Constitutive A Priori

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To the memory of Arda Denkel,

to whom I owe the best change in my life

and all the wonderful things that followed

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ABSTRACT

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Recently there has been a renewed interest in the issue of *a priority*. Many philosophers have proposed accounts that attempt to establish the existence of *a priori* propositions while avoiding the difficulties of the former accounts. One of these philosophers is Michael Friedman, who has put forward the account of constitutive *a priori*. Friedman aims both to characterize constitutiveness with respect to a scientific framework and thereby to complement Kuhn's theory of scientific revolutions, and to establish a sense of *a priority* that the former gives rise to and thereby to challenge Quinean epistemological holism.

In my thesis, I provide a critical discussion of Friedman's own attempt to characterize constitutiveness with respect to a scientific framework. I argue that, in contrast to what Friedman claims, constitutiveness does not give rise to an epistemological difference that conflicts with Quinean epistemological holism. I rather suggest that the peculiarity of the putatively constitutive propositions can rather be accounted for by appealing to the notion of functional *a priority* that is proposed by Arthur Pap.

KISA ÖZET

Bilimsel Kuramları *Teşkil Edici A Priori* Önermeler

Melis Erdur

Son zamanlarda *a priori* konusuna olan ilgi arttı. Birçok felsefeci eski kuramların karşılaştığı zorlukları aşacak yeni *a priori* kuramları ortaya attılar. Bu felsefecilerden biri olan Michael Friedman bilimsel bir kuramı *teşkil eden a priori* önermelerin varlığını göstermeye çalışmıştır. Friedman hem bilimsel bir kuramı *teşkil eden* önermeleri karakterize ederek Thomas Kuhn'un bilimsel devrimlere ilişkin kuramını tamamlamaya çalışmış, hem de bu tür önermelerin *a priori* olduğunu göstererek W. V. Quine'ın bilimsel bir kuramın her parçasının *a posteriori* olduğu şeklindeki görüşünü sorgulamıştır.

Ben bu tezde Friedman'ın bilimsel kuramları teşkil eden önermeleri karakterize etmekte başarısız olduğunu ve kendi iddia ettiğinin aksine söz konusu önermelerin Quine'ın görüşlerine ters düşen bir yanı olmadığını savunuyorum. Ayrıca Friedman'ın bahsettiği türden önermelerin Arthur Pap'in ortaya attığı fonksiyonel a priori kavramıyla karşılanabileceğini iddia ediyorum.

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I. Introduction

The question as to whether there are *a priori* elements in scientific knowledge is one of the central issues in philosophy of science. As is well known, Kant argued for the existence of *synthetic a priori* judgments, which employ the categories and forms of the human mind that are constitutive of experience. Logical empiricists, on the other hand, rejected the Kantian idea of *synthetic a priori*, but maintained the existence of *analytic a priori* statements that are true in virtue of their meaning and thus can be known without appeal to experience. However, both accounts of *a priori* have faced serious problems; the former due to the advent of non-Euclidean geometries and the relativity theory, and the latter mainly due to Quine's attack on analyticity. These problems have led many philosophers to embrace Quinean epistemological holism, which denies that scientific knowledge has an *a priori* part.

Recently there has been a renewed interest in the issue of *a priority*[1]. Many philosophers have proposed accounts that attempt to establish the existence of *a priori* propositions while avoiding the difficulties of the former accounts. One of these philosophers is Michael Friedman, who has put forward the account of *relativized a priori* in his book *Dynamics of Reason*. His main point of departure is Hans Reichenbach's distinction between the "two meanings" of Kantian '*a priori*': "[i)] 'necessarily true' or 'true for all times,' and...[ii)] 'constituting the concept of object'" (Reichenbach, 48). According to Friedman, the first sense of the Kantian a priori has been undermined by the scientific revolutions in the twentieth century. The principles, such as the ones belonging to Euclidean geometry, that Kant took to be "built into the fundamental capacities of the human mind" (Friedman, 27) and

[1] For a collection of recent papers on *a priori* see *New Essays on the A Priori*. Paul Boghossian and Christopher Peacocke (eds.), New York: Oxford University Press, 2000.

therefore as the necessary presuppositions of *any* possible natural science have been replaced by alternative ones. Hence, he claims, it has been understood that any defensible account of a priori principles in science has to recognize that the a priori principles may "change and develop with the continual progress of empirical natural science, and in response to empirical findings" (71). That's why the first sense of Kantian a priori, which implies the unrevisability of such principles, must be dropped.

However, he goes on, the revolutionary developments in question have also made it clear that "a fundamental distinction between constitutive principles, on the one side, and properly empirical laws against the background of such principles, on the other" (43) must be drawn. For, he states, Kuhn's theory of scientific revolutions, which is "our best current historiography of science" (43), requires us to distinguish the changes in the scientific framework that result in *revolutions*, from the changes that occur within the relevant framework, and thus during *normal science*. For Friedman, such a distinction makes sense only if we are able to differentiate the principles that are constitutive of a scientific framework from the ones that are not. Hence, he concludes that the second sense of the Kantian a priori, which is based on constitutiveness, must be retained.

As Friedman notes, however, the previous attempts to characterize constitutiveness, such as Carnap's analytic *a priori*, which rest on purely syntactic and semantic properties within a scientific framework have not been successful. That's why, he suggests, what needs to be done is to

> articulate a conception of dynamical or relativized a priori principles within an historical account of the conceptual evolution of the sciences rather than a purely syntactic or semantic account of the formal

> language(s) of the sciences. One could thus reap the benefits of Kuhnian conceptual history while simultaneously avoiding the drawbacks of Carnapian formal Wissenschaftslogik. In particular, W.V.Quine's well-known attack on the Carnapian conception of analytic truth need no longer compel us to adopt a thoroughgoing epistemological holism according to which there is nothing left of the a priori at all. (xii)

Hence, by putting forward his account of relativized/constitutive a priori, Friedman aims both to characterize constitutiveness with respect to a scientific framework and thereby to complement Kuhn's theory of scientific revolutions, and to establish a sense of a priority that the former gives rise to and thereby to challenge Quinean epistemological holism.

