Convenient Myths: Reconciling Indispensability and Ontological Relativity

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I. Introduction

A distinguishing mark of naturalistic theories in metaphysics is that the scope of our ontological investigations should be delimited by the natural sciences. Accordingly, where matters ontological are concerned, naturalism centers on the claim that any answer to the question "what exists?" must be framed in concordance with our overall best scientific theory of the world. In the naturalist's austere system, objects, whether theoretical or physical in character, are auxiliaries (posits) which are required only in relation to their contribution to the simplicity and elegance of our best scientific—considered in the broadest possible sense—theory of the world.[1] Those objects that play a central role in facilitating the overall simplicity and elegance of our scientific theory are accorded a special status—in short they have attained "indispensability." Thus, electrons, protons, frictionless planes, and other posits required for the predictive statements of science to come out true gain admittance into our ontology. Critics of the program outlined above point out that there is a deep and perhaps irresolvable tension in the naturalist's challenging reconceptualization of the aims and scope of metaphysical investigation.

Otavio Bueno (2003) and Penelope Maddy (1997) have both recently argued that indispensability is fundamentally incompatible with another core naturalistic doctrine—Iontological relativity.[2] To see the nature of the problem, consider that indispensability arguments purport to tell us to which entities we should be committed. As the critic points out, however, what entities we take to exist is always determined relative to a background theory. Thus, there is no way to determine in an absolute sense what exists.

The problem which thus emerges, even in relation to the highly schematic version of indispensability laid out above, is that the naturalist's commitment to the indispensability of certain objects needs to be squared with a marked indifference to the postulation of particular objects, or an overarching commitment to a specific ontology in the naturalist's system. The Argument from Scientific Practice (ASP) is designed to show that despite its pretensions, the indispensability argument fails to take into account key features of the scientific enterprise.[3] The challenge posed under the ASP is stated succinctly as follows: How can the naturalist, with his penchant for empirical testing and theoretical simplicity, justify commitment to certain indispensable entities given that

either no empirical test is available (e.g., mathematical objects) or (as in the case of frictionless planes) the entity in question is accepted only as a "useful" fiction which carries no ontological commitment?

In what follows, I will argue that even when key features of the Argument from Scientific Practice are considered, the naturalist can still hold to both the indispensability thesis and the indeterminacy of reference thesis without sacrificing a naturalistic orientation toward ontic commitment. I will now turn to assessing some of the central implications of the ASP. In this section, I also identify some reasons why extant naturalistic rejoinders to this type of argument fail.

II. Indispensability Undermined

As laid out above, the naturalist is committed to the existence of those entities which can be read off from the true statements of our best theory of the world. It is important to point out that the naturalistic account of ontological commitment is in line with an essentially deflationary view of ontology.

As adumbrated by W. V. O. Quine, naturalism thus rests on the claim that ontic commitment is a fundamentally trivial matter. In postulating indispensability, the appeal to a conception of objects which "exist" in an ultimate, irreducible, and non-theory relative manner is not allowed. Ultimately, it is the humble variable as the locus of reification that is our guide to what exists. The preceding claim reveals the essence of the Quinean maxim "to be is to be the value of a bound variable." Importantly, this statement is not intended to "know what there is." Rather, as Quine points out, "to be is to be the value of a bound variable only to know what a given doctrine remark, ours or someone else's, says there is."[4] Under the naturalist's account of ontic commitment it is thus that "(∃x) (X is proton)" refers to a true existential statement. As in the preceding claim, it is the regimented language of first order logic that allows us to identify clearly to which objects our theory is committed. Ultimately, in line with Quine's conception of ontology, we postulate objects to determine their salience to some empirical question. It is thus that certain abstract objects, including mathematical objects, find their admittance into the naturalist's scheme as indispensable objects.

In *The Indispensability of Mathematics,* Mark Colyvan holds that the indispensability argument can be appropriately characterized under the following argument:

The Quine/Putnam Indispensability Argument

1. We ought to have ontological commitment to all and only those entities that are indispensable to our best scientific theories
2. Mathematical entities are indispensable to our best scientific theories. Therefore:

