowledged as one of the main proponents of both confirmation holism and underdetermination. In the recent literature, however, his views have been often criticized and misrepresented: the distinction between the two theses has been often blurred, the obviousness of holism has been rejected, and the plausibility of underdetermination has come under attack. This paper attempts to formulate both theses as clearly as possible and to defend Quine's views against some recurrent criticisms. In particular, it is argued that Quine's theses are significantly weaker than they have been taken to be and that only confirmation holism, but not underdetermination, plays a fundamental role in his philosophy.

Key words: confirmation holism, underdetermination, Quine.

Resumo
Quine é frequentemente reconhecido como um dos principais proponentes tanto do holismo confirmacional quanto da subdeterminação. Na literatura recente, entretanto, suas concepções têm sido com frequência criticadas e representadas de forma distorcida: a distinção entre as duas teses tem sido com frequência ofuscada, o caráter óbvio do holismo tem sido rejeitado e a plausibilidade da subdeterminação tem sido atacada. Este artigo tenta reformular ambas as teses tão claramente quanto possível e defende a concepção de Quine contra lgumas críticas recorrentes. Em particular, argumenta-se que as teses de Quine são significativamente mais fracas do que têm sido sido interpretadas, e que apenas o holismo confirmacional, mas não a subdeterminação, desempenha um papel fundamental em sua filosofia.

Palavras-chave: holismo confirmacional, subdeterminação, Quine

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Introduction

Confirmation holism and underdetermination have been very much associated with Quine's philosophy.[2] In 'Two Dogmas' (1980 [1951]), Quine presented confirmation holism as an alternative, or "countersuggestion" (p. 41), to the dogma of reductionism, the view that the empirical content of individual cognitive statements can each be reduced to statements containing only terms for sense-data and logical terms. More generally, holism is an alternative to the view – sometimes dubbed "atomism" – that each statement is endowed with an empirical content of its own.[3] Against atomism, holism says instead that in general empirical content attaches not to individual sentences or terms but to more or less large sets of sentences, the whole of science or "chunks" of it (Quine, 1980, p. 268), i.e. to sets of sentences large enough to entail empirically testable sentences.[4] Throughout Quine's work, holism is presented as a trivial doctrine, undeniable, and obviously true. In response to an objection by Grünbaum, for example, Quine wrote:

> For my own part I would say that the thesis [of confirmation holism] as I have used it *is* probably trivial. I haven't advanced it as an interesting thesis as such. I bring it in only in the course of arguing against such notions as that the empirical content of sentences can in general be sorted out distributively, sentence by sentence, or that the understanding of a term can be segregated from collateral information regarding the object (1976b, p. 132).

In later writings the obviousness of the doctrine is reaffirmed; in Quine (1992, p. 16) for example, he wrote that "[i]t is difficult to see how anyone can question holism, in the sense now before us".[5]

Confirmation holism is a fundamental doctrine of Quine's thought. Most aspects of his philosophy are directly affected by it: for example, Quine's qualms about Carnap's use of the analytic-synthetic distinction, the theses of indeterminacy of translation and ontological relativity, naturalized epistemology and Quine's overall conception of philosophy as continuous with science. Despite Quine's characterization of holism as trivially and obviously true, some of its implications have seemed unbelievable to some of his readers. Of those implications, perhaps the most polemical is the claim that scientific theories are underdetermined by observations: the so-called thesis of *underdetermination*. Quine himself did not maintain that confirmation holism *entails* underdetermination, but merely that it renders underdetermination plausible (1975, p. 313). Unlike confirmation holism, underdetermination is not trivially true, and both its formulation and justification are controversial.[6] Even within Quine's philosophy, underdetermination is neither

[2] Prior to Quine, Duhem (1954 [1914]) had defended confirmation holism, and for that reason it is also known as the "Duhem-Quine thesis". Duhem's version of the thesis is narrower in scope than Quine's, however (see below). Some authors distinguish "confirmation holism" and "meaning holism" (see, e.g., De Rosa and Lepore, 2004, p. 66), but this paper is concerned primarily with the former.

[3] See Fodor and Lepore (1992, chapter 2), and Hylton (2002, p. 12-13; 2007, chapter 3).

[4] In a well-known passage of 'Two Dogmas', Quine wrote that "our statements about the external world face the tribunal of sense experience not individually but only as a corporate body" (p. 41). The suggestion was that only theories as a whole have empirical content. In later works, Quine mitigated the thesis. In Quine (1991), for example, he refers to those statements as a "needlessly strong" (p. 268) assertion of holism, and concedes that empirical content can attach also to portions and branches of science, and to individual observation sentences and observation categoricals. See also Quine (1969, p. 79).

[5] See also Quine (1975, p. 313-314).

[6] For discussion, see Laudan and Leplin (1991), Norton (1993, 1994), Hoefer and Rosenberg (1994), Kukla (1998), Stanford (2001), Okasha (2002), and Magnus (2003).

trivially true nor a fundamental doctrine, and it does not affect other aspects of his philosophy in the same pervasive way holism does.

Something similar to what we see in Quine can also be seen in the philosophy of science literature more generally: in its more modest versions, confirmation holism is quite widely accepted, whereas the thesis of underdetermination remains problematic. The former is nonetheless generally perceived as suggesting some version or other of the thesis of underdetermination, at least *prima facie*, even by those who then go on to reject it. Some of the authors who reject underdetermination have also come to question holism itself, especially if the two theses are perceived as entailing some sort of uncertainty about the results of science.[7] Oftentimes those criticisms are facilitated by characterizations of the two theses which systematically blur their differences. An example of this kind of blurring can be found in Laudan (1990), who defines "Quinean underdetermination" as the thesis that "[a]ny theory can be reconciled with any recalcitrant evidence by making suitable adjustments in our other assumptions about nature" (p. 274). As we shall see below, at best this is a statement with which Quine would reluctantly agree only insofar as it is an imprecise characterization of *confirmation holism*, but not as a statement of the thesis of *underdetermination*, as Laudan suggests.[8] Underdetermination is not a thesis about the reconciliation of hypotheses or theories with observations, but about the possibility of alternative theories that predict the same observations. Strictly speaking, the thesis stated by Laudan is false even as a characterization of confirmation holism, since some theories clearly imply false observation categoricals and are therefore irreconcilable with observations. Quine's thesis of confirmation holism says rather that individual hypotheses or sentences – but not whole theories, or at least not global theories – can be reconciled with observations by making adjustments in other sentences of the original theory, or in the original background and ordinary assumptions. Adjustments to a theory as a whole yield new theories, not the same theory; so the claim cannot simply be that any theory can be reconciled with any evidence.

