Structuralism and Reference

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An argument concerning representation and structure has recurred in various guises in analytic philosophy since its first formulation in the nineteen-twenties by Rudolf Carnap and the mathematician M.H.A. Newman. Perhaps because of the fundamental issues about representation it raises, the argument has spawned much literature without managing to secure a consensus response.

The argument is directed at the view that scientific knowledge is just knowledge of the *structure* of the natural world and not knowledge of its intrinsic nature. The origin of the view is the post-Galilean conception of modern science, which views science as yielding a picture of nature stripped of all color, explaining all physical processes purely in terms of space-time, particles, fields, forces and the like, the intrinsic natures of which are never themselves analyzed. It is safe to say that this conception of the limits of scientific knowledge, i.e. of its purely mathematical and structural character, is still a dominant one for both philosophers and scientists.

This picture of the nature of scientific inquiry, and the nature of the knowledge that it produces, has rarely been rendered precise enough to yield a thesis amenable to serious scientific or philosophical debate. In the early twentieth century, however, both Bertrand Russell and Rudolf Carnap tried to provide a more or less formal characterization of the idea using the newly-developed tools of modern logic and set theory. Their formulations of this structuralism about science, however, immediately led to an incisive critique that went to the heart of the project of characterizing scientific knowledge as knowledge of structure alone. This critique is what I will call "the master argument against structuralism" developed by Newman—in response to Russell's *Analysis of Matter*—and Carnap—in response to his own project in the *Aufbau* (Carnap, 1928). Moreover, a similar argument appeared again in a different guise with Putnam's

famous "model-theoretic" argument against metaphysical realism.[1] David Lewis later adapted Putnam's model-theoretic argument, calling it "Putnam's Paradox" and used it to support his theory that the metaphysically fundamental properties, metaphorically speaking, attract reference. Given this history, it's safe to say that master the argument against structuralism ranks as one of the more influential arguments of twentieth-century philosophy.

The general argument, as I understand it and as Newman and his commentators have understood it, is an a priori argument to the conclusion that one cannot have knowledge *just* of the structure of nature. If one is to know anything at all about nature, one must also know something about its intrinsic character. In this paper I explore the basic form of argument and some responses to it. My main claim is that only those who shackle themselves with an impoverished conception of linguistic reference will allow the argument to have any force against a structuralist conception of our knowledge of the natural world. In particular, I argue that if we bear in mind the indexical or ostensive nature of linguistic reference the argument loses its force.

The plan of my paper is as follows: First, I will introduce the basic form of the master argument. Then I will discuss how it affects Carnap's project in the *Aufbau*, arguing that it is quite devastating for his project. I will then suggest a way to respond to the master argument when it is considered as a general worry against structuralism. After this, I show how my response to the argument relates to the distinction between foundational semantics and plain semantics.

1 Problems of Structure

Carnap and Newman independently developed the argument I will discuss.[2] Newman used the argument to argue that Russell's account of scientific knowledge as structural knowledge was unstable. Carnap similarly used the argument to show that that his own project of treating all scientific knowledge as knowledge of the structure of experience was incomplete without adding a rather *ad hoc* postulate.

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[1]Putnam's original argument appears in Putnam (1978). Demopoulos and Friedman (1985) show the intimate relation between his problem and that raised by Carnap and Newman.

[2]In Carnap (1928, §153–155) and Newman (1928).

I will describe the common thread behind the two versions of the argument in this section. For now, I'll ignore the details of the particular philosophical programs which Russell and Carnap were pursuing and concentrate on what they share in common. The master argument against structuralism, on one understanding, is directed against a particular conception of how we use theories to represent things in the world. Carnap and Russell, at various times, both considered scientific representations to be accurate only in virtue of having structures isomorphic to the structures of the things represented. This idea is quite simple and elegant: Consider both the representation and the represented, i.e. the object of representation, to be domains of objects with various properties and relations over them. On Carnap and Russell's view—or at least on a view that might be attributed to them—there is an accurate representation if and only if there is a one-to-one function f that goes from the representation to the represented and preserves structure in the following sense:

Isomorphic Representation with respect to f For any two-place relation $\mathbf{R}$ in the representation there is a relation $\mathbf{S}$ in the represented such that for any objects x, y in the representation : $x\mathbf{R}y \iff f(x)\mathbf{S}f(y)$.[3]

In other words, one thing represents another just in case there's a way of seeing it as having the same structure of relations over it as over what it represents.