3. We ought to have ontological commitment to mathematical entities [5]

Accordingly, in line with Colyvan's observations above we see that indispensability is, for the naturalist, a highly useful tool for diagnosing when an object or structure is of utility to our overall best theory of the world. The naturalist holds that indispensability only occurs if reference to an object is (1) completely resistant to paraphrase (appears as the value of a bound variable in our best theory of the world) and (2) of utility in furthering the elegance and simplicity of our best theory of the world. Importantly, indispensability requirements are held to apply even when an ontology of abstract objects is considered. Quine maintains that mathematical objects are objects which are prized for their explanatory role. In speaking of mathematical objects, Quine writes that "this higher myth is a good and useful one…in so far as it simplifies our account of physics. Since mathematics is an integral part of this higher myth, the utility of this myth for physical science is evident enough."[6] The talk of myth-objects for Quine is more than a picturesque metaphor, it is a key to understanding how indispensability requirements are expected to work. In advancing his deflationary views, Quine stresses that in making ontic commitments we must always keep in mind the fundamental triviality or weakness of ontic commitment.

Accordingly, for the naturalist, all of the objects taken to exist are "real" from the standpoint of the background theory in which those objects are countenanced. Thus, the ultimate nature of the objects is not what is at issue for the naturalist. As Quine points out, "What matters for any objects, concrete or abstract, is not what they are but what they contribute to our overall theory of the world as neutral nodes in its logical structure…sameness of reference is all that ontology contributes to science and truth."[7]

The central question which emerges in relation to the preceding argument for indispensability is as follows: if sameness of reference is all that ontology can contribute to science, we might wonder precisely to *which* objects we should be committed? What about fundamental particles? And energy, what of its insubstantial nature? More important, are we committed to the indispensability of objects like frictionless planes or the abstract objects of set theory? We can conceive of the Argument from Scientific Practice (ASP) as encompassing the preceding observations regarding the difficulty of holding to both ontological relativity and indispensability. The following argument clearly illustrates a central challenge to the indispensability thesis as considered in relation to scientific practice. The essential features of the ASP are given as follows:

Undermining Indispensability: The Argument from Scientific Practice

(C1) As opposed to the picture suggested by the indispensability argument, scientists don't accept indiscriminately all the components of a scientific theory.… For example, to be able

> to model certain phenomena, scientists often need to introduce idealizations and simplifications; the phenomena in question might be intractable otherwise. As a result, scientists know that the resulting descriptions clearly don't correspond to the way things are.
>
> (C2) Thus, despite the fact that idealizations and simplifications are indispensable to our best scientific theories scientists don't take them to carry ontological commitment.[8]

There are two strains of argumentation that are derived from the ASP, both of which if sound fatally undermine the naturalist's commitment to indispensability. First, critics contend that there is a fundamental tension between the core doctrines that underlie the naturalist's account of ontic commitment. Bueno identifies the nature of this tension as evolving from the strongly *realist* character of the indispensability argument (which tells us that we must be ontically committed to the existence of certain objects) and the seemingly *anti-realist* character of ontological relativity (which is the claim that what objects we take to exist will always be relative to a given background theory).

In line with preceding claim, critics of indispensability argue that even if one tries to advance indispensability requirements tied to empirical results, it seems that indeterminacy is ever present, given that a multiplicity of objects or structures can be determined to have conformity with a given result. Second, the critic maintains that given the tension between ontological relativity and indispensability the naturalist would be well advised to drop indispensability requirements, especially since indispensability requirements are irrelevant to the practice of scientific inquiry. As outlined in C1 above, scientists regularly invoke entities in working out some aspect of physical theory which they nonetheless hold do not exist. For example, frictionless planes, while indispensable to our overall best physical theory are imported into our conceptual scheme as idealizations of certain phenomena. These objects are barred from existence in a world, such as ours, in which it is impossible to actually produce an inclined plane devoid of friction. Accordingly, the critic holds that it is clear that the Quinean has no grounds to cling to the indispensability thesis by appealing to the practices of working scientists, for it seems evident that they are untroubled by the fictional nature of many of the entities which they posit. As Colyvan points out, "scientists regularly distinguish between the real and the fictional entities in scientific theories."[9] Thus, the critic contends that despite its purported standing as a properly scientific metaphysic, naturalism's commitment to indispensability is a fundamentally flawed doctrine which is incompatible with scientific practice.

In considering the scope of the challenge that the ASP poses to naturalist theories, we should first assess some extant naturalistic rejoinders to the anti-indispensabilist claims advanced under the ASP. Understanding why these rejoinders fail will further illustrate why the critic maintains that indispensability requirements should be abandoned.