In what follows, I will provide a critical discussion of Friedman's own attempt to characterize constitutiveness with respect to a scientific framework. The first chapter will consist of a demonstration of the constitutive functions he attributes to the putatively constitutive propositions, and the implications he draws from them concerning the epistemological status of the propositions in question. In the second chapter, I will critically evaluate his account. First I will consider the functions that he attributes to the putatively constitutive propositions, and argue that Friedman fails to establish a precise characterization of the constitutive propositions on the basis of such functions. Nevertheless, I will suggest that his main argument concerning the epistemological status of the putatively constitutive propositions may be constructed without appealing to the specific functions in question.

In the light of such a suggestion, I will turn to the evaluation of his main argument. I will argue that, in contrast to what Friedman claims, constitutiveness does not give rise to an epistemological difference that conflicts with Quinean epistemological holism. In particular, I will argue that there is no reason to suppose that the constitutive propositions cannot be empirically confirmed or disconfirmed,

or that we encounter a particular difficulty in arguing against them on the basis of empirical evidence.

Finally, in the third chapter, I will suggest that the peculiarity of the putatively constitutive propositions can rather be accounted for by appealing to the notion of functional *a priority* that is proposed by Arthur Pap. I will argue that by viewing the putatively constitutive propositions as functionally a priori, we can capture the idea of constitutiveness that is needed in order to make sense of the distinction between scientific revolutions and normal science, and do so in a much simpler and more fruitful way.

Let me, then, start by demonstrating Friedman's attempt to characterize constitutiveness with respect to a framework, and his argument concerning the epistemological difference it gives rise to.

II. Friedman's Account of Relativized A Priori

According to Friedman, "advanced theories in mathematical physics", such as Newtonian mechanics and Einsteinian relativity theory, consist of a *constitutive* part that includes both logico-mathematical propositions and certain fundamental physical propositions such as Newtonian laws of motion and the Einsteinian light principle (Friedman, 71). These propositions are constitutive in the following senses:

i.Presuppositions

ii.Coordinating Principles.

II.i. Presuppositions

First of all, Friedman claims that a constitutive proposition of a scientific theory is a "presupposition" of the empirical claims of that theory in the sense that it is a necessary condition of their having a truth-value (74). For him, the situation is the same as in Russell's well-known example. Friedman claims that the statement 'The present King of France is bald' presupposes that there is a unique present King of France in the sense that it *lacks a truth-value* if there is no unique King of France (that is, if the latter proposition is false). Similarly, he argues, the empirical claims of a theory presuppose the constitutive propositions of that theory.

For instance, he states that in Newtonian physics,

> The law of universal gravitation says that there is a force of attraction or approach, directly proportional to the product of the two masses and inversely proportional to the square of the distance between them, between any two pieces of matter in the universe. Any two pieces of matter therefore experience accelerations towards one another in accordance with the same law. But relative to what frame of reference are the accelerations in question defined?...The privileged frame of reference in which

> the law of universal gravitation is defined is what we now call an *inertial frame*, where an inertial frame of reference is simply one in which the Newtonian laws of motion hold (36).

Thus, according to Friedman, the law of universal gravitation "essentially employs a concept –absolute acceleration-" (74) that is defined in terms of inertial frames, which are in turn defined as the reference frames in which the laws of motion hold. Hence, he argues, if the laws of motion are not true, that is, if there are no reference frames in which they hold, then there will be no inertial frames. In that case, he goes on, the law of universal gravitation, which employs the concept of inertial frames (by employing the concept of absolute acceleration), will lack a truth-value. That's why the law of universal gravitation, which is an empirical claim of Newtonian physics, presupposes the laws of motion, which are its constitutive propositions.

Having put forward such a general claim that a constitutive proposition is a presupposition of the empirical claims of the theory to which it belongs, and supported it with an example from Newtonian physics[2], he turns to a qualification of it. As he notes, empirical propositions may be said to have various presuppositions. For instance, the empirical statement 'The rock on the table is at rest', which may as well be formulated within the Newtonian framework, may be said to presuppose that there is a table. However, it will not make much sense to claim that the proposition that there is a table is a constitutive proposition of Newtonian physics. Thus, Friedman qualifies his claim as follows: the constitutive propositions are those "which...can plausibly be taken as fundamental presuppositions of *all* empirical truth " (74, his emphasis).

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[2] Although he does not provide a general argument for his claim, it at least seems that the examples can be multiplied. The reasoning he uses above, for instance, is applicable to any proposition in Newtonian physics that employs the concepts of mass or force, which may be said to be defined in terms of the laws of motion.

However, despite his qualification above, "all empirical truth" should not be understood as all the *objective truths* about the world, but rather as all the empirical *claims* of a theory. For otherwise, whether a proposition is a constitutive proposition or not will be determined not relatively to the theories, but independently from them. A proposition will be constitutive if it is presupposed by all the objective empirical truths (which are determined independently from the theories), and will be non-constitutive otherwise. The role it plays in the scientific theory to which it belongs will not matter. On the other hand, if constitutive propositions are defined as those that are presupposed by all the empirical *claims* of a given theory, then constitutiveness will depend on the role that a proposition plays in a theory regardless of the objective truths about the world. Since Friedman is attempting to establish constitutiveness *relatively* to scientific theories, "all empirical truth" should be understood as all the empirical *claims* of theories.

Hence the first function that he attributes to the constitutive propositions is better formulated as being the presuppositions of all empirical claims within the framework to which they belong.

II.ii. Coordination

The second function that Friedman attributes to the (physical) constitutive propositions is related to a specific problem that he claims to arise in modern mathematical physics. In pre-modern Aristotelian-Scholastic physics, he claims, the fundamental concepts of space, time and motion are all defined in terms of concrete empirical phenomena. Space is a three-dimensional Euclidean sphere whose center is the Earth, and whose boundary is determined by the fixed stars. Uniform passage of time is given in terms of the diurnal rotations of the he heavenly bodies, and

natural motion is given in terms of each body's natural place. That's why, in pre-modern physics, "the 'scientific image' is a straightforward systematization of the 'manifest image'" (75).