The main goal of this paper is to formulate both confirmation holism and underdetermination as clearly as possible, sorting out the connections and differences between the two. In so doing, we shall be arguing against authors who have blurred the distinction between them and laying out the ground for a defense of moderate versions of both. The second section introduces confirmation holism, focusing primarily on Quine's formulation; the next section briefly recalls the origins of this thesis in Duhem's work and in Quine's reaction to Carnap's project in the *Aufbau*; the following section formulates the thesis of underdetermination and explains why confirmation holism renders it plausible but is insufficient to establish it; and the final section outlines some of the main consequences of each thesis.

Confirmation holism

Both confirmation holism and underdetermination have been variously formulated. Perhaps it would be more appropriate to speak of *theses* of confirmation holism and *theses* of underdetermination instead, since those formulations are not all equivalent. Broadly speaking, confirmation holism may be understood as saying that empirical content attaches in general not to individual sentences but to more or less large sets of sentences.

[7] An example is Norton (1994).

[8] Similar confusions can be found in Kitcher (1993, p. 251), and Leplin (1997, p. 210).

This initial characterization turns on the notion of 'empirical content', which may not be immediately clear. In the debates on the topic, the *content* of a sentence or set of sentences is usually taken to be the set of sentences which it implies that are neither logically valid nor analytic.[9] Logically valid and analytic sentences are thought to follow from any other sentence or set of sentences, regardless of what those say. If the notion of 'content' is to play a useful role, it must be capable of setting apart the logically valid and analytic sentences implied by a sentence or set of sentences from the other sentences that they imply. In determining the content of "there are zebras in Africa", for example, it is irrelevant that "it is raining or not raining", or that "no bachelors are married" logically follow from it. On the other hand, it *is* relevant that some synthetic and logically invalid sentences also follow from it. For example, "there are zebras in Africa" implies that "there are mammals in Africa" and "there are vertebrates in Africa". So the content of a sentence can be characterized as the set of logically invalid and synthetic sentences that it implies. This definition can be trivially extended to sets of sentences: the set of logically invalid and synthetic sentences that follow from a given set of sentences.

The notion of 'content' can then be used to define the *empirical* content of a sentence or set of sentences: not the set of logically invalid and synthetic sentences that are implied by a given sentence or set of sentences, but some favored subset of such sentences held to be confirmed or refuted by observations. Naturally, there is much room here for divergencies about which sentences are actually confirmed or refuted by observations, and even about what counts as an observation. It is not clear whether any precise borderline can be conceived, even in principle. In an attempt to circumvent those difficulties, Quine avoids talking of observations and of sentences being confirmed (or refuted) by observations. He settles instead for the notions of 'observation sentences' and 'observation categoricals'. Observation sentences are sentences like "It's raining", "It's getting cold", and "That's a rabbit". They are *occasion sentences*, true on some occasions and false on others, and

> [...] should command the subject's assent or dissent outright, on the occasion of a stimulation in the appropriate range, without further investigation and independently of what he may have been engaged in at the time. A further requirement is intersubjectivity: unlike the report of a feeling, the sentence must command the same verdict from all linguistically competent witnesses of the occasion (Quine, 1992, p. 3).

What Quine calls "observation categoricals" are general sentences of made up of observation sentences.[10] These are sentences of the form "Whenever this, that": "Whenever there is smoke, there is fire", for example. The "whenever", Quine notes,

> [...] is not intended to reify times and quantify over them. What is intended is an irreducible generality prior to any objective reference. It is a generality to the effect that the circumstances described in one observation sentence are invariably accompanied by those described in the other (1992, p. 10).

As such, Quine argues, observation categoricals can be learned very early on, even by a child before she has fully acquired something like quantification theory.

[9] See, for example, Carnap (2002, § 49) and Sellars (1980, p. 266). There are various ways of characterizing the 'analyticity', but this issue is not particularly relevant here. But see Coffa (1991) for an historical reconstruction; Quine's views can be found in Quine (1980, 1976a, 1992, p. 54-56).

[10] In works published in the 1970s and before, Quine was using the "less fruitful" notion of 'observation conditional', which is made up not of observation sentences, but of "standing sentences". For further clarification and discussion, see Quine (1981, p. 26-27).

They are unlike observation sentences in that they are not occasion sentences, but *standing sentences*, true or false once and for all. They can be immediately rejected if some occurrence of the first occasion is not followed by an occurrence of the second; and command assent if the relevant occurrences systematically follow one another in the right order. As such, they play a crucial role in the testing of scientific theories. Scientific theories typically do not imply observation sentences, since most theories comprise general statements or laws only, which cannot entail statements about particular occasions but only general relations among occasion types. Scientific theories do, however, imply observation categoricals, and it is by way of these that they come to be tested. Such, at least, is the way Quine broadly conceives the relations between theories and observations (see 1975, p. 314 ff., 1981, p. 24-30, 1991, p. 268).