III. Indispensability, Relativity, and Naturalism

In replying to the arguments advanced by Bueno and other critics of indispensability, the naturalist might respond that the ASP does not introduce any problems for a naturalistic theory of ontic commitment. In answering the question "Which entities must we be indispensably committed to?" the naturalist must respond "all of those entities required to work out the relevant portion of scientific theory." As laid out above, the nature of those objects, whether abstract or concrete in nature goes by the board. Hence, the advocate of indispensability will contend that there is no problem posed by ontic commitment to unobservables and idealizations. After all, since there is no further vantage point outside of scientific theorizing from which to determine the nature of ontic commitment, there is no tension between the realism and fictionalism or instrumentalism endorsed by the naturalist. In short, objects are posited to round out our overall best explanation of experience. And since there are many objects that are relevant or germane to the best explanation of experience, the ultimate nature of those objects will be a matter of complete indifference.

This is the line of defense adopted by Roger Gibson in his paper "Quine on Matters Ontological." In responding to the critic of indispensability Gibson maintains that there is no tension between the two doctrines because both indispensability and ontological relativity are compatible with a sufficiently deflationary view of ontology. In responding to the critic of indispensability requirements Gibson writes:

> The answer is, because current scientific theory maintains that surface irritations exhaust our clues to an external world, and even all possible surface irritations woefully underdetermine physical theory. Furthermore, the objects posited (sticks and stones, neutrinos and quarks, classes and numbers) are justified only insofar as they contribute to the smooth running of the engine of scientific method[10]

Thus, in line with Gibson's observations, we can see how the epistemic story told by the naturalist meshes with his account of ontic commitment. For the naturalist, our overall best theory of the world commits us to the idea that the only connection we ultimately have to an external reality is the "stimulation of sensory receptors." From these initial stimulations we import objects into our conceptual scheme as a means for unifying and predicting the range of stimulations we experience. Thus, in response to the claim that the indispensability requirement yields a problem vis-à-vis the idealizations which are postulated in scientific practice, the naturalist can hold that we can be committed to unobservables and idealizations given that they have some salience to an empirical

question. Accordingly, Quine, in considering scientific discourse about immaterial or idealized entities postulated in the sciences, points out that:

> [w]e discourse about certain immaterial entities, real or erroneously alleged, viz., sets or classes. And it is in the effort to make up our minds about genuine truth and falsity of sentences about these objects that we find ourselves engaged in something very like convention in an ordinary non-metaphorical sense of the word. We find ourselves making deliberate choices and setting them forth unaccompanied by any attempt at justification other than in terms of elegance and convenience. These adoptions, called postulates, are true until further notice[11]

We can identify the process outlined in the preceding quotation as one of Legislative Postulation.[12] Legislative postulation is simply the submission of a particular entity for consideration to the corporate body of science for empirical testing and evaluation. Ultimately, the truth of sentences regarding the postulation of a given entity is subject to considerations of "elegance and simplicity." The point to stress in assessing rejoinders to the anti-indispensabilist arguments is that the choice in accepting a given entity is conventional in nature. To further see the conventional nature of ontic commitment in the naturalist's metaphysics we should assess what happens when our commitment to the existence of objects is recast in naturalistic terms.

Following the naturalistic procedure outline above, the common sense ontology of physical objects can be re-construed into an ontology which countenances only points in space time. Accordingly, the hand which I hold in front of me can be re-conceived of as a set of material states which exist at points x, y, and z at time t. In turn, we can obviate the need to talk of points in space time, in favor of the ontology of pure set theory. Hence, the ontology of points in space-time now "evaporates" into talk of sets.

The important point to notice here is that each of the ontologies discussed above are equally compatible with the scheme countenanced by the overall best theory of the world, and yet each theory seems to commit us to the existence of a different class of objects (i.e., physical objects, space time points, and sets). But the ontological indifference outlined in the preceding example need not trouble the naturalist, given that each of the respective ontologies discussed above are merely in place to predict and control certain aspects of experience.

However, the critic of indispensability will reply that if all the entities of the best confirmed scientific theories are considered as implying ontological commitment (such as frictionless planes), then we introduce massive inconsistencies into our physical theories, because these entities fail to correspond directly to features of the phenomena modeled by a physical theory. If all the preceding

is taken to be true, then the indispensability thesis will have been fatally undermined by the very doctrine it is designed to uphold—naturalism. After all, the Quinean naturalist is committed to all those entities which can be read off from the true statements of our best theory of the world.