By contrast, he goes on, in the theories of modern mathematical physics, such as Newtonian mechanics and Einsteinian relativity theory, "this unproblematic fit between physical theory and sense experience is irretrievably lost" (75). In these theories, the concepts such as space, time, and natural motion are *not* defined in terms of concrete empirical phenomena. For instance, in Newtonian mechanics, the concept of "uniform passage of time is no longer given by any observable physical motion (such as the diurnal rotation of the fixed stars), but rather by a natural state of inertial motion that is never actually observed" (76).

Hence, Friedman claims, with Newtonian physics there emerges the "problem of somehow *coordinating* our new mathematical representations with concrete sensible experience" (76). By this he means the following. We have our theoretical concepts such as *inertial frames*, on the one hand, and concrete empirical phenomena such as the observable motions in the solar system, on the other hand. However, since the concepts are not defined in terms of concrete empirical phenomena, how they apply to the latter (that is, whether, say, the reference frame determined by the center of mass of the solar system is an inertial frame or not) cannot be determined by direct observation.

According to Friedman, for such a determination to be possible, the physical constitutive propositions are needed. For instance, in Newtonian physics, *inertial frames* are defined as the reference frames in which the Newtonian laws of motion hold. Hence, by investigating whether these laws hold within the reference frame determined by the center of mass of the solar system, "we can...empirically establish

that the center of mass of the solar system determines such an inertial frame to a very high approximation" (76). In a similar way, we can go on to "take the motions defined in this frame [center of mass of the solar system] to be absolute motions (again to a very high degree of approximation), and approximate the uniform passage of time by these same empirically determinable motions"(76).

Thus, according to Friedman, by defining the theoretical concepts and hence by providing the criteria for their application, the physical constitutive propositions make the application of these concepts to concrete empirical phenomena possible[3]. Moreover, he argues, since the laws of a theory employ these theoretical concepts, the constitutive propositions are necessary for "the precise laws of nature formulated with the help of the mathematical part in fact [to] have empirical meaning" (80). For instance, as we have seen, the law of universal gravitation asserts that two bodies accelerate towards each other in such and such a way. However, whether or not two bodies accelerate in such a way with respect to a concrete empirical reference frame, such as the one determined by the center of mass of the solar system, can only be determined with the help of the laws of motion, on the basis of whether or not the laws of motion hold within that reference frame.

To sum up, for Friedman, the constitutive propositions of a scientific theory have the two following functions: first, they are presuppositions of all the empirical claims of that theory, and second, by defining the theoretical notions, they

[3] When Friedman's claim is understood like this, it is very similar to Reichenbach's views concerning coordinating principles. According to Reichenbach, the coordinating principles of a theory are those that are "constituting the concept of the object" (Reichenbach, 48) in the sense that "only under [those] presupposition[s] [can] something be thought as a physical thing" (Reichenbach, 95). Friedman notes the similarity between the two accounts. However, he does not mention a significant dissimilarity between them, namely that, contra Friedman, Reichenbach explicitly accepts that the coordinating principles are empirically confirmed and disconfirmed. See Reichenbach, 64, 93, 104. That's why Friedman is extremely misleading when he attributes to Reichenbach the view that the coordinating principles are non-empirical. See p.79.

"coordinate" the claims formulated within the relevant framework with concrete empirical phenomena in the sense that they make them have meaning and become applicable to empirical phenomena. In this way, he claims to have established a well-defined distinction between the propositions of a theory: the *constitutive* propositions, which are presuppositions and the "coordinating principles" of the other empirical propositions, and the "properly empirical" ones, which presuppose, and are "coordinated" with empirical phenomena by the former.

II.iii. Epistemological Status of the Putatively Constitutive Propositions

Having proposed such a characterization of the constitutive propositions, Friedman draws a conclusion concerning the role that the constitutive propositions play within the scientific framework to which they belong. He argues that in virtue of being the presuppositions of the empirical claims and of coordinating the theory with empirical phenomena, the constitutive propositions are necessary for empirical testing within the framework to which they belong. For presumably (he does not explicitly state this, but we may fill the gap), empirical testing requires propositions that both have truth-value and are coordinated with empirical phenomena.

According to Friedman, such a role (of making empirical testing possible within the relevant framework) has a significant epistemological consequence, which, he believes, undermines Quinean epistemological holism. Quinean epistemological holism is *based* upon the fact that a hypothesis does not imply an observable prediction by itself, but only together with other hypotheses. Hence, when there is a prediction failure, "[t]he most that the experiment shows is that at least one of these hypotheses is false; it does not show which" (Quine, 1970, p.5).

That's why, according to Quine, the prediction failure cannot be seen as the disconfirmation of any single hypothesis, but only of the hypotheses as a whole.

As Friedman notes, Quine recognizes that there is a difference among the parts of a theory. For instance, some propositions, such as those of logic or arithmetic, are relatively more general or central than others. And he accepts that these differences may make some propositions less likely to be revised in case of a "recalcitrant experience". However, as Friedman states,

> from an epistemological point of view, there is simply no relevant distinction to be made...Strictly speaking,...empirical evidence –either for or against – spreads over all the elements of the vast conjunction that is our total system of science, wherein all elements whatsoever equally face the "tribunal of experience". And it is in this precise sense, for Quine, that all beliefs whatsoever, including those of logic and mathematics, are equally empirical. (Friedman, 34)

However, Friedman argues, once we observe that certain propositions within a scientific framework have the constitutive function described above, we see that Quinean epistemological holism is mistaken. A scientific theory consists of a set of propositions (that is, the constitutive propositions) that are the necessary conditions for the others to have a truth-value and to be applied to (or coordinated with) empirical phenomena. In this way, he explains, these propositions are the ones that make empirical testing possible within the framework to which they belong. Therefore, he goes on, in contrast with Quinean epistemological holism, the constitutive propositions and the "properly empirical" (or non-constitutive) ones "are not happily viewed as symmetrically functioning elements of a larger conjunction: the former is rather a necessary part of the language or conceptual framework within which alone the latter make...empirical sense" (37).