Given these characterizations of content, observation sentences, and observation categoricals, Quine defines the notion of 'empirical content' rather straightforwardly as follows:

> Call an observation sentence *analytic* for a given speaker if, as in 'Robins are birds', the affirmative stimulus meaning for him of the one component is included in that of the other. Otherwise *synthetic*. Call a sentence or set of sentences *testable* if it implies some synthetic observation categoricals. Call two observation categoricals *synonymous* if their respective components have the same stimulus meanings. Then the *empirical content* of a testable sentence or set of sentences for that speaker is the set of all the synthetic observation categoricals that it implies, plus all synonymous ones. I add the synonymous ones so that merely verbal variation will not obstruct sameness of content. Having thus defined empirical content and hence empirical equivalence for the individual speaker, we can call two sentences or sets of sentences equivalent for a whole community when equivalent for each member (1992, p. 16-17).

Quine offers no definition of the empirical content of sentences that are not testable, or for theories that do not imply testable observation categoricals because of vagueness in the formulation. Yet he nonetheless uses a related, more loosely defined notion in contexts where they are involved:

> [...] much solid experimental science fails testability in the defined sense. This can happen [...] because of vague and uncalibrated probabilities in the backlog of theory. No doubt it happens also in more complex ways, not clearly understood. I have no definition of empirical content to offer for such theories, but it still seems to make reasonable intuitive sense to speak of empirical equivalence among them, since experimentation is still brought to bear. The idea is that whatever observation would be counted for or against the one theory counts equally for or against the other (1992, p. 95-96).[11]

Given Quine's definition of empirical content, it follows that meaning holism and confirmation holism are just two aspects of a single thesis, which can be stated thus: scientific, or cognitive, sentences *in general* lack empirical content when considered individually, or in isolation from other sentences. In general they do not, on their own, imply observation sentences or synthetic observation categoricals. The "in general" above is needed to accommodate two exceptions. The first is that some scientific statements are themselves observation sentences or synthetic observation categoricals. Since they imply themselves, they do have an empirical content of their own even

[11] This extended use of the notion of 'empirical equivalence' appears in Quine's formulation of the thesis of underdetermination; some of the difficulties associated with that thesis turn on the extended use of the notion. More on this issue below.

when considered individually. The second exception is that individual sentences that lack empirical content may be conjoined into longer sentences that do have empirical content. One may even conjoin all the sentences that make up a scientific theory, or large portions of them, into a very long conjunctive sentence. That sentence would then have an empirical content of its own (see Quine, 1998a, p. 620).

Granted those two exceptions, confirmation holism has an almost trivial justification. Most sentences that make up the corpus of a scientific theory can only imply observation sentences and synthetic observation categoricals together with a number of other sentences and ordinary assumptions. Take, for example, the statement that most living plants produce oxygen in the presence of sunlight. This is true of most living plants, but false of some plants that are parasitic on other plants, and of some plants which extract their nutrients from dead organic matter. The general claim on its own, however, implies no observation sentences or synthetic observation categoricals, since it says nothing about what oxygen is and how one detects it or what living plants are and how they are identified. In the absence of such specifications, the claim that most living plants produce oxygen in the presence of sunlight fails to imply any observation sentence or synthetic observation categorical. A very large number of sentences is needed for that implication to obtain, including sentences specifying what oxygen and plants are. Only together can those sentences have some empirical content. But once those sentences are added, what one has is a whole theory, or at least a significant portion of a theory.

Confirmation holism is even more obvious if one considers sentences which are steeped into the more theoretical realms of science, such as sentences about subatomic particles or about the most general features of space-time. Think, for example, of Einstein's famous statement that $E=mc^2$. The truth of that claim can only begin to be ascertained once one has some specification of what to count as energy, mass, and the speed of light, and how to identify and measure those things. Hence, a number of additional sentences, most of them also theoretical in nature, have to be brought in for the original one to imply a synthetic observation categorical and thus be tested. In fact, if we were to regard Einstein's statement in isolation, it could hardly be thought to have any meaning at all. Only in the context of a theory can we more or less specify what the sentence says and what has to be the case for it to be true. Strictly speaking, the sentence itself, on its own, makes no claim upon reality; only the theory of which it is part, or more or less large portions of that theory, can be said to make such a claim.

In ordinary scientific practice, a background theory is commonly presupposed each time terms such as 'energy' and 'mass' are used. Given those background assumptions, theoretical sentences like Einstein's above may perhaps be thought to imply synthetic observation categoricals, even when considered in isolation from other sentences. Confirmation holism does not have to be thought as denying that. Rather, it merely calls attention to those background presuppositions; it says that without them, theoretical sentences cannot imply synthetic observation categoricals. Moreover, it says that, in general, for those implications to obtain, the assumptions built into the use of theoretical terms have to be fairly large in number and encompass a wide stretch of the theory or theories of which they are part. Assertion of a theoretical sentence oftentimes presupposes the assertion of a large portion of a theory, or at least of a system of interrelated sentences.[12]

[12] Quine's holism is – in this regard at least – very much akin to a point later made by Wittgenstein: "What I hold fast to is not *one* proposition but a nest of propositions" (1969, § 225). For a comparative discussion of Wittgenstein and Quine on this particular issue, see Gibson Jr. (1996).

One important and immediate consequence of confirmation holism is that if a theory implies an observation categorical that is disconfirmed by observations, no individual sentence of the theory is thereby immediately refuted. Rather, what is refuted is the theory, or system of sentences as a whole, together with whichever ordinary assumptions played a role in implying the failed observation categorical. Confirmation holism can thus be thought to complement the claim that scientific hypotheses, because of their generality, cannot be *verified* by any finite number of observations. It complements that claim by saying that theoretical hypotheses, on their own, cannot be *refuted* either. Only theories as wholes, or portions of them large enough to imply observation sentences or synthetic observation categoricals can be refuted by observations. Confirmation holism still entail that theories as wholes can be refuted, however.