This idea about the nature of representation, for Carnap and Russell, has immediate epistemological implications: If scientific theories only represent the world by virtue of such isomorphisms holding, then knowing that a scientific theory is accurate only amounts to knowing that what the theory represents has a certain set-theoretic structure. In this respect, the view of scientific representation as working by isomorphism allows one to cash out the thought that scientific knowledge is only structural (or mathematical). Indeed, any thesis about the limits of scientific representation is likely to be linked to a thesis about the limits of scientific knowledge.[4]

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[3] Of course, this definition must be expanded for n-ary relations rather than just two-place relations.

[4] It is because of this close link between the limits of knowledge and representation that I take the liberty of treating Carnap and Russell's claims as being first and foremost ones about representation. For Russell (1927, ch. 22) especially, the primary thesis was the one about knowledge. The important point is that he described the knowledge as knowledge that an isomorphism held.

Both Newman and Carnap saw a problem with the idea that accurate representation just consists in the existence of isomorphisms between one's representation and the natural world. Consider the question of what one *knows* in virtue of knowing that a representation is accurate in the way described. Of course, one knows that the represented domain has a structure which is isomorphic to the structure of the representation. But this knowledge, it turns out, is trivial as long as the cardinality of the representation and the represented are the same.

Let me explain: To analyze the relation of representation in terms of isomorphism, one has to think of representations themselves as consisting of domains of objects with sets of relations over them. Given any representation of this sort there is an easy way to show that it is an accurate representation of anything else (with the same cardinality). First take some 1-1 function, f, from the objects in the representation to the objects in what is represented (which is possible as long as the cardinality of the two are the same). Then, for all the relations in the representation their images in the represented with respect to f will have to exist—that is just a matter of set theory. But these images are just what is needed to satisfy the **Isomorphic Representation** condition above. So any representation, up to having the same cardinality as the thing represented, is successful.

Here's a simple example. Suppose my representation has three objects, x, y, and z and one relation $\mathbf{R}$ which holds only for the pair z,y. Knowing that this representation is an accurate representation of some real world domain would be a putative example of having "structural knowledge" of that real world domain. However, the problem is that the information encoded by this representation—structural or not—is trivial. This is because any mapping of this representation onto three real world objects will allow a correspondence from $\mathbf{R}$ to a relation in the real world: All you need to do is take the image of the relation R in the representation through this one-to-one mapping. This last relation, call it S, has to exist by set theory. We can then use S to show that there is a perfect isomorphism between our three real world objects, and the representation. So, whatever the three objects in the real world are like, the representation will be accurate.[5]

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[5]You might note that there's an asymmetry in the problem as stated: The argument takes it for granted that representations have some privileged set-theoretic structure, but refuses to allow such a

The basic point is this: All possible relations among objects in the real world trivially exist. All we need is a way of identifying the different objects and we can stipulate by set theory the existence of any relation. So, if we do not know something more about *which* relations one is talking about, we cannot make a non-trivial claim about structure. It may seem, then, that in order to have an informative representation of some part of the world we need to know something about that part of the world besides its mere set-theoretic structure.

The above reasoning is one version of the master argument against structuralism— very close to Newman's version. It is this line of thought that I will discuss for most of this paper. In the next section, I will look back on Carnap's project in the *Aufbau* and explain why the version of the argument he faced was fatal for his project. In the process I will flag the particular assumptions he made that allow the argument to affect his project. Then I will examine the general form of the argument against structuralism as Newman presented it. In doing so, I'll try to show that one has to have an impoverished notion of linguistic reference—something Carnap and Russell shared—to be bothered by the argument.