At this point, we face a central challenge. For it seems that postulating the indispensability of unobservables and idealizations leads to intractable difficulties for the Quinean naturalist. As Beuno points out:

> [I]f the indispensability argument is used, the empiricist ends up believing in the existence of abstract entities, such as sets, functions and numbers. Since the latter are *unobservable*…the empiricist's set of beliefs turns out to be incoherent.[13]

Hence, in line with C1 in the argument for scientific practice above, we can see why the rejoinders advanced by the advocates of indispensability seem to fail. For it seems readily apparent that the Quinean cannot be committed to all the entities involved in our best theory of the world, because many of these entities do not admit of empirical confirmation. So unless the Quinean wants to introduce massive inconsistencies in his overall best scheme of the world, he had better refrain from commitment to unobservables.

With the central features of Bueno's argument before us it would seem to indicate naturalism should best be characterized as an instrumentalist, as opposed to a realist, theory of ontic commitment.

In response to the criticisms cited above, I will invoke two further conceptual resources, which upon initial consideration, may seem at variance with the deflationary project in ontology. To make my case for indispensability (naturalized) I will require (1) a weak criterion of ontological commitment that allows for the admission of abstract objects into our best theories of the world Naturalized Platonism (NP), and (2) a Diagnostic Principle that identifies which entities have "gone indispensable" relative to our best theory of the world.

Primae facie, it might seem that by invoking the preceding principles in my defense of naturalized indispensability, I have failed to resolve the tensions which seem to fatally undermine indispensability arguments.

After all, as the critic points out, how can one hold to both a weak criterion of ontological commitment and a principle which holds that certain object are *indispensable*, when we can never determine in absolute terms what objects there are? Accordingly, in what follows, I will consider how NP when considered in relation to a specific instance in the history of science (i.e., Einstein's investigation of the phenomena of Brownian motion) can provide key conceptual resources to reconcile indispensability and ontological relativity. Why turn to an example from scientific

theorizing to make the case for indispensability? After all, is not the question at hand whether indispensability and indeterminacy can be reconciled as a set of metaphysical doctrines? Of course, it is important to note that the regimentation of ontology is something that practicing scientists would not be concerned with given their more pragmatic interests in exploring some aspect of physical theory. Nonetheless, given the thoroughgoing empiricism of the Quinean system, we must try to reconcile indispensability with relativity in relation to key features of scientific practice.

IV. Reconciling Indispensability and Ontological Relativity

At first glance, a consideration of the phenomenon of Brownian motion would hardly seem to provide any grounds for closing the conceptual breach between ontological relativity and indispensability. However, the evaluation of a few salient features of the phenomenon of Brownian motion will play a vital role in my defense of indispensability. Brownian motion or movement refers to the phenomena discovered by British botanist Robert Brown in 1828. Brown observed that tiny pollen grains suspended in a fluid medium exhibited a continual "swarming motion" which "arose neither from currents in the fluid, nor from its evaporation, but belonged to the particles themselves."[14] Importantly, in further investigation the movement seemed to extend over a range of particulates and was exhibited regardless of the fluid medium in which the particles were suspended. After discarding a number of vitalistic explanations for the appearance of Brownian motion, a number of theories were advanced to explain the cause of continual movement of particles. These theories ranged from Renault's notion that irregular heating and incident light caused the motion of the particles to Jevon's contention that the phenomenon was caused by differing electrical charges within the fluid medium.[15]

Andrew Whitaker in his work *Einstein, Bohr, and the Quantum Dilemma* points out that the classical interpretation of the Second law of Thermodynamics in many ways obviated the need for any atomic or molecular concepts.[16] When combined with Maxwell's insights into the electromagnetic theory of light, which predated the discrete or quantized theory of light, nature seemed to be an arrangement of continuous, rather than discrete processes. The spectacular achievements of classical physics and chemistry in providing an empirical explanation and a firm theoretical underpinning for understanding macroscopic phenomena led to a "tendency to view matter as continuous in nature and to question critically the particulate matter of the past."[17] The theories of physics which reduce all phenomena to the motion and equilibrium of smallest particles, the so-called molecular theories, have been gravely threatened, and we may say that "their days are numbered."[18] The limitations of the technologies employed to provide an empirical basis for explaining Brownian motion and the investigations of Brownian motion carried out prior to

Einstein's *annus mirabilis* 1905 were to a large extent caused by the notion that the atomic theory had only metaphysical validity. This point was underscored by the chemist F. A. Keluké who stated that:

> the question whether atoms exist or not has but little significance from a chemical point of view; its discussion belongs rather to metaphysics…. I rather expect that we will some day find for what we now call atoms a mathematico-mechanical explanation which will render an account of atomic weight of atomicity, and of numerous other properties of the so-called atoms.[19]

Importantly, the Second Law maintains that "heat is always lost when energy moves from a higher to a lower state." Thus, within the constraints of the Second Law, perpetual motion such as that apparently exhibited by the Brownian Particles would be a fundamental impossibility. What then was the ultimate cause of Brownian motion?