In the presence of an adverse observation, the scientist is more or less at liberty about which part of his theory to revise, and he may also choose to keep the theory as it is and revise some ordinary assumptions which may have played a role in implying the false categorical. He is of course constrained by the weight and strength that he assigns to various portions of his theory and ordinary assumptions, and by certain maxims of theory construction (such as simplicity, conservatism, generality, and fecundity). Nonetheless, in the face of a counterexample, a scientist always must decide between various courses of action, even if all but one of the alternatives seems reasonable to him at that moment.[13] He may choose to retain the hypothesis under scrutiny and revise some of the assumptions of his experiment, or perhaps some more fundamental tenets of his theory. More frequently, he will retain the experimental results and the basic assumptions of his theory and revise only the specific hypothesis he set out to test. These considerations are confirmed by the practice of experimental scientists, who typically devise a number of alternative explanations for why an experiment may not have come out as expected.

Some statements are of course more easily revised than others. What I claim to see now in front of me may be revised in the light of what I come to see later on. Other sentences are not as easily given up. The general laws and principles of natural science, for example, are typically upheld for a long time. And the sentences of elementary logic and mathematics, because they are common to all branches of science, can only be revised at the cost of making considerable adjustments throughout science. They are thus only very seldom changed. Nevertheless, changes in logic and in number theory have indeed occurred, and to a large degree they were justified by the overall benefits they brought to science. Typical examples were the introduction of negative numbers – thought to be absurd by thinkers such as Descartes – and the development of infinitesimal calculus.

These rather trivial remarks make up the core of Quine's thesis of confirmation holism. But they were also the source of, or the motivation for, some controversial claims which we find in Quine's "Two dogmas":

> The unit of empirical significance is the whole of science (1980, p. 42).
>
> [A]ny statement can be held true come what may, if we make drastic enough adjustments elsewhere in the system. [...] Conversely, by the same token, no statement is immune to revision (1980, p. 43).

[13] In many cases, it is in fact rather inappropriate to speak of a decision. Oftentimes the scientist will not even say that there are alternatives. This does not contradict holism; it just shows that in many cases the background theory held at the moment is thought to be beyond reasonable doubt, thus ruling out alternatives which would otherwise be thought to be relevant. For discussion on how evidence may constrain a scientist's options, see Norton (1993, 1994), and Massimi (2004).

Most of the criticisms of Quine on holism that one finds in the literature aim at those two passages. Quine himself, however, would later describe those claims as a "needlessly strong" (1991, p. 268). They are true, he adds, in a "legalistic sort of way" (1991, p. 268), but they divert attention from what is more fundamental. Holism is an alternative to the claim that the empirical content of a theory can be sorted out distributively among the sentences and terms that comprise it. To contravene that claim, it suffices to say that some sentences of a theory, on their own, lack empirical content. There is no need to further claim or suppose that empirical content attaches only to the whole of science. Clusters of sentences "sufficient to imply an observable effect of an observable experimental condition" (1991, p. 268) can also be thought as having an empirical content, even if they do not comprise the whole of science. It is true that science is considerably integrated, and that some components, such as elementary logic and mathematics, are common to all branches.

> But we can appreciate this degree of integration and still appreciate how unrealistic it would be to extend a Duhemian holism to the whole of science, taking all science as the unit that is responsible to observation. Science is neither discontinuous nor monolithic. It is variously jointed, and loose in the joints in varying degrees. In the face of a recalcitrant observation we are free to choose what statements to revise and what ones to hold fast, and these alternatives will disrupt various stretches of scientific theory in various ways, varying in severity. Little is gained by saying that the unit is in principle the whole of science, however defensible this claim may be in a legalistic way (1975, p. 314-315).

In his writings after "Two dogmas", Quine would likewise maintain that, legalistically speaking, it remains true that any individual statement can be revised or abandoned without affecting the net empirical implications of the resulting theory, so long as adjustments are made elsewhere in the theory or background assumptions. In the actual practice of working scientists, however, a large number of statements are effectively shielded from revisions because of their centrality to the theories accepted at that moment, or because they are directly confirmed by a very large number of observations. Scientists only subject a few statements to scrutiny at any given moment, and this is crucial for the development of the scientific enterprise. Revisions in statements that are central to the whole of science require a very large number of adjustments throughout, and alternatives to those statements are oftentimes unavailable at a given moment. These difficulties counsel against revisions, whenever possible. Quine offers these considerations as an explanation of the perceived 'necessity' of some theoretical statements; for example, those of mathematics:

> [...] mathematics infiltrates all branches of our system of the world, and its disruption would reverberate intolerably. If asked why he spares mathematics, the scientist will perhaps say that its laws are necessarily true; but I think we have here an explanation, rather, of mathematical necessity itself. It resides in our unstated policy of shielding mathematics by exercising our freedom to reject other beliefs instead (1992, p. 15).

Revisions in those central statements occur only very seldom in the history of science, and while they occur other statements are maintained as they are.[14]

[14] A more or less clear illustration of this point can be found in the revision of our notions of space and time brought about by contemporary physics. The classical notions of space and time were indeed very central to modern science and philosophy; they were sometimes described as necessary and a priori notions – for example, by Kant – and revisions of them were thought to be absurd or impossible to philosophers up to the early nineteenth century. In 1827, Ferdinand Möbius, for example, rejected the idea of spaces with more than three dimensions because, he wrote, they "cannot be thought" (1991, p. 40-41). Spaces with more than three dimensions are nowadays routinely posited by string theories, for example.