2   Carnap's Problem

Carnap's project in the *Aufbau* could be described as the task of defining every possible object of scientific inquiry just by use of descriptions of the structure of experiences.[6] The details will take us too far afield, but here is the basic story: Carnap assumed that experiences were discretely divisible and that there existed a resemblance relation between different experiences. Thus, we can think of experiences as the members of a set with a two-place resemblance relation, **R**, over it. This relation is meant to have a complex structure over the domain of experiences, which we can then make interesting statements about. What Carnap wanted to do was to find a way of translating all scientific speech into statements about the structure of the resemblance relation

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privileged structure for the what is represented. One response to the argument pursued by Carnap and later adopted by Lewis is to claim that there is also a privileged set-theoretic structure in the world itself.

[6]This quick discussion of the *Aufbau* owes much to Michael Friedman's inspiring work on Carnap, collected in Friedman (1999).

over experience. So while his contemporary scientists were talking about things like atoms and waves, Carnap wanted to show that they could be interpreted as just making statements about the structure of their experiences.

The overarching aim of *Der Logische Aufbau der Welt*—usually translated as "The Logical Structure of the World"—goes beyond even this modest phenomenal reductionism. Not only did Carnap wish to reduce all scientific talk to discussion of the structure of experience, he also wanted to ensure that scientific discourse was entirely non-demonstrative, or, as he put, that it did not involve any "ostensive definition" (*Aufweisung*). It's hard to understand what Carnap's exact motivation for this constraint was, but we must assume it is because he thought ostensive definitions were subjective and hence unscientific. To achieve his structuralism, Carnap had to ensure that every object of scientific concern could be picked out without demonstrative reference. So, all scientific discourse, for Carnap, could be viewed as talk about the logical structure of the resemblance relation over experiences. Carnap writes, "Thus, each scientific statement can in principle be transformed into a statement which contains only structural properties and the indication of one or more object domains" (§16). In this case, only the experiences themselves are identified by ostension but the relations over them are identified purely by structural means. (Carnap also wants to eliminate the ostensive identification of experiences, but I won't discuss that here, as the problems for his project arise before it becomes relevant.)

I will focus on Carnap's aim of showing that science does not need to rely on ostensive reference. First, we need to get clear on what Carnap meant by "ostensive." He writes that an ostensive definition is one where "the object which is meant is brought within the range of perception and is then indicated by an appropriate gesture, e.g. 'That is Mont Blanc'" (Carnap, 1928, §13). What he means is something even broader than this may indicate. For Carnap, any definition is ostensive if it uses some term which itself can only be given an ostensive definition. To see how strict Carnap's constraint of eliminating ostensive reference was, it is useful to look at a famous passage where he considers giving a structural description of the Eurasian rail network. Here he is discussing the possibility of identifying all the connection points on the rail network merely by the structural features of the relations over them (in Carnap's terminology, if two points are not distinguishable they are "homotopic"):

No one will suppose that there can still be two points which are homotopic under all of the relations we have introduced [i.e. about the rail stations and their connections]. However, such a case merely contradicts our notion of what actually exists, but it is not altogether unimaginable. Thus, in order to solve the problem in principle, we must still pose the further problem: how can we produce a [purely structural] definite description if all these relations do not suffice. So far we have utilized only spatial relations, since their schematic spatial representation is both customary and easily understood. But we can also employ other geographic relations and establish a connection between number of inhabitants. . . . if we are still left with two homotopic elements of the object domain, then we still have two locations that are geographically indistinguishable. If we then move on to a new type of relation and take into account all the historic relations. . . we shall ultimately have used up all the concepts of cultural as well as physical sciences. If there should still be two locations for which we have found no difference even after exhausting all available scientific relations, then they are indistinguishable, not only for geography, but for science in general. They may be subjectively different: I could be in one of these locations, but not in the other. But this would not amount to an objective difference, since there would be in the other place a man just like myself who says, as I do: I am here and not there. (Carnap, 1928, §13)

Indexical descriptions are ostensive, and so cannot, within Carnap's constraints, be used to distinguish between different things. This leads Carnap to the dramatic conclusion that those things which can only be distinguished indexically are not really different—they are only *subjectively* different.