The determination that Brownian motion was caused by the "molecular motions of heat" represent the metaphysical assertion that the molecules or atoms in the liquid medium are real entities with tangible effects on the movement and agitation of Brownian particles. From this metaphysical position, Einstein was able to determine the reality and dimension of the atom by calculating the mean displacement of the particles in the liquid medium. Such a determination (of course, pending Jean Perrin's empirical confirmation of molecular reality) was only possible according to the proposition that the formulae advanced to explain Brownian motion were reflective of the existence of real entities.

With this brief account of Brownian motion before us, we have everything in place to mount a defense of indispensability. First, in relation to our preceding discussion of Brownian motion, we see that the tension between indispensability and ontological relativity can be resolved by invoking the notion of Naturalized Platonism. In their "Naturalized Platonism Vs. Platonized Naturalism" Benard Linsky and Edward N. Zalta point out that the variant of Platonism (Naturalized Platonism) that Quine invokes to "force belief" in abstract objects is a variant of Platonism in which "sets and theory and logic are continuous with scientific theories, and that the scientific theoretical framework as a whole is subject to empirical confirmation."[20] In stressing the continuity of logic and set theory, we have the conceptual resources in place to resolve the tension between indispensability and ontological relativity. For, simply, there is no tension between the two doctrines because ontological relativity is fundamentally compatible with the privileging of certain objects in the naturalist's system of the world. If this seems obscure, consider that the notion of "realism" invoked in the Quinean system is simply one in which for a given entity to count as "real" or irreducibly indispensable it only has to figure as a bound variable somewhere in our overall best theory of the world. Thus, in line

with the preceding claim, unobservables, mathematical entities, and other abstracta have equal claim to indispensability given some salience to empirical results.

In discussing the essential compatibility between naturalism's two core ontological doctrines, Peter Hylton maintains that relativity and realism can be reconciled once we accept the full implication of Quine's oft-cited maxim "to be is to be the value of a bound variable." Hylton writes:

> We can for example use an ontology which contains just sets instead of sets and numbers. If we accept that reduction, that means that we are not realists about numbers (except insofar as we identify numbers with sets) but it does not threaten realism more generally, It changes which objects that we are committed to but it does not change the *nature* of the commitment: we are committed to the reality of those objects which must be in the range of our quantifiers for our theory to be true.[21]

In line with Hylton's observations we can see how ontological relativity and ontological privileging can be reconciled in the naturalist's system. This is so because naturalism itself disavows the tension between realism and fictionalism. Accordingly, a given object (e.g., a frictionless plane) that is accepted as a mere fiction has much claim to reality as the object countenanced under the ontology of physical objects. By considering examples derived from the history of scientific theorizing, like Brownian motion, we can further demonstrate how ontological relativity and indispensability are fundamentally compatible doctrines.

Consider that, as outlined in our preceding discussion, there is a wide array of phenomena involved in the confirmation of atomicity. The determination that the ultimate cause of Brownian motion was the presence of a real entity (water molecules) involved a great deal of abstract mathematical apparatus including the Langevin equations, which represent the effects of thermal fluctuations in the Brownian particle.[22] The finding that Brownian motion is caused by the movement of molecules within the liquid medium is resultant from exploring a set of relations within the formulas promulgated by the molecular-kinetic conception of heat. From these mathematical relationships, Einstein is able to posit the existence of atoms and molecules as the causative agents behind Brownian motion. It must be remembered that the explanation of Brownian motion found in Einstein's work combines a number of explananda (i.e., diffusion, osmotic pressure, and the once discarded atomic theory) as evidence that the motions of the particulate matter are the result of the collision of spherical molecules. In essence, the explananda invoked a number of unobservables whose postulation seems primae facie incompatible with empiricist considerations.