Revisions of statements directly linked to systematic (widely repeated) observations also require a large number of adjustments and are likewise shielded from revisions. In principle, or legalistically speaking, they are possible and have happened in the history of science.[15]

Quine replaced his "needlessly strong" assertion of holism in "Two dogmas" with a more modest one in later works, which stresses what he calls the "empirical bias" of science, on the one hand, and the centrality of some theoretical sentences to the system of science as a whole:

> [...] the scientist does occasionally revoke even an observation statement, when it conflicts with a well attested body of theory and when he has tried in vain to reproduce the experiment. But the Duhem thesis would be wrong if understood as imposing an equal status on all the statements in a scientific theory and thus denying the strong presumption in favor of the observation statements. It is a bias that makes science empirical (1975, p. 314).[16]

Once these qualifications to confirmation holism are granted, the thesis turns out to be quite modest, and its justification rather straightforward. Nonetheless, it has far-reaching consequences, not the least of which is the inseparability of questions of meaning from empirical questions (thus the inseparability of meaning holism and confirmation holism in Quine), and the difficulties it raises for the traditional notion of 'a priori'.[17]

A stronger version of the thesis, criticized by Grünbaum (1960, 1962) and sometimes thought to have been suggested by the controversial passages in "Two dogmas" quoted above, says that in the face of adverse observations any statement can be held true by revising the accepted theory and ordinary assumptions so that the threatened hypothesis together with the revised theory will *imply* the observation categorical whose negation was implied by the original theory. Quine explicitly acknowledges Grünbaum's criticism, granting him the point while maintaining his own version of the thesis: "Inactivating the false implication is all that is at stake" (1992, p. 16).[18]

Quine's confirmation holism merely says that given an hypothesis *H*, an accepted theory *T*, and a synthetic observation categorical *O* which is found to be false, if (*H* and *T*) implies *O*, then one can revise *H* and *T* and come up with *H'* and *T'* such that (*H'* and *T'*) does not imply *O*. Moreover, one should also be able to come up with at least one alternative revision, say, *H''* and *T''*, such that (*H''* and *T''*) does not imply *O* either. The stronger version of holism criticized by Grünbaum says instead that in the face of adverse observations *H* and *T* can be revised so that (*H'* and *T'*) implies not-*O*, and likewise for (*H''* and *T''*). The latter, stronger version of holism is not trivially true, since alternative theories that imply a given observation are not always easy to come by. Oftentimes, in the history of science, some observations remain anomalous for considerable periods of time. Coming up with theories that can predict and explain such anomalies is not a requirement of Quine's thesis, which merely says that alternative ways of *preventing* a theory from entailing a false observation categorical are always available. To prevent an implication

[15] An example is the belief that the Sun moves around the Earth. That belief was, in ancient times, thought to be rather closely tied to the observation of the Sun moving across the sky every day.

[16] See also Quine (1995, chapter 4).

[17] For further discussion, see Harman (1996, 2003), and Hylton (2002, 2004, 2007).

[18] See also Quine (1976b, p. 132, 1990b, p. 11-12). Laudan (1990, p. 271 ff.), Kitcher (1993, p. 250), and Leplin (1997, p. 210), however, have insisted in assigning to Quine the stronger version of confirmation holism criticized by Grünbaum, despite Quine's explicit disavowals.

from obtaining it suffices to weaken one or more sentences of the accepted theory or of the hypothesis under consideration. Whereas "[e]xplaining the unexpected counter-observation is quite another step of scientific progress, which may or may not be made in the fullness of time" (Quine, 1992, p. 16).

Duhem and Carnap

Prior to Quine, confirmation holism had already been put forth by Duhem:

> A physicist decides to demonstrate the inaccuracy of a proposition [...] The prediction of the phenomenon, whose nonproduction is to cut off debate, does not derive from the propositions challenged if taken by itself, but from the proposition at issue joined to [a] whole group of theories; if the predicted phenomenon is not produced, not only is the proposition questioned at fault, but so is the whole theoretical scaffolding used by the physicist. The only thing the experiment teaches us is that among the propositions used to predict the phenomenon and to establish whether it would be produced, there is at least one error; but where this error lies is just what it does not tell us (Duhem, 1954, p. 185).

Duhem's thesis has a narrower scope than Quine's, however. Duhem takes confirmation holism to be true of theoretical hypotheses in physics and a few other areas of natural science that are sufficiently removed from ordinary experience; but he takes it to be false of mathematics and logic, on the one hand, and of physiology, certain branches of chemistry, and other disciplines which are more closely tied to observations than theoretical physics. In these disciplines, he wrote, it is expected of the scientist that he "establish an absolute separation or watertight compartment between the consequences of his theoretical deductions and the establishing of the facts shown by his experiments" (Duhem, 1954, p. 182), whereas in physics such separation cannot exist: "it is impossible to leave outside the laboratory door the theory that we wish to test, for without theory it is impossible to regulate a single instrument or to interpret a single reading" (Duhem, 1954, p. 182). In theoretical physics, he concludes, only "whole theoretical groups" can be tested, isolated hypotheses cannot.

Duhem argues that, contrary to what happens in theoretical physics, the results of experiments in physiology, for example, do not presuppose a theoretical (physiological) explanation of the workings of the equipment used in the experiments. Experiments in physiology can thus be regarded as establishing facts regardless of what theories in physiology might lead one to expect as the right outcome of those experiments. Observations would in that sense override theoretical hypotheses. Similarly, but on the other end of the spectrum, in mathematics and logic, a strict separation also exists between theory and observation. In this case, however, observations would be completely immaterial: in establishing the truths of mathematics and logic, experiments do not matter.

While reading Duhem nowadays, one is forcefully reminded of changes that chemistry and physiology, as well as math and logic, have undergone in the century that has passed since he wrote his work. Nowadays, chemistry and physiology are as theoretical as almost all other branches of natural science, and the separation Duhem speaks about has become much harder to detect, if it exists at all. Also, physics seems now even more tightly connected to the developments in mathematics and logic than it was in Duhem's time. As Quine would often note (for example: 1980, p. 43), alternative logics have been proposed as ways of dealing with empirical problems brought about by quantum mechanics.