Moreover, he claims, such a difference in the functions of propositions result in a difference with respect to empirical testability within the relevant framework. With the help of the constitutive propositions, he goes on, the "properly empirical" propositions of a theory can be empirically tested. However, he states,

> it is...a mistake [of Quinean epistemological holism] to view the coordinating principles comprising the mechanical part [i.e., the physical constitutive principles] as being empirically tested by the same procedure [deducing predictions concerning planetary perturbations]. *For*, as we have emphasized repeatedly, the procedure in question would not even be set up in the first place without some or another coordinating principle in place. (81, my italics)[4]

So, according to Friedman, the constitutive propositions of a scientific framework make empirical testing possible within that framework in the first place, and *therefore* are not tested themselves. In that case, for him, Quinean epistemological holism, which takes all parts of a theory to be empirically tested (and confirmed or disconfirmed), is mistaken. The case is rather that theories[5] consist of a constitutive part that cannot be empirically tested (and confirmed or disconfirmed) within the framework of that theory. In this sense, the constitutive propositions are *a priori* relative to the framework to which they belong.

This ends my demonstration of Friedman's attempt to characterize constitutiveness with respect to a framework and his argument concerning the epistemological status of the propositions with that property. Let me now turn to their evaluation.

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[4] For a similar type of reasoning, see pp.46, 83 and 86.

[5] Note, however, that his account does not apply to all theories. In formulating his main thesis, he states that "every advanced theory in mathematical physics" (71) consists of a constitutive part, and leaves the issue regarding other theories open. However, we at least know, for instance, that, for him, there is no "coordinating principle", hence no *fully* constitutive proposition, within the pre-modern physics.

III. A Critical Discussion of Friedman's Account

As we saw, one of Friedman's main aims in putting forward his account of relativized/constitutive a priori is to provide a characterization of constitutiveness with respect to a scientific framework, which is necessary in order to make sense of Kuhn's theory of scientific revolutions. His attempt for such a characterization is based on the two functions that he attributes to the constitutive propositions, namely being the presuppositions and the coordinating principles of the other propositions of the theory. I believe neither of these functions enables Friedman to establish a well-defined distinction between the constitutive propositions and the "properly empirical" ones. Here is why.

III.i. Concerning the Constitutive Functions

Let me start with his claim that the constitutive propositions of a scientific theory are presuppositions of all the other empirical claims of that theory. First of all, note that if his claim were only meant to be the definition of 'a constitutive proposition with respect to a theory', then it could hardly be challenged. For even if there were no propositions that were presupposed by all the empirical claims of a theory, he would not be putting forward a *false* claim. Rather, we would simply conclude that there were no constitutive propositions.

However, Friedman does not merely provide a definition for 'constitutive propositions'; he also claims that certain propositions are constitutive. For instance, as we have seen before, he claims that the Newtonian laws of motion are constitutive propositions of Newtonian physics. Similarly, he claims that the Einsteinian light principle is a constitutive proposition of Einsteinian relativity theory. Hence, given his characterization of constitutive propositions, the Newtonian laws of motion and

the Einsteinian light principle have to be presupposed by all the empirical claims that can be made within the Newtonian framework and within the Einsteinian framework respectively.

However, there are obvious examples of empirical claims that do *not* presuppose these propositions. For instance, an observational claim that can be formulated within the Newtonian framework such as "The pointer of the measuring device D points to '30' at time t" is either true or false regardless of the truth-value of, say, Newton's second law of motion. It makes no sense to claim that the statement "The pointer of the measuring device D points to '30' at time t" *lacks* a truth-value when the law is false. Similarly, an observational claim that can be formulated within the Einsteinian framework such as "There is a rock in the box" would have a truth-value even if the light principle turned out to be false.

So it seems that some of the propositions that are claimed to be constitutive by Friedman are not presupposed by *all* the empirical claims of the theories to which they belong. Now, one can defend Friedman against such an objection by saying that it is not his *account* of constitutive propositions that is undermined by such examples, but only his *claim* that certain propositions (such as the Newtonian laws of motion) are constitutive.

However, given that simple observational claims such as the ones I have suggested above (that there is a rock on the table, for instance) are diverse and numerous, the only candidates for propositions that are presupposed by *all* such claims seem to be the very basic logical propositions such as the law of non-contradiction. And if such basic logical propositions turn out to be the only constitutive propositions of scientific theories, then, although Friedman's claim will not be refuted, his account of constitutive *a priori* will lose most of its attractiveness.

For first of all, since such basic laws like the law of non-contradiction are common to all theories, one of the central aspects of Friedman's account will be lost. That is, constitutiveness will not be relative to scientific theories. Friedman's account will only be a more modest version of Kant's attempt to characterize the constitutive principles that are the necessary presuppositions of all possible science.

Moreover, such a characterization of constitutive propositions will not help us in our accounts of scientific revolutions, as Friedman aims to achieve. Since the constitutive propositions are common to all theories, scientific revolutions will not be explained in terms of the change of the constitutive propositions. To put it differently, if we define a scientific revolution as a change in the constitutive propositions, we will have to claim that there has not been a scientific revolution so far.

And finally, if the only constitutive propositions turn out to be the basic logical laws like the law of non-contradiction, then the epistemological significance of constitutiveness will be lessened. For, there probably are simpler ways to establish the *a priority* of laws like the law of non-contradiction than studying the particular claims of scientific theories, and see whether they are presupposed by all such claims.

Of course, the examples I have provided above show only that there are *some* empirical propositions formulated within a scientific framework that do not presuppose *some* constitutive propositions of that framework. Perhaps the issue can be resolved by restricting either the empirical propositions that are supposed to presuppose the constitutive propositions, or the constitutive propositions that are supposed to be presupposed by the empirical propositions. In any case, the moral to

be drawn is that Friedman's account of presuppositions calls for further clarification and elaboration in this aspect.