So, in the case of Brownian motion the Quinean naturalist is indispensably committed to a number of unobservables. Hence, in our preceding discussion of Brownian motion the question becomes to which objects should the Quinean be committed? For, in line with the criticisms of indispensability outlined earlier, it seems readily apparent that the Quinean cannot be committed to all the entities involved in the calculation of Brownian motion, because many of these entities do not admit of empirical confirmation. So unless the Quinean wants to introduce massive inconsistencies in his confirmational holism, he had better refrain from commitment to unobservables. Recall that, as outlined above, the explanation for Brownian motion involved a number of notions which are obviously idealizations (e.g., the Langevin equation, which is an idealized representation of thermal effects). Yet, this response will only seem unattractive if we (wrongly) place the emphasis on the objects themselves and forget that objects are mere auxiliaries to the theories in which they are embedded. So, we can be committed to unobservables given that the importance we attach to unboservables and idealizations is that they figure as bound variables somewhere in our overall best theory of the world.

At this point the critic of indispensability stands ready to launch some objections, based on the notion that there are a (potentially infinite) number of structures that can meet empirical requirements. Before responding directly to this objection, however, I will return to the case of Brownian motion to head off a few of the most pressing rejoinders to my proposed reconciliation of indispensability and ontological relativity. The conceptual situation is as follows: At (T1) our best (19th Century) science was committed to the notion that the atomic conception only had validity as a metaphysical notion. The progress of the science of the 19th century science held out the promise that all phenomena in the natural realm could be understood in a conception of the natural order that made reference only to continuous as opposed to discrete processes.

However, at (T2) with the introduction of Einstein's explanation of Brownian motion (through a calculation of the mean displacement of particles in a liquid medium) and confirmation by subsequent empirical investigation, discarded notions of atomicity were found to have (indispensable) importance to the best sciences of the day. Accordingly, in the preceding (highly simplified) account of the explanation for Brownian motion, we see that at (T1) our "best science" was committed (indispensably) to the notion that atomicity had only "metaphysical validity." At (T2) a concept that was taken to have only metaphysical consequences was found to have empirical significance as well. Notice the weakness of the concept of indispensability at work in the preceding example. Indispensability is seen to be largely a *diagnostic* notion. We postulate objects to test their empirical consequences. As outlined previously, indispensability only occurs if an object is (1) completely resistant to paraphrase (appears as the value of a bound variable in our best theory of the world) and (2) of utility in furthering the elegance and simplicity of our best theory of the world.

When objects have nothing to contribute to the overall utility, simplicity, or elegance of our best theories they are dispensed with. In relation to the seeming tension between realism and anti-realism advanced in C1 we respond by pointing out that indispensability must be considered as a naturalistic thesis regarding which neutral nodes in a structure best meet the demands of elegance, simplicity, and empirical test.

As was demonstrated in our consideration of Brownian motion, the postulated reality of the molecular concept better fulfilled the demands of empirical testing. Hence, at (T2) we should be committed to all the entities (even the mathematical ones) that figure in the confirmation of a given theory. But a pressing objection comes to the fore, namely, given that a multiplicity of reference relations can be generated for any object, it seems that indeterminacy still undermines any notion of indispensability. The naturalist, however, has a ready response.

As in our example of Brownian motion it seems that indeterminacy can only be carried so far. If one gets carried away with a penchant for relativity, we lose sight of the fact that for the Quinean naturalist ontological commitment is constrained by empirical results. Of course, we can generate any arbitrary reference relation we wish. Such arbitrary reference relations can be generated through application of proxy functions. A proxy function is simply a "one-to-one" re-interpretation of objective reference.[23]

With a proxy function, we could reinterpret objective reference (ostension) to a given object to its cosmic complement (the rest of the physical universe). But there are limits to how far indeterminacy can be carried in relation to empirical results. The principle under consideration is that when we postulate objects, we should minimize mutilation to our best theory of the world. For instance, introducing a one-to-one reinterpretation of current concepts of combustion in relation to the discarded theory of phlogiston, which explained the differences between weights of heated and unheated materials (such as wood or iron) as related to the absence or presence of a mysterious substance "phlogiston," would (while entirely possible) require contortions and distortions of currently acceptable scientific theory which would simply be too much to bear. Similarly, we see that one could reinterpret true statements of contemporary molecular theory into its 19th century counterpart. For example, we could attempt to re-interpret all talk of discrete entities (molecules) into talk of continuous processes. But who would want to do such a thing? Not only would it render our explanations of many phenomena (chemical bonding, for example) hopelessly complicated but it would also leave certain phenomena (Brownian motion) unexplained. Thus, while there is a (perhaps infinite) number of reference relations that can be generated, some relations between objects and nomological structures will have bearing on an empirical result. More perspicuously, while any arbitrary proxy function can be generated, only a few will have relevance to our best theory of the world. Those objects and relations which have passed the test of contributing to the elegance and

simplicity of "our best" theory, and which have to be posited to achieve significant empirical results, are considered to have "gone indispensable."