In sum, Carnap wants to establish that "*science deals only with the description of structural properties of objects*" (§13). To achieve this, Carnap tries to represent all of scientific knowledge in a way that does not use any ostensive definitions. This means he wants to treat all scientific terms as not even involving *implicit* ostension. Everything spoken about in science must be identified entirely by reference to structural features alone. If this is not possible then the features in question are, by stipulation, not properly the object of science.

However, this prohibition on ostensive reference leads to a fatal problem for the phenomenal reduction proposed in the *Aufbau*: Carnap *starts* the *Aufbau* by discussing the relation of resemblance between experiences. He never picks this relation out by any structural features, he just takes it for granted that his readers know what he is talking about. Then he moves on to translate scientific discourse into discourse about this relation. It seems, then, that his identification of the resemblance relation is itself ostensive, for he gives no other means of picking it out in the early sections.

Carnap is well aware that this foundation is inadequate. After he has sketched the project of identifying the content of scientific claims in terms of the resemblance relation, he then tries to eliminate (or make redundant) his initial ostensive reference to the relation. In §153–155 (strangely labeled "may be omitted"), Carnap *defines* the resemblance relation as the one which would satisfy all the structural claims of scientists. This comes down to identifying the resemblance relation purely by its set-theoretic structure. This identification, then, conforms to Carnap's methodological constraints.

By following this strategy, Carnap is able to translate all scientific claims into purely structural ones. This follows because all scientific claims are merely about the structure of a certain relation, which is itself, now, identified structurally. However, as Carnap realizes, this proposal will not work. This is because any number of gerrymandered relations over experiences will have the same structure as the actual resemblance relation over experiences. In §154 Carnap observes that in this case for any accurate representation there corresponds another one which one can make just by taking any 1-1 function from the object domain to itself: "to each originally constructed object, there corresponds one new one with the same formal properties." For Carnap, then, structural descriptions cannot uniquely identify the objects of scientific claims.

This realization which Carnap confronts in §153–155 is another form of the master argument against structuralism I described in the last section. The basic lesson of that argument is as follows: We cannot identify a relation solely on the basis of its set-theoretic structure. It is axiomatic of the set-theoretic tools we use that for any given relation with a certain structure over a certain set of objects many relations sharing that structure exist over the same set of objects. So we must use something *more* to identify a relation.

Carnap, however, explicitly disallows using anything like ostensive reference to iden-

tify the relation in question. Thus, his only recourse is to postulate some basic property: one possessed by the right relations not by the other, gerrymandered, relations. This property he calls "foundedness" (§154). This move is *ad hoc* and unsatisfying. For Carnap faces the problem that this property, foundedness, seems itself to only be identified by ostension.[7] In this case, the quest to eliminate ostension from scientific inquiry ends in failure.

The question I will turn to now is whether Carnap's failure reveals a general problem affecting all philosophical ways of making precise the thesis that scientific knowledge is purely structural knowledge.

3   The Master Argument against Structuralism

We saw how the master argument against structuralism was fatal within Carnap's strictly non-ostensive framework. However, there is a tradition stemming from Newman (1928) which suggests that the problem is of more general application. Newman's reasoning—his version of the argument against structuralism discussed in Section 1—has been endorsed by Demopoulos and Friedman (1985), Psillos (1999, p. 61–69), Ladyman (1998) and other philosophers.[8] The conclusion usually reached, in discussions of Newman's argument, is that it is not possible *just* to know the structure of the natural world; if one is to know anything about the natural world one must also know some of the intrinsic, non-structural properties of the world. To give one quotation, here is Demopoulos and Friedman (1985, p. 630) endorsing Newman's argument:

> The conclusion Newman draws from this analysis is, we think, the right one: since it is indisputably true that our knowledge of structure is non-trivial—we clearly do not stipulate the holding of the structural properties our theories postulate—it cannot be the case that our knowledge of the unperceived parts of the world is *purely* structural. [their emphasis]

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[7]In fact, Carnap claims that "foundedness" is a logical property and thus kosher on his system. However, it's hard to take this very seriously, since foundedness is obviously not a logical property.