Furthermore, it is not even clear whether *any* proposition presupposes another in the sense Friedman uses. Note that, although Friedman makes use of Russell's example, he accepts an anti-Russellian account of presuppositions without any argument in its favor. Claiming that the statement 'The present King of France is bald' lacks a truth-value if there is no unique King of France is by no means the only way to analyze that statement. In fact, Russell himself has provided an alternative account.

According to Russell, 'The present King of France is bald' can be analyzed as follows: there is something such that it is a unique King of France *and* it is bald (uniqueness can be analyzed further, but that is not necessary for our purposes). So the proposition is a complex existential proposition for Russell. Given such an analysis, if there is no unique King of France, then there is no unique King of France that is also bald. Hence the proposition does *not* lack a truth-value, but is simply false.

A similar analysis can also be given for the example Friedman provides from Newtonian physics. Recall Friedman's claim that the law of universal gravitation lacks a truth value if the laws of motion are false, because the former "essentially employs" the concept of absolute acceleration that is defined in terms of the laws of motion. In contrast to such an account, a Russellian could perhaps analyze the law of universal gravitation as follows: there are reference frames such that the laws of motion hold *and* any two masses accelerate towards each other with respect to these reference frames in such and such a way.

So, as in the case of Russell's example, the law of universal gravitation can be seen as a complex existential proposition. In that case, if the laws of motion are not true, that is, if there are no reference frames in which they hold, then there are no reference frames in which they hold *and* with respect to which two masses accelerate towards each other in that way. Hence, if the laws of motion are false, then the law of universal gravitation will *not* lack a truth-value, but rather be false.

Surely, the existence of an alternative account does not undermine Friedman's claim that the constitutive propositions are necessary conditions for the truth-values of the empirical claims of the theories to which they belong. However, it is clear that the account of presuppositions on which his claim rests is questionable and needs further argument in its favor.

Hence, the first function that Friedman attributes to the constitutive propositions is problematic on at least two accounts. First, the very account of presuppositions that Friedman appeals to has alternatives, and therefore needs argumentation in its favor. And secondly, even if such an account is correct, contra Friedman, it is not the case that *all* empirical claims formulated within a scientific theory presuppose the putatively constitutive propositions of that framework; hence some revision or clarification as to which propositions are supposed to presuppose the constitutive propositions is needed. As it stands, his claim that the constitutive propositions of a theory are constitutive of the truth-values of all the empirical claims of these theories is dubious.

Having discussed in some detail the first function that Friedman ascribes to the constitutive propositions, let me now turn to the second, namely, the function of coordinating the empirical claims with empirical phenomena. Note, first of all, that his account of coordination rests heavily on a very controversial assumption. It may

be true that, in contrast with the pre-modern period, the concepts of modern physics are not defined in terms of concrete empirical phenomena, and thus that there emerges the problem of coordinating them with experience. However, that this function is carried out *only* by the physical constitutive propositions, which *alone* define these concepts, is dubious. Such a claim presupposes that there is a well-defined distinction between the propositions that define concepts and others that (do not define, but) merely make assertions using these pre-defined concepts.

However, such an assumption is highly controversial. Consider the Newtonian case again, for instance. The first law of motion states that an object acted on by no net external force will remain at rest if it is at rest, and will continue in motion with constant velocity if it is in motion, all with respect to inertial frames. And the law of universal gravitation states that two bodies will accelerate towards each other in such and such a way with respect to inertial frames.

Now, note that both laws make assertions concerning the motions of objects with respect to inertial frames. However, according to Friedman, the notion of inertial frames is defined by the laws of motion, but *not* by the law of universal gravitation. An *inertial frame*, it is said, is defined as a reference frame in which the first law of motion holds; and the law of universal gravitation merely makes an empirical assertion concerning the pre-defined inertial frames.

However, putting the pragmatic considerations aside, what reasons do we have to take Newtonian laws of motion as defining the notion of *inertial frames* and the law of gravitation as not, when all are statements involving inertial frames? It seems equally possible to define *inertial frames* as the reference frames in which the

law of universal gravitation holds, and then take the first law as merely an empirical assertion concerning the pre-defined inertial frames[6].

If that is the case, the distinction between the laws that define the concepts and the laws that only make empirical assertions concerning them seems to be arbitrary. Hence, Friedman's distinction between the "properly empirical" propositions, and the physical constitutive propositions that give meaning to the "properly empirical" propositions seems to be ill defined. The fate of such a distinction seems similar to that of the analytic-synthetic distinction that Quine has strongly argued against in "Two Dogmas of Empiricism": being an analytic statement boils down to being under the label of 'semantic rule', as Quine has argued, and it seems that being a proposition constitutive of meanings boils down to being under the label of 'warning: constitutive of meanings'.

However, the above objection to Friedman may not be completely fair. Already in the preface of his book, he claims that he does not want to base his account on purely syntactic-semantic considerations (xii) since such accounts have not proved to be quite successful. So perhaps we should not place so much emphasis on his claims concerning meaning relations. After all, his account of coordination concerns the *application* of the "properly empirical" laws to empirical phenomena as much as it concerns their meanings.

So, on behalf of Friedman, and without presupposing anything about meanings, we can explicate the coordinating function slightly differently as follows. We formulate certain laws of nature in our theory. However, for these laws to apply to empirical phenomena, in the sense that observable predictions can be deduced

[6] Such alternatives seem to exist regarding the definitions of other concepts as well. Thomas Kuhn, for instance, claims that it is possible to take the notion of *force* as defined either by the second law of

from them, we need the physical constitutive propositions. For instance, we may say, in order to deduce observable predictions concerning the motions in the solar system from the law of universal gravitation, we need to assume the laws of motion. And it is in this sense, we may go on, that the physical constitutive propositions give "empirical meaning or application" (79) to the properly empirical laws (that is, in the sense that they help in deducing observable predictions from the properly empirical laws).