Quine's confirmation holism is, accordingly, broader in scope than Duhem's: it purports to hold in all branches of science, including math and logic. It is likely that this difference between Duhem and Quine is at least in part due to the scientific developments that occurred in the first half of the twentieth century, which only Quine witnessed. Duhem must have had in mind the science of his time, which was a lot less theoretical than it later became. Quine himself also connects the difference between his version of the thesis and Duhem's to his own "view of common sense as primitive scientific theory" (1998a, p. 619) and his realistic attitude towards the theoretical entities and principles posited by science, as opposed to Duhem's fictionalistic attitude. Duhem, like others in the first half of the twentieth century, thought that the physical hypotheses positing theoretical entities and principles were strictly speaking neither true nor false, but symbolic approximations intended to facilitate or produce adequate predictions of observations.[19] Quine, on the other hand, thought of the posits of science as on a par with directly observable objects posited by common sense, such as chairs and tables: "Science is a continuation of common sense, and it continues the common-sense expedient of swelling ontology to simplify theory" (1980, p. 45).[20]

Duhem originally developed his version of confirmation holism in the late nineteenth and early twentieth century. Quine's views were developed independently in the 1930s and 1940s,[21] as a reaction to his reading of Carnap's *Aufbau*.[22] On Quine's reading, Carnap fully embraced a reductionist project in the *Aufbau*, which aimed at translating, and thus reducing, all of science into logic and observation terms (1969, p. 76). Quine praises Carnap as "the first empiricist who, not content with asserting the reducibility of science to terms of immediate experience, took serious steps toward carrying out the reduction" (1980, p. 39).[23]

The *Aufbau*, however, contains only a very rough guide on how to proceed in order actually to produce a reduction of science into logic and observation terms. Yet, even apart from sketchiness, the project as laid down by Carnap turned out to be unviable. Only a few years after its publication Carnap had already substantially weakened it.[24] On Quine's reading, the project failed because it could not fulfill its promise of "specifying a sense-datum language and showing how to translate the rest of significant discourse, statement by statement, into it" (1980, p. 39).[25] The crucial problem is made evident in sections 126 and 127 of the *Aufbau*, where

[19] The following passage by Einstein illustrates this point: "[The general theory of relativity] revealed that is was possible for us, using basic principles very far removed from those of Newton, to do justice to the entire range of the data of experience in a manner even more complete and satisfactory than was possible with Newton's principles. But quite apart from the question of comparative merits, the *fictitious character* of the principles is made quite obvious by the fact that it is possible to exhibit two essentially different bases, each of which in its consequences leads to a large measure of agreement with experience. This indicates that any attempt logically to derive the basic concepts and laws of mechanics from the ultimate data of experience is doomed to failure" (Einstein, 1934, p. 166, emphasis added).

[20] For a comparative analysis of Duhem's and Quine's theses, see Vuillemin (1998).

[21] Commenting back on "Two dogmas", Quine wrote: "In a footnote to 'Two Dogmas' I noted Duhem's priority in stressing holism. As a matter of curiosity, however, I might mention that when I wrote and presented 'Two Dogmas' [...] I didn't know about Duhem. Both Hempel and Philipp Frank subsequently brought Duhem to my attention, so I inserted the footnote when 'Two Dogmas' was reprinted in *From a Logical Point of View*" (1991, p. 269).

[22] See Carnap (1967).

[23] Quine's reading of the *Aufbau* has been contested in the recent literature: see Michael Friedman (1999) and Alan Richardson (1998). These authors emphasize Carnap's neo-Kantianism: the *Aufbau*, on their reading, was an attempt to explain all knowledge in logical terms only, without the pure concepts of the understanding which were at the heart of Kant's metaphysics.

[24] See Carnap (1936, 1937), and Quine (1969, p. 77); see also Carnap's Preface to the second edition of the *Aufbau* (1967, p. viii).

[25] See also Quine (1969, p. 76-77).

Carnap lists a set of desiderata that need to be fulfilled in order for the reduction to take place. Those desiderata concern the reduction of sentences expressing perceptions of colors to sentences assigning colors objectively to space-time points. The sections are meant to illustrate how the reduction of scientific sentences in general is supposed to take place and they mark what Carnap calls the passage from the "autopsychological" realm to the objective world. They attempt to show how solipsistic, or subjective, constructions of sensations and experiences can be assigned objective space-time points. By specifying a recipe, however sketchy, for making those assignments, it would show how to reduce all statements about color properties to statements comprising only logical terms and terms for sense-data and provide a guide for the assignment of other types of sensations and experiences to the objective world. Carnap lists 11 desiderata in § 126, which are subsequently supplemented (§ 127 contains an alternative presentation of the same material).

The idea is to assign each color sensation to a certain space-time point, and assign colors to all the remaining space-time points so as to maximize the overall continuity and simplicity of the system of space-time points, at least inasmuch as colors are concerned. If, for example, the color red is assigned to point *p* at time *t*, and the same assignment is made a few minutes later, then in the time interval in between those two assignments we should assume that point *p* remained red, unless some other assignments determine otherwise. Thus, desideratum 10 says that

> [W]e have to assign a color to the unseen color spots. Taking into account the colors of seen color spots, we make a preliminary choice of these colors in such a way that the color of the points of a world line, considered as a function of time, shows a rate of change which is as small as possible, i.e., if possible, remains constant (1967, p. 196-197).

Likewise, as new sensations are had and new assignments are made, previous assignments may need to be revised accordingly, always attempting to maximize the overall continuity and simplicity of the assignments. Since the desiderata listed by Carnap are meant to provide a general recipe for specifying which color sensation *is at* each space-time point, they can be understood as providing instructions for reducing the relation "is at" to logical terms and terms for sense data. As Quine points out, however, the intended reduction cannot obtain even in principle:

> Carnap did not seem to recognize [...] that his treatment of physical objects fell short of reduction not merely through sketchiness, but in principle. Statements of the form 'Quality *q* is at point-instant *x*;*y*;*z*;*t*' were, according to his canons, to be apportioned truth values in such a way as to maximize and minimize certain over-all features, and with growth of experience the truth values were to be progressively revised in the same spirit. I think this is a good schematization (deliberately oversimplified, to be sure) of what science really does; but it provides no indication, not even the sketchiest, of how a statement of the form 'Quality *q* is at *x*;*y*;*z*;*t*' could ever be translated into Carnap's initial language of sense data and logic. The connective 'is at' remains an added undefined connective; the canons counsel us in its use but not in its elimination (1980, p. 40).