[8]Indeed discussions of the issue have played a leading role in the debate over the new "structural realism" in the philosophy of science, a view associated with John Worrall (1989) and others.

It would be an impressive achievement of philosophical reasoning if such a strong claim about the limits of knowledge could be established. I think, however, that the argument for the claim rests upon a naïve conception of linguistic reference.

To show this I will consider what assumptions we need to make to get the argument against structuralism from Section 1 to yield the conclusion attributed to it by Demopoulos and Friedman. For simplicity's sake, let's work with a picture on which science aims at revealing the structure of a relation, $\mathbf{R}$, over a set, S, of objects, as in the case of the *Aufbau*'s resemblance relation over experience. (Obviously this view of science is hopelessly abstracted, but this is the view that the argument against structuralism is directed against, and so it is the natural frame within which to discuss the logic of the argument.) What Carnap and Newman realized is that one cannot say anything interesting about such a relation just by making a claim of the following form:

Over the set S, there exists a relation $\mathbf{R}$ s.t. $\mathbf{R}$ has such and such a structure.

That would be a trivial statement. Rather, to say something non-trivial, one has to *refer* to the relation $\mathbf{R}$ and say *of* it that it has a certain structure. To make a non-trivial structural claim one has to first set the topic—one must be speaking *of* some particular relation or class of relations.

Now, the argument against structuralism, as developed by Newman and others, is meant to show that one cannot *just* know the structure of X (for this case, read: the structure of the relation $\mathbf{R}$ over S); if one is to know anything about the structure of X, one must also know something *else* about X (for this case, read: something else about the relation $\mathbf{R}$ over S). This claim seems right to the extent that one cannot know anything about the structure of a relation without an independent grasp on *which* relation one is speaking of. However, this leaves us with the critical question: *must such a grasp amount to knowledge of non-structural features?*

A brief consideration of a couple of famous cases in the philosophy of language will show suggest the answer to this last question is "no." Consider for instance, self-predication. To know *of* yourself that you are in pain, you need have no non-indexical knowledge of who you are. That is, you can know of yourself that you are in pain while, because of amnesia, know nothing about who you are.[9] So it is not true in general

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[9]This is, at least, a common sense view. Some philosophers (such as Strawson's Kant) have tried to articulate substantive constraints on self-reference. Since reference to properties in nature is not really

that the ability to speak of something requires much knowledge of it. Demonstrative reference provides another example when one can know some properties of something without having identifying knowledge of it. One can see a cat quickly run by one, and can know of *that thing* that it was moving fast without having any sense of whether it was an animal or not or even what color it was. What these cases show is that it is possible to know certain facts about things, without knowing much about the general properties that distinguish those things from other things around them. This seems to open up the possibility that we may know structural facts about objects in nature without having any non-structural information about them.

These cases in mind, let us review Newman's version of the argument against structuralism. Before doing so, we need some background. Newman was a Cambridge mathematician whose one (published) foray into the world of philosophy is his acute note on Russell's *Analysis of Matter*.[10] A major thesis of Russell's book was that our scientific knowledge was solely knowledge about the *structure* of things in the world, not their intrinsic nature. (Russell's argument for this thesis comes from his causal theory of perception and discussing it would take us too far afield.) Russell states his thesis in this passage:

> What we assume is formally, something like this: there is a roughly one-one relation between stimulus and perception—*i.e.* between the events just outside the sense-organ and the event which we call perception. This enables us to infer certain mathematical properties of the stimulus when we know the percept, and conversely enables us to infer the percept when know the mathematics properties of the stimulus.(Russell, 1927, p. 227)

Newman, critiquing this aspect of Russell's view, presented a clear version of the argument against structural knowledge which I have been discussing:

> These statements [i.e. Russell's structuralism as quoted above] can only mean, I think, that our knowledge of the external world takes this form: The world consists of objects, forming an aggregate whose structure with

a form of self-reference I won't discuss these issues here.