V. Conclusion

In line with naturalized Platonism, the admission of abstract objects (like all objects) are subject to the demands of empirical confirmation. Importantly, this does not preclude, as was evinced in the preceding discussion of Brownian motion, the possibility of some unobservables eventually being submitted for empirical test. Hence, we can respond to Bueno's criticism in C1 by pointing out that there is no tension between realism and anti-realism because the "reality" of a given system entity is only a matter of an object entering in some point as the value of a bound variable. As demonstrated in our discussion of Brownian motion some entities (molecules) will play an indispensable role in the confirmation of a given theory. And the indispensability of certain objects is reflected in the progress of science in postulating some objects as irreducibly central to the development of certain aspects of physical theory. Thus, we can respond to the concern expressed in C2 as well by pointing out that indispensability appears to be as general a phenomena as indeterminacy, given that all reference relations are possible, but not all reference relations contribute to our overall best theory of the world. Simply, those objects which are resistant to paraphrase and which are deeply embedded in the structure of our best theory will (given the trivial nature of ontological commitment) be seen to be indispensable. Hence, we can see how indispensability is, in line with the Diagnostic Principle given earlier, a highly useful tool for diagnosing an object or structure's utility to our overall best theory of the world. But wait! We have only considered cases where an empirical test has demonstrated that a commitment to some objects (molecules) can be determined by an empirical test. Bueno explicitly points out that in some notable cases, no decisive empirical test is available. As Bueno points out:

> [T]he problem is that there is indeterminacy even at the level of structure. What exactly are the structures provided by quantum mechanics? Should we take them to be those given by group theory (Weyl), the theory of Hilbert spaces (von Neumann) or q-algebras (Dirac) all these structures are mathematically very different.… But when used to formulate Quantum mechanics they yield the same empirical result.[24]

The (potentially devastating) implications of the preceding passage for the indispensability thesis are clear. For, even if one tries to advocate a naturalized version of indispensability tied to empirical results, it seems that indeterminacy is ever present, given that a multiplicity of structures

can be determined to have conformity with a given result. However, the Quinean does have a response to this relativistic move. The answer is that, again, we are only committed to the idea that there are certain nodes in a structure which fulfill certain roles. In cases where neutral nodes yield (exactly the same) empirical results, Quine counsels "tolerance and an experimental spirit."[25] What objects there are is a matter of complete indifference. So, in response to the objection above, we can respond that so long as they correspond to some empirical result (and there is no paraphrase available) that under NP we are indispensably committed to those objects. Of course, the critic of indispensability will maintain that in some cases (e.g., contemporary sub-atomic physics) the nature of the phenomena in question bars the door to a decisive empirical test.

However, even when this potential rejoinder is considered, the naturalist can still hold to the realist account of ontological commitment in the naturalist's system. To see how the naturalist can make the preceding claim, we can further strengthen the critic's case against indispensability. For example, much as in the case of the thoroughgoing indeterminacy in quantum mechanics, there are also some questions which are—by their very nature—at present undecidable through empirical means. Consider, for example, the following claim: "There is a hydrogen atom which now exists at some space-time coordinate in alpha centauri." This claim is at the present moment undecidable. Yet, the naturalist is committed to there being a matter of objective fact about this question. However, the naturalist need not concede that undecidables or—as in the case of quantum mechanics—equivalent formulations threaten the naturalist's commitment to realism. As Quine points out in "What Price Bivalence," questions regarding hydrogen atoms at remote corners of space and time:

> [M]ake empirical sense to us only by virtue of the devious connections between our systematic theory of the world and the various observations to which the system as a whole is answerable. The connections are more complex and more tenuous in this case of the hydrogen atom…the question is still, for the bivalent-minded, a question of objective fact.[26]

With Quine's observations before us, we see how we can retain a commitment to the indispensability of abstract objects even in the face of ever present ontological indeterminacy. The simple answer is that both doctrines can be reconciled given a suitably naturalistic picture of ontological commitment. As I pointed out above, indispensability is a *diagnostic* tool. Certainly we can accommodate those structures like the aforementioned q-algebras, because they fall well within the range of entities that conform to empirical results. But doesn't this reintroduce the notion that ontological relativity should consider the more general phenomena? In line with the preceding claim, the critic of indispensability will maintain that "[t]here is a tension between the two arguments