I believe that such an understanding of Friedman's claim is both more charitable (especially when we take into account what he says in the preface of his book) and less problematic. However, it still cannot establish a principled distinction between physical constitutive propositions and properly empirical ones. When observable predictions are deduced from the properly empirical laws *and* the physical constitutive propositions, why is it the latter that give empirical meaning or application to the former, and not the reverse? If having empirical meaning or application for a proposition is having observable consequences deduced from it, then why don't the physical constitutive propositions acquire empirical meaning or application like the non-constitutive ones? When a single empirical test is taken into account, the functions of the putatively constitutive and the non-constitutive propositions are the same: they are all assumed to deduce a prediction. Hence there seems to be no reason to take the observable consequence as the application or empirical meaning of one assumption, and regard the others as helping it acquire such meaning or application. The non-constitutive propositions help the constitutive ones have empirical meaning or application, as much as the latter help the former.

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motion or by the law of gravitation, and then consider the other one as an empirical assertion concerning force. See Kuhn, p. 306.

Thus, no principled distinction between the physical constitutive propositions and the properly empirical ones can be drawn on the basis of which propositions *are applied* to empirical phenomena and which ones (*are not applied* themselves but only) *help* others with that. That is, there cannot be a principled distinction between the propositions that coordinate propositions with empirical phenomena (and that are not coordinated themselves), and the propositions that are coordinated (and that do not coordinate others). It seems that every physical proposition both coordinates others with empirical phenomena, and is itself coordinated.

So, contrary to Friedman's claims, the difference between constitutive propositions and properly empirical ones cannot be that only the latter are applied to or coordinated with empirical phenomena, and the former help. Therefore, even if we divorce the idea of coordination with empirical phenomena from the controversial assumptions concerning definitions, it does not help Friedman provide a precise distinction between the constitutive and the properly empirical propositions.

However, this does not mean that there is *no* difference in the roles they play in the coordination or application of the theory to empirical phenomena. In fact, one may suggest that there seems to be at least the following difference between, say, the laws of motion and the law of universal gravitation. If the law of universal gravitation were abandoned, it seems that some propositions formulated within the Newtonian framework would still be applicable to empirical phenomena (that is, we could still deduce some observable consequences from them). By contrast, if the laws of motion were abandoned, no proposition would be applicable to empirical phenomena (that is, it would not be possible to deduce observable consequences from them).

What would such a difference imply? Clearly, it will not imply that the physical constitutive propositions coordinate others with empirical phenomena without being coordinated themselves. So, constitutiveness will still not be characterized as having a specific coordinating function within a particular framework. It will imply at best that the physical constitutive propositions are so central and fundamental for the theory to which they belong that without them no proposition can be applied to or coordinated with empirical phenomena.

I believe that even though he fails to provide a precise characterization of constitutiveness on the basis of the putatively constitutive functions, such a claim is sufficient for Friedman to maintain his argument concerning the special epistemological status of the constitutive propositions. As you will recall, Friedman argues that, the constitutive propositions of a scientific framework make empirical testing possible within that framework and therefore are not tested themselves. Now, although not in virtue of the specific functions Friedman attributes to them, we can still claim that the constitutive propositions make empirical testing possible within the framework to which they belong in that without them we would hardly be able to deduce observable consequences from the empirical claims of that framework. Assuming that this is the case, let me turn to the discussion as to what it implies concerning the epistemological status of the constitutive propositions. Since Friedman puts forward his argument against Quinean epistemological holism, I will start by considering whether constitutiveness in this sense poses a challenge to it.

III.ii. Concerning Friedman's Argument Regarding the Untestability of the Constitutive Propositions

Recall that, according to Quinean epistemological holism, whatever is assumed in deducing an observable prediction is equally tested, because a prediction

failure by itself does not indicate which assumption(s) is responsible for it. Now, let us consider whether and how constitutiveness gives rise to an objection to such a position. Suppose that an observable prediction is deduced from a set of hypotheses including the constitutive propositions and that the prediction fails. As Quine points out, the prediction failure by itself does not indicate which hypothesis is responsible for the negative result. As far as the test outcome is concerned, any one (or more) of the hypotheses that is possibly false may be responsible.

Now, if the constitutive propositions *cannot* be false, then one can argue that they *cannot* be responsible for the prediction failures, for presumably the reason for a prediction *failure* cannot be a true proposition. In that case, one can say, being not even possibly responsible for prediction failures, the constitutive propositions do not admit empirical evidence against them.

However, constitutiveness does not entail truth. The propositions that make empirical testing possible within a scientific framework are constitutive of that framework regardless of their truth-value. Thus, there seems to be no reason at first sight to claim that the constitutive propositions (which are possibly false) are not tested or that they do not admit empirical evidence against them. Constitutiveness does not pose an immediate challenge to Quinean epistemological holism.

On the other hand, one may suggest that the peculiarity of the constitutive propositions is not that they cannot be responsible for prediction failures, but rather that it is impossible to *consistently argue* against them on the basis of such failures. Note that these two claims are distinct, for it is one thing that a proposition is false and another that we are able to consistently *argue* for its falsity.

One way to argue for the impossibility of arguing against the constitutive propositions on the basis of prediction failures is to suggest that the constitutive propositions are "most basic" in the sense that Hartry Field uses that phrase. According to Field, certain logical propositions are most basic in the sense that it is impossible (within our evidential system) to argue for or against anything without assuming them. That's why he argues, in order to *argue* that some empirical evidence *undermines* such logical propositions, we have to presuppose them. But in that case, he notes, we would be arguing against such propositions on the basis of themselves.

In a similar way, one may claim that the constitutive propositions of a theory are "most basic". That is, one may argue that it is impossible to argue for or against anything within a scientific framework, without assuming its constitutive propositions. If that is the case, in order to argue that a prediction failure undermines the constitutive propositions, we have to assume them. But in that case, one may note, we would be arguing against the constitutive propositions on the basis of themselves.