[10]Russell's book and Newman's response are covered very well by Demopoulos and Friedman (1985). I disagree with them only in the conclusions they draw, not their description of the argument.

regard to a certain relation R is known, say W, but of the relation R nothing is known (or nothing need be assumed to be known) but its existence; that is, all we can say is, "*There is* a relation R such that the structure of the external world with reference to R is W." Now I have already pointed out that such a statement expresses only a trivial property of the world. Any collection of things can be organized so as to have the structure W, provided there are the right number of them. Hence the doctrine that *only* the structure is known involves the doctrine that *nothing* can be known that is not logically deducible from the mere fact of existence, except ("theoretically") the number of constituting objects. (Newman, 1928, p. 144, Newman's emphasis)

We can see that Newman assumes that Russell's view must amount to the idea that scientific knowledge is just knowledge of the truth of an *existence* claim.

As I suggested, we need not follow Newman here. We can drop the assumption that scientists make existential claims about relations in nature, and instead consider a structuralist view according to which scientists are actually speaking *of* a particular sort of relation (or class of relations). In this case, it seems that Newman's argument no longer gets a grip.

However, there are worries remaining for the structuralist even if we understand the view in this last way. A first misguided worry is about how we can speak of something without knowing anything about it. This misguided because, on the structuralist view, the scientists do know something about the relations they are speaking of, namely their structure. It is not a condition on reference that we know *uniquely* identifying information about anything we can refer to. For example, I can refer to a the box right in front of me right now. However, surely, such reference does not depend on my ability to uniquely identify myself or the box by a non-indexical description.

We can understand scientific practice as an activity that yields a form of indexical reference to certain sorts of relations. These cannot be picked out by any identifying description; rather, they can be picked out because they are *those* relations that the scientists are investigating.

We might call this sort of reference a form of ostension, but we have to expand the notion of ostension beyond its typical understanding. The paradigm case of ostension is

one of pointing to a medium-sized dry good. As I understand it pointing works because it makes what is pointed to *more salient* for the purposes of the conversation. Critically, of course, it does so without saying anything non-indexical about the thing itself. What is more salient is more easily available for reference. Now, if the critical component of ostension is that it makes something more salient (to the speaker or to the hearer), then many activities a far cry from pointing will count as forms of ostension. For instance, by simply engaging with an object in some way we make it more salient and hence more easy to refer to. In particular, I would suggest that various forms of scientific inquiry, by being directed at certain phenomenon, make salient some relations in nature and not others. They may do so moreover, in an ostensive way, that is, without identifying the relations by description.

Given this situation Newman's claim is in rough waters. The proponent of the master argument can defend one of two claims to make the argument go through:

1. To speak of anything one needs a completely identifying, indexical-free, definite description.

2. Reference through demonstrative or indexical means always requires some sort of non-structural knowledge of the thing referred to.

The first option is clearly untenable. Obviously, for Carnap it represents exactly the constraint he places on objective, as opposed to subjective, knowledge. However, today this constraint seems unmotivated. Russell at times, also, would have been sympathetic to something like 1. with an exception for demonstrative reference to experiences themselves. However, this notorious Russellian view is also not widely held today, not the least because few would endorse Russell's Cartesian notion of experience.

The second option is more complex. It is natural to think that reference to many things in everyday life comes with lots of non-structural knowledge about them. You might think that one can rarely (perhaps never) refer to a visually presented object without knowing something about how it appears—and it is unclear how to think about what appearances reveal as just structural. However, Russell and Carnap are talking about fundamental scientific relations. With them it is not clear even what non-structural information means. It would be strange, on the basis of a tenuous analogy to vision, to suppose that in order to refer to fundamental scientific relations we need to

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know something about them besides their structure. Indeed it would be in some sense question-begging to assume that conscious vision is the right model for thinking of any knowledge of the external world.

On this topic, one prominent line of thought needs to be addressed. Some philosophers interested in demonstrative reference such as Gareth Evans and John Campbell aim to put strict conditions on what it takes for something to be available for demonstrative reference in thought.[11] If we follow them we might think that the unobservable relations posited by modern science are not possible candidates for demonstrative reference. In this case my reply to Newman would be inadequate, since scientific practice could not be construed as allowing a form of demonstrative reference to unobservable properties. I do not, however, think that conscious attention to an object—and the knowledge of categorical properties that perhaps accompanies it—is a necessary condition for non-descriptive reference.