(indispensability and ontological relativity). The indispensability argument is an argument for realism about mathematics. The indeterminacy of reference argument…is a powerful anti-realist argument. However, as I argued earlier, indeterminacy must be shown to have some salience to an empirical question. In order for ontological indeterminacy to hold across the board, the critic of indispensability must be able to show that a given translation into another idiom must preserve our commitment to the overall simplicity and elegance of our best theory of the world. Even in cases where no empirical test is available, the naturalist contends that, in line with his realist commitments, there is some objective matter of fact regarding the question at hand. Thus, ontological indifference, ontological indispensability, and realism are in complete conformity in the Quinean system. As Quine points out:

> Science ventures its tentative answers in man-made concepts, perforce, couched in man-made language, but we can ask no better. The very notion of object, or of one and many, is indeed as parochially human as the parts of speech; to ask what reality is really like, however, apart from human categories, is self-stultifying. It is like asking how long the Nile really is, apart from parochial matters of miles or meters.[27]

Accordingly, for the naturalist all objects (whether concrete or abstract in character) are to be considered ontologically on par. Yet, *not all objects are indispensable*. To paraphrase a line from George Orwell—all entities are equal—however some entities are more equal than others. In cases where the same entities or structures (the theory of Hilbert spaces, q-algebras) yield exactly the same empirical results we simply await further paraphrasing to simplify our conceptual scheme.

After all, even the molecular hypothesis was viewed "only to have metaphysical validity," before the reality of molecules was confirmed by Perrin's work. Accordingly, we see that although all entities are neutral nodes in a structure, some neutral nodes facilitate empirical study. Ontological indifference looks unattractive only if we assume that there is more to the structure we create through our use of language and our theories. So ontological indeterminacy and ontological privileging can co-exist given that ontology is only a way of determining the ontic commitments of science in a more perspicuous manner.

Notes

[1] See, for example, W. V. O. Quine, *Ontological Relativity and Other Essays* (New York: Columbia, 1990).

[2] See Penelope Maddy, *Realism in Mathematics* (Oxford: Clarendon, 1990) and Otavio Bueno, "Quine's Double Standard: Undermining the Indispensability Argument via the Indeterminacy of Reference," *Principia* 7 (2004): 17-39.

[3] Bueno 33-34.

[4] W. V. O. Quine, "On What There Is," *The Review of Metaphysics* 2 (1948): 21-28.

[5] Mark Colyvan, *The Indispensability of Mathematics* (Oxford UP, 2001).

[6] Quine, "On What There Is," 142.

[7] W. V. O. Quine, *From Stimulus to Science* (Cambridge, Mass.: Harvard. UP, 1995) 72-75.

[8] Bueno 33.

[9] Colyvan 98.

[10] Roger F. Gibson, "Quine on Matters Ontological," *The Electronic Journal of Analytic Philosophy* 5 (Spring 1997): 2-3. Available at: http://ejap.louisiana.edu/EJAP/1997.spring/gibson976.html.

[11] W. V. O. Quine, "Carnap and Logical Truth," in *The Ways of Paradox and Other Essays* (Cambridge, MA: Harvard UP, 1976).

[12] See George D. Romanos, *Quine and Analytic Philosophy* (Cambridge: MIT, 1983).

[13] Bueno 19.

[14] Abraham Pais, *Subtle is the Lord: The Science and Life of Albert Einstein* (Oxford UP, 1982) 11.

[15] Einstein 87.

[16] Andrew Whitaker, *Einstein, Bohr, and the Quantum Dilemma* (New York: Cambridge UP, 1995) 52.

[17] Mary Jo Nye, *Molecular Reality: A Perspective on The Scientific Work Of Jean Perrin* (American Elsevier, Inc., 1972) 14.

[18] Ernst Mach, *Popular Scientific Lectures* (Open Court, 1943) 104.

[19] Nye 5.

[20] Bernard Linsky and Edward N. Zalta, "Naturalized Platonism versus Platonized Naturalism," *The Journal of Philosophy* XCII (October 1995): 3.

[21] Peter Hylton, *Quine* (New York: Routledge, 2007) 319.

[22] F. Reif, *Fundamentals of Statistical and Thermal Physics* (New York: McGraw Hill, 1965) 15.

[23] Quine, *From Stimulus to Science,* 72.

[24] Bueno 33.

[25] Quine, "On What there Is," 143.

[26] Quine, "What Price Bi-Valence," 5.

[27] W. V. O. Quine, "Structure and Nature," *The Journal of Philosophy* 89.1 (January 1992): 5.

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