Thus, if the constitutive propositions were "most basic", then it would be impossible to consistently argue against them on the basis of prediction failures. But alas, they are *not* "most basic" in Field's sense. That is, it *is* possible to make inferences on the basis of test outcomes without necessarily appealing to the constitutive propositions. For instance, as Friedman states in a different context, "[b]oth a Newtonian and an Einsteinian physicist... can and must agree that general relativity yields more accurate predictions for the advance of the perihelion of Mercury" (83). That is to say, the fact that the relativity theory yields more accurate predictions regarding the perihelion of Mercury can be accessed without necessarily

presupposing the constitutive propositions of either theory. Thus a Newtonian scientist can argue that the inaccuracy of the predictions of her theory regarding the perihelion of Mercury constitutes some (although not decisive) empirical evidence against it, without assuming the constitutive propositions (say, laws of motion) in her argument. That she can give such an argument without presupposing the laws of motion is evident, since the same argument can be given by an Einsteinian scientist as well. Therefore, the constitutive propositions of a scientific framework are not most basic in Field's sense, and hence the type of inconsistency that arises in Field's case of fundamental logical laws does not arise in the case of constitutive propositions.

However, the inconsistency may be due to another factor. One can say that we necessarily assume the constitutive propositions not in *inferring from* empirical data to the falsity of certain propositions, but rather in taking the empirical data as *premises*. And this is because, one can suggest, all observational claims imply the constitutive propositions. Hence, whenever we take an observational claim as a premise, we also take what it implies, namely the constitutive propositions, as premises as well. That's why, arguing on the basis of observations means arguing on the basis of the constitutive propositions. Therefore, one can conclude, it is not possible to argue consistently against the constitutive propositions on the basis of prediction failures that involve observational claims, which in turn imply the constitutive propositions.

However, the above argument fails as well due to the falsity of its premise. Not all observational claims imply the constitutive propositions. As I have stated in the previous chapter, there are obvious examples of simple observational claims whose truths do not depend on the truth of the constitutive propositions (such as the

proposition that there is a rock in the box). That's why as long as one deduces such simple observational claims that do not imply the constitutive propositions, she does not need to assume the truth of the constitutive propositions, even if she takes the observational claims for granted or as secure premises[7]. Hence arguing *on the basis of observational claims* does not challenge the possibility of arguing against the constitutive propositions within the framework to which they belong.

A related argument fails for the same reason. One can suggest that the observational claims *presuppose* the constitutive propositions, in the specific sense I have explained earlier. If that is the case, that is, if the observational claims *lack* truth-value when the constitutive propositions are false, then, the prediction *failure* (i.e. a false observational claim) will entail the *truth* of the constitutive propositions. If so, it will not be possible to argue that the constitutive propositions are false on the basis of test outcomes, without assuming at the same time that the constitutive propositions are true (for, accepting that the prediction *fails* is accepting that the constitutive propositions are true).

However, as I have said, such a suggestion will not work for the same reason as in the previous suggestion. Not all observational claims presuppose the constitutive propositions (if any proposition does). Hence, it is possible to argue for the falsity of the constitutive propositions on the basis of test results as long as we deduce predictions that do not presuppose the constitutive propositions.

Thus, there seems to be no reason to suppose that the constitutive propositions differ from other propositions in that they cannot be responsible for the prediction failures or that we cannot consistently argue against them on the basis of

[7] And a strict holist would object to this suggestion from the start by claiming that nothing is really taken for granted or as a secure premise in an empirical test.

test outcomes. Therefore, there is no reason to conclude that constitutiveness conflicts with Quinean epistemological holism, which takes all parts of a theory as equally tested.

That's why Friedman's argument against Quinean epistemological holism fails. His account fails, therefore, not only in providing a precise characterization of constitutiveness with respect to a framework, but also in establishing a sense of a priority that conflicts with Quinean epistemological holism. Nevertheless, it can hardly be denied that the constitutive propositions do have a special status within the theory to which they belong. I suggest that the notion of functional a priority that is proposed by Arthur Pap explains such a special status and is sufficient to account for the idea of constitutiveness that is needed for making sense of Kuhnian idea of scientific revolutions.

IV. Constitutiveness as Functional A Priority

Being possibly responsible for prediction failures, the constitutive propositions may be abandoned or revised. However, if they make empirical testing possible within the framework to which they belong, abandoning them will mean giving up the whole possibility of performing further empirical tests within that framework. That's why, although, logically speaking, they are on a par with other hypotheses in so far as the prediction failure is concerned, scientists are reluctant to revise or abandon them for they want to maintain the possibility of performing empirical tests. For the same reason, scientists never design empirical tests with the purpose of revising or abandoning the constitutive propositions. In this sense, the constitutive propositions are never "under test"[8].

Note that the above notion of being "under test" is pragmatic. The constitutive propositions are not "under test", because scientists do not design tests with the *purpose* of revising or abandoning them, and once they perform the tests they are *reluctant* to revise or abandon them on the basis of the failure. Hence the justification for the claim that they are not "under test" concerns how the scientists *treat* the constitutive propositions. In this sense, such a notion of testing is a pragmatic notion.

In the light of such a difference with respect to being tested (in the pragmatic sense), we can also suggest that the constitutive propositions are *functionally a priori* in the sense Pap has proposed. According to Pap, certain propositions enjoy a *functional* necessity in the sense that they are necessary to achieve certain *ends*. For

[8] This is a phrase Elliott Sober uses in his paper "Testability". In that paper, Sober argues that the auxiliary assumptions are usually independently supported prior to empirical tests and that's why scientists do not change their opinions about the auxiliary assumptions on the basis of test outcomes. Therefore, he concludes, the auxiliary assumptions are not "under test" but "used in a test" (Sober, 9).

instance, Newton's second law enables scientists to measure force (Pap, 481); the assumption that time is a continuum correlates time with the number-continuum and thereby makes a mathematical treatment of motion possible (476-7); and so on. Because of such a functional necessity, these propositions are treated differently in the light of test outcomes. When they are assumed, together with other hypotheses, to deduce certain observable predictions, and the predictions fail, scientists do not "choose to abandon or revise" them due to the significant roles they play (482). Instead, they abandon or revise other assumptions that do not have such important functions. That's why these propositions are *functionally a priori*, that is, "adopted as necessary presuppositions of science" (477) in order to achieve certain ends (such as measuring force or making a mathematical treatment of motion possible) even though they *can* be revised in the light of experience.