Perhaps there are *certain types* of thoughts that are only made available for things that are available consciously. Nonetheless, I don't think we should conclude that those things which we do not consciously encounter we must thereby pick out by definite description. I think rather that by engaging in research projects directed at certain aspects of the natural world those aspects become available for demonstrative reference (of a broader kind than Evans and Campbell consider). It is this form of implicit ostension that I claim contributes to the ability of scientists to speak of unobservable properties and relations without (perhaps) having knowledge of any of their categorical properties.

I can still see, however, a general worry that relations in nature are simply not the objects of demonstrative reference. I will say two things in response to this worry. The first is that scientific research, on the realist picture, constitutes a project analogous, if not identical to, perception. This holds at least to the extent that scientific study is directed towards elements of the natural world in such a manner as to make them available for reference, just as our perceptual systems make available for reference the parts of the world that it receives information about.[12] Now, of course, there will be

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[11]I am grateful to Naomi Eilan for making clear the relevance of this work to my claims.

[12]I still want to maintain significant disanalogies, since I do not think we need to say that science makes available the intrinsic categorical features of nature in the way that perception might be thought

significant disanalogies between the types of thoughts we can have about things made available for reference by perception and those made available for reference by research projects occurring largely outside the head. Nonetheless, both processes involve the same sort of sustained focus and causal interaction that is the precondition for reference.[13]

There is one other response I want to develop for those who are uncomfortable with the idea of treating scientific statements about the structure of the natural world as involving a form of demonstrative reference.

Recall that Newman's argument depended upon understanding the structural claims as existentially quantified claims of the form: ∃ a relation **R** s.t..... It's widely recognized that natural language quantifiers are often used to communicate thoughts about partial domains of objects. For instance, apparent universal quantifiers such as "each" and "every" usually speak about highly selective subsets of individuals. A typical utterance of the sentence, "Everyone wore a coat and tie last night," will only be a claim about a relevant group of individuals, not everyone on earth (or beyond). We might think that existential claims also exhibit a form of quantifier domain restriction. For instance, an utterance of the sentence, "A student is sick," may be a statement about students at some school and not students in general.

We can likewise think that the underlying logical form of the scientific claim about the structure of the world as an existential statement over a restricted domain. Recall that the statement was taken by Newman to be of the form: ∃ a relation **R** s.t. .... If we restrict the domain of relations the statement quantifies over then this could be a non-trivial statement. In particular, if we exclude mere set-theoretic relations from the domain, then the claim will be a substantial one about the natural world.

The important question for this proposal is whether expressing such a statement with a restricted domain requires one to have a grasp on what the properties are that distinguish the domain one is speaking of from other potential domains. I think it is quite plausible to think that one does not need to know of any particular (non-indexical) properties that distinguish the domain one wants to speak of from other domains. To

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[13]Some might be tempted to say that they are made available for reference because of our causal connection to them. However, mere causal connections in addition to explicitly formulated descriptions does not seem sufficient to me to pick out the objects of scientific research. I suggest, rather, that it is a persisting perception-like interaction that makes available the possibility of reference.

support this claim it is useful to think of an example inspired by John Perry. Imagine a group of people living on an island, blissfully unaware of the rest of humanity. Indeed so unaware, that it has never occurred to them that there might be other people in other places or that there might be anything beyond the waves that crash against their shore. Suppose one of these people thinks "Everyone is happy". It may be, in this case, that the content of his thought is somehow restricted to those on the island, despite the fact that he does not explicitly consider the idea that he is only thinking of a restricted domain of individuals.

With scientists the case may be similar. When they say there exists relations of such and such a structure (or whatever they say that supposedly comes down to this) they may not explicitly consider the fact that their existential quantification is restricted to certain relations in the world and not other ones. Nonetheless, it may still be the case that by virtue of their practice their statement is only about a restricted domain of relations, a domain which may not include the gerrymandered relations considered by Newman. In this case it may be that one can speak of some restricted domain of objects without knowing or even thinking about the features that differentiate the restricted domain from the universal domain.