Furthermore, Carnap does not give any indication of the relative weight of each desideratum. Hence, conflicting desiderata may in principle yield conflicting assignments of colors to objective space-time points. More importantly for our purposes here, the assignment of colors to space-time points cannot be executed one at a time, since some assignments are dependent on others. If a certain color sensation is an

hallucination, for example, there is no corresponding assignment to be made in the objective space-time. But whether a sensation is an hallucination can only be judged by comparing it to other sensations that are not hallucinatory. Hence, the assignments of colors to objective space-time points cannot be made one by one. Rather, they must be holistic and proceed from the totality of sensations (or a very large number of them) to the totality of objective space-time points (or a large portion of them). However, since the totality of color-sensations is never completely given, one can never be sure that the assignments made up to a given time will not have to be revised later in the light of new sensations. Thus, one can never actually reduce, one by one, the sentences containing assignments of color to objective space-time points to a sentence containing only terms for sense-data and logical terms.

To his credit, this is a point which Carnap seems soon to have acknowledged, since in later writings he proposes a reduction of a slightly laxer kind. In "Testability and meaning" (1936, 1937), for example, he puts forth the weaker notion of 'reduction form' as an alternative to the explicit definitions proposed as instruments of reduction in the *Aufbau*. Perhaps not surprisingly, in the *Logical syntax of language* [1937], Carnap explicitly endorses Duhem's confirmation holism:

> [...] it is not possible to lay down any set rules as to how new primitive laws are to be established on the basis of actually stated protocol-sentences. [...] Further, it is in general impossible to test even a single hypothetical sentence. In the case of a single sentence of this kind, there are in general no suitable L-consequences of the form of protocol-sentences; hence for the deduction of sentences having the form of protocol-sentences the remaining hypotheses must also be used. Thus *the test applies, at bottom, not to a single hypothesis but to the whole system of physics as a system of hypotheses* (Duhem, Poincaré).
>
> No rule of the physical language is definitive; all rules are laid down with the reservation that they may be altered as soon as it seems expedient to do so. This applies not only to the P-rules but also to the L-rules, including those of mathematics. In this respect, there are only differences in degree; certain rules are more difficult to renounce than others (2002, p. 316-317).

Incidentally, Quine lectured on the philosophy of Carnap in 1934 (see Quine, 1990a) and may have picked up the gist of the reasons for holism from Carnap himself.

Confirmation holism lends credence to underdetermination

Confirmation holism, even in its more modest version defended by Quine after "Two dogmas", suggests the plausibility of a stronger one, the thesis of underdetermination.

> If in the face of adverse observations we are free always to choose among various adequate modifications of our theory, then presumably all possible observations are insufficient to determine theory uniquely (1975, p. 313).

The reasoning here seems clear enough on a first approximation: each "adequate" modification would yield a new theory which is compatible with observations in that it does not imply observation categoricals that are known to be false. Since various new theories are thus made possible, the observations available at any given moment cannot, on their own, determine one theory above all others.

This, however, is not yet the thesis of underdetermination, but just an immediate consequence of confirmation holism itself.[26] Underdetermination further enjoins us to entertain the unlikely possibility of two theories that imply exactly the same observation categoricals and yet differ from one another at the level of theoretical sentences. Quine thinks of the thesis in connection to what he often calls – following Newton – "systems of the world", that is, global theories, or theories of everything, sufficiently general in scope to encompass not only all given observations but all possible ones, insofar as sense can be made of that notion. Underdetermination thus seems a stronger thesis than confirmation holism, because of its use of the notion of 'empirical equivalence' even beyond the limits of testability. However, for Quine, underdetermination would always remain somewhat "beset with obscurities" in ways that confirmation holism is not. The latter is confirmed by the practices of experimental scientists; no such confirmation is available for underdetermination, since that could only happen if we had at least two rival systems of the world which were not only correct but also empirically equivalent.

Quine's most important analysis of underdetermination was laid out in Quine (1975), which purports to "explore its meaning and its limits" (p. 313). The essay begins with a presentation of confirmation holism and argues that it "lends credence" to the thesis of underdetermination. The paper reformulates the thesis of underdetermination itself and presents the rivalry which empirically equivalent theories can be thought to have as cases of non-intertranslatability. The thesis then says that we cannot rule out the possibility of us finding empirically equivalent theories which we will systematically fail to render empirically equivalent through reconstrual of predicates, or translation (1975, p. 328). In this regard, the so-called *thesis* of underdetermination is not much more than a conjecture. As such, it is weaker than confirmation holism, at least in the sense that as a conjecture it cannot, on its own, entail or support any significant doctrine in epistemology or metaphysics. Furthermore, confirmation holism alone cannot establish underdetermination, and in (1975) Quine offers two main reasons why it cannot:

(i) Given confirmation holism, we have reason to expect that various theories can be designed to conform to a given set of observations. "Adequate modifications" can yield new theories which are consistent with observations in the sense that they do not entail observation categoricals that are known to be false. However, those "adequate modifications" of a theory could, for all we know, each imply a different, or perhaps a new set of observation categoricals. The revised theories, in other words, might not end up being empirically equivalent. In fact, that is to be expected, since revisions of different hypotheses are likely to affect the implied observation categoricals in different manners. Hence, even though the new theories may each be compatible with the observations that led to the revisions of the original theory, they may not be compatible with future observations, or past events that went unobserved. Hence, they fail as cases of underdetermination.