As I have mentioned before, a very similar idea is present in Quine's views as well. According to Quine, although a prediction failure counts as empirical evidence against all the statements that are assumed in the deduction of that prediction, they differ on other accounts. In particular, although all the assumptions are revis*able* in the light of such counter-evidence, scientists refrain from revising the most general (or "entrenched") ones, because a revision in one of them would require a revision in many other claims of the theory. Such a conservative strategy is called the "maxim of minimum mutilation" (Quine, 1970, p.7).

Now, it may be asked whether and how functional a priority differs from Quinean idea of entrenchment. The functionally a priori propositions, just like the merely "entrenched" ones, are on a par with other propositions in that they admit empirical evidence for and against them, and differ from them only in that scientists refrain from revising them. The only difference, therefore, seems to be that whereas

Quine enumerates possible reasons as to why scientists may refrain from revising these propositions, Pap characterizes the basis for such an attitude as functional necessity. Therefore, functional *a priority* is in fact ultimately no different from Quine's entrenchment, perhaps with an emphasis on the roles or functions that these propositions have.

I suggest that constitutiveness with respect to a scientific framework is best viewed in terms of functional *a priority*. The constitutive propositions enjoy a functional necessity in that they are *necessary in order to* perform empirical tests. Hence, although they are revisable in the light of experience, scientists refrain from revising them in order to keep performing empirical tests.

However, some qualification is necessary. Any general proposition, for instance, may be said to have a functional necessity, for its revision results in the revision of a number of other propositions. That is, any general proposition may be said to be functionally *a priori*, since it may be kept (unrevised) in the theory in order to avoid such a series of revisions. However, not all general propositions are constitutive of the scientific framework to which they belong.

The constitutive propositions can be characterized in terms of functional *a priority* as follows. If the constitutive propositions of a theory are given up, then empirical tests *cannot* be performed and therefore scientific practice within that framework ceases. For instance, abandoning the Einsteinian light principle (a constitutive proposition of Einsteinian physics) means abandoning scientific practice within the Einsteinian framework. Therefore, unless there is an alternative theory available, abandoning the constitutive propositions of the theory at hand means abandoning the entire scientific practice in that area at that time. So the constitutive

propositions are those propositions, we can suggest, whose functional necessity continues until a plausible alternative theory is available.

In this way, the idea of constitutiveness with respect to a scientific framework, which is necessary in order to make sense of scientific revolutions, can be captured. Certain propositions of a scientific theory are so central and fundamental that they cannot be abandoned until an alternative set is available. That's why scientists refrain from abandoning them as long as possible. However, once they encounter persistent anomalies (which suggest that there is something wrong with the very basic assumptions of the theory at hand), and they come up with an alternative, they switch to the alternative. Such a significant change in the very central propositions that have been impossible before (unless scientists decided to cease scientific activity) is a scientific revolution.

Such an understanding of constitutiveness with respect to a scientific framework is more fruitful than Friedman's account in that it applies to a wider range of theories. In Friedman's characterization of constitutiveness, the constitutive propositions are described as those that are coordinating principles of the theory with empirical phenomena. And he states that such a function of coordination has emerged with Newtonian physics. However, if that is the case, then the account of constitutiveness that Friedman proposes falls short of making sense of the scientific revolution, for instance, from the pre-modern Aristotelian physics to Newtonian physics. Since his characterization of constitutive propositions does not apply to the fundamental physical assumptions of the Aristotelian physics, the switch from them to their Newtonian counterparts cannot be described as a change in the constitutive propositions. Hence, with Friedman's characterization of constitutiveness, we are

unable to account for some of the scientific revolutions that have occurred in the history of science.

By contrast, if we characterize constitutiveness in terms of functional *a priority*, then the scientific revolutions in question are accounted for as well. Aristotelian physics, too, consists of certain central assumptions whose abandonment results in the inability to continue scientific activity in that area at the time unless an alternative set of assumptions are available. And the scientific revolution in question simply consists in the switch from these propositions to the alternatives.

Thus, by characterizing constitutiveness as functional *a priority*, we end up with an account that not only is simpler and less problematic than Friedman's (in that we do not need to appeal to presuppositions or coordinating principles, both of which are highly problematic), but also is more fruitful than the latter since it has a wider scope.

V. Conclusion

The propositions of a scientific theory are not all alike. Some are more general than others, some are newly formulated hypotheses and others have already been confirmed by a series of empirical tests, some are shared by other theories in other fields and others are specific to the theory to which they belong. These are all objective differences among the parts of a scientific theory. In my thesis, I have considered Friedman's account that aims to establish a further objective difference among the propositions of a scientific theory (of an advanced theory in mathematical physics, more precisely), which he labels as 'constitutiveness', and which, he claims, results in the *a priority* of the propositions having that property.

However, I have argued that he fails to provide a well-defined distinction between the constitutive and non-constitutive (or properly empirical) propositions on the basis of the functions he attributes to the putatively constitutive propositions. Nevertheless, I have suggested that there seems to be at least the following difference between the propositions of a theory, which we can label as 'constitutiveness'. Abandoning certain propositions of a theory results in the inability to perform empirical tests within the framework to which they belong, whereas others may be abandoned without such a result. Such propositions, I have suggested, are *functionally a priori*, that is, they are kept in the theory *in order to* perform empirical tests. However, as I have argued, this does not imply that the constitutive propositions cannot be empirically tested or do not admit empirical evidence for or against them. They are on a par with the other propositions in that they may as well be responsible for prediction failures, and there is no particular difficulty in arguing against them on the basis of empirical evidence. What is peculiar to the constitutive propositions is rather that scientists refrain from abandoning them since their

abandonment results in the inability to perform empirical tests and therefore in the inability to carry on the scientific practice within the framework to which they belong.

Finally, I have suggested that such a difference, which can be explained in terms of functional a priority, is sufficient to capture the idea of constitutiveness that is needed in order to make sense of the Kuhnian theory of scientific revolutions. In this way, we establish a much simpler and less problematic characterization of constitutiveness, while at the same time avoiding unwarranted epistemological consequences.

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