(ii) Even if the new theories, produced by "adequate modifications" of an older theory, were all empirically equivalent, one cannot thereby conclude that they are in fact distinct theories. Since they presumably agree on all observation categoricals, whatever differences they may have must be confined to sentences that hinge on observations only indirectly, that is, the so-called theoretical sentences. But then one cannot in principle exclude the possibility that all the new theories produced by that revision process are not only empirically equivalent but in fact versions of

[26] Some authors, for example, Sklar (1975, 1981) and Stanford (2001) – refer to this thesis as "transient underdetermination". It is not clear, however, how that thesis differs from holism. See Hoefer and Rosenberg (1994) for discussion of this particular point.

the same theory, which can be rendered logically equivalent by "reconstrual of predicates", or translation. A physical theory in which all occurrences of "proton" and "electron" are interchanged is indeed empirically equivalent to the original theory in which those terms are not interchanged. The two theories, however, can be clearly rendered logically equivalent by translating both into the vernacular English of technical physics. This is a fairly trivial case. In principle, however, more complicated cases might also turn out to be likewise intertranslatable, even if a manual of translation is hard to come by.

Holism is thus insufficient to establish underdetermination.[27] The latter can only obtain if not only alternative ways of revising a theory can render it compatible with a given set of observations, but also if the resulting theories are empirically equivalent but cannot be rendered logically equivalent through intertranslation. There are considerable difficulties in demonstrating that this is possible even in principle, and for that reason Quine tended to treat the thesis as a conjecture (see, e.g., 1981, p. 181). Whether there are empirically equivalent systems of the world that are not intertranslatable, he wrote, is an "open question" (1975, p. 327). Also open is the question whether, upon finding such theories and failing to intertranslate them, that failure is to be accounted on our lack of ingenuity or on intrinsic features of the two theories that would prevent any intertranslation in principle (1975, p. 328). Underdetermination, in other words, although plausible on a first approximation, cannot be asserted as categorically as confirmation holism can.

Some implications of the two theses

Within Quine's philosophy, confirmation holism has far-reaching consequences, despite its trivial justification. Quine argued that it provides good reasons to reject the idea of a realm of epistemologically privileged sentences – say, "analytic" or "a priori" sentences – which would be immune to revision or true in virtue of meaning or necessarily true. All the sentences that make up the corpus of a scientific theory are justified by the net empirical implications of that theory. If the synthetic observation categoricals implied by the theory are confirmed, so are all the sentences that comprise the theory, however removed they might be from observations. The thesis thus entails that the traditional distinctions between the various branches of science must be quite plastic, and that even the traditional distinctions between metaphysics and science, and between empirical claims and theoretical claims are rather arbitrary. Confirmation holism thus supports some substantial theses which are at the core of Quine's philosophy, including *meaning* holism (the thesis that isolated sentences do not in general have empirical content).

Quine used this in his justification of the thesis of indeterminacy of translation:

> [I]f the English sentences of a theory have their meaning only together as a body, then we can justify their translation into Arunta only together as a body. There will be no justification for pairing off the component English sentences with component Arunta sentences, except as these correlations make the translation of the theory as a whole come out right. Any translations of the English sentences into Arunta sentences will be as correct as any other, so long as the net empirical implications of the theory as a whole are preserved in translation (1969, p. 80).

[27] Quine is frequently misread on this point: Laudan (1990, p. 271 ff.) and Kitcher (1993, p. 251), for example, suggest that for Quine underdetermination is "grounded" on holism.

Indeterminacy of translation, like underdetermination, is a rather controversial thesis in the secondary literature. As is the case with underdetermination, it has also been frequently misunderstood. Besides unnerving commentators, the two theses share another interesting parallel: neither categorically affirms its peculiar form of indeterminacy. Quine distinguishes the thesis of indeterminacy of translation from ontological relativity (or indeterminacy of terms). The latter, he wrote, admits of trivial proof: "The essence of the proof is just that *x* is an *F* if and only if the proxy of *x* is the proxy of an *F*" (1998b, p. 728). The former, on the other hand, is a conjecture.[28] In this regard the thesis of underdetermination is similar to the thesis of indeterminacy of translation (or indeterminacy of sentences, or "holophrastic meaning").

The thesis of underdetermination, because of its conjectural status, cannot, on its own, support the weight of substantial doctrines. This is a point on which Quine is widely misread. The following passage, by Laudan and Leplin, illustrates well the misunderstanding in question:

> By the 1920s, it was widely supposed that a perfectly general proof was available for the thesis that there are always empirically equivalent rivals to any successful theory. [...] [B]y the 1940s and 1950s, it was thought that – in large part because of empirical equivalence – theory choice was radically underdetermined by any conceivable evidence. Whole theories of knowledge (e.g., W. V. Quine's) have been constructed on the presumption that these results are sound (1991, p. 449).

It is certainly true that confirmation holism (alongside empiricism and naturalism) plays a fundamental role in Quine's theory of knowledge. Underdetermination, given its rather conjectural justification, cannot play such role. The thesis suggests that alternative descriptions of the world may turn out to be equally tenable. But this is not an implication which can be asserted categorically within Quine's philosophy. Rather, the possibility of rival theories of the world which are empirically equivalent and yet non-intertranslatable remains "an open question" (1975, p. 327). Given holism and the "less-than-rigid" connections that seem to obtain between theories and observations, it is to remain a plausible conjecture, however. In later works, Quine vacillated on what to make of this conjecture. In Quine (1990b and again in 1992), he discusses two alternatives: one is to hold rival underdetermined theories as equally true, the other to hold only our current theory as true and all alternatives as false or meaningless. The former he calls the "ecumenical" attitude, the latter – which he eventually settled for – is the "dogmatic" attitude.[29]

In Quine (1975), he takes underdetermination to hold an important lesson for our attitudes towards science: however certain we may be of the correctness of the theories we hold, however well those theories may be supported by observations, there may always be room for "undiscovered systematic alternatives" (1975, p. 327) which may remain forever undetected. Symptomatically, the lesson Quine derives from underdetermination concerns our *attitudes* toward science, and not any metaphysical or epistemological doctrine.

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[28] See Quine (1998b, p. 728, 1969, p. 33, 1990b).

[29] I discuss this issue further in Severo (2008).

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