I conclude that it is unclear how the master argument against structuralism can be compelling when ostensive reference (in the very broad sense I've sketched) is countenanced. Of course, the argument against structuralism does show that, if structuralism is true, one does need to have some indexical understanding of *which* things in nature one is ascribing structure to. However, such indexical identification does not seem to amount to non-structural knowledge of the things in any interesting sense.

4 The Semantics and Foundational Semantics of Indexicals

My reply to the master argument makes much use of the concept of ostensive reference, something typically associated with indexicals and demonstratives. Appeals to ostension or indexicality in a philosophical context often engender confusion. One might worry, in particular, that the claim I have made commits me to the idea that scientific terms

have demonstrative or indexical *meanings*. Some find this idea implausible on its own. An additional worry, if we accepted that scientific claims are demonstrative or indexical, is that this would mean that scientific theories themselves are somehow indexical and hence not sufficiently "objective." I think these worries are both ill-founded and rest on a confusion about the nature of semantic content.

One reason for this confusion is that a critical distinction is too often glossed over or ignored. I call it the distinction between foundational semantics and plain semantics. Foundational semantics is the study of the facts that go into determining the content of plain semantics. Plain semantics is the study and representation of the meanings of various forms of representations. It studies the content of representation without studying what facts determine content. The distinction is covered in various ways by many philosophers and my comments here are not intended to be original, though they represent a viewpoint not shared by all philosophers of language.[14] (It's worth noting that an analogous distinction can be made between the content of a thought, and the means by which one comes to have that thought.) My goal here is to relate this not entirely uncontroversial distinction to the debate over structuralism.

When I suggest one can only make *ostensive* reference to the relations spoken of in science I am making a claim about the foundational semantics of scientific claims, not the plain semantics. In other words, I don't think we should treat scientific statements as indexical, or as containing hidden indexicals as part of their meaning, i.e. as part of their plain semantics. Rather we should recognize that various indexical forms of reference play a part in the story of how scientific terms come to mean what they do, i.e. in their foundational semantics. In the rest of this section, I will clarify what it means for something to have an indexical foundational semantics without being semantically indexical. (I will freely interchange the terms "ostensive," "demonstrative," and "indexical" here.)

Semantic representations are tools that we use to model the content of our representations (scientific, linguistic, or mental). We can, for instance, model some aspects of the knowledge we gain by science by a set-theoretic model.[15] Thus we could say that our

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[14]The distinction I am making is close to the one made by Stalnaker (1997) who attributes the distinction to Kripke (1972).

[15]As in, for example, van Fraassen (1980, ch. 3).

theory of dynamics has as part of its content that nature has such and such a structure. In doing so, however, we are making a claim about the content of the theory, not about the facts (about scientists' intentions and so on) that make it such that the theory has the content it does. We leave it open that theory may come to have such a content in part by various ostensive acts of identification on the part of the people putting forth the theory.

Certain sorts of thoughts and sentences allow for a semantic representation of their indexicality or ostension. Typical representations include centered-possible worlds or indexical "modes of presentation." Centered-possible worlds are possible worlds with one particular spot marked as the center. Normally, sets of ordinary possible worlds are used to represent the content of an expression. But no obvious set of worlds represents the content of a proposition like the one expressed by the sentence "It is cold here." Obviously any world representing the content of such a sentence would need to have at least one cold place in it. However, the set of worlds with one cold place in them does not seem to capture the meaning of "It is cold here." But one can expand the machinery of possible worlds to deal with this problem. This is done by taking worlds to have centers representing the location of the "subject." Using this tool one can represent "It is cold here" as being the set of possible worlds with a cold spot in the center.[16] This type of semantic representation is one uniform system for capturing the indexical character of certain thoughts. Such systems tend to be used to capture indexical thoughts expressed with words like "I", "here", and "now."

Carnap's notion of what makes a statement ostensive goes far beyond statements which included words like "I." For Carnap the proposition that Mt. Blanc is the highest mountain might be ostensive. But, we can easily imagine representing this proposition with possible worlds just by using the set of all possible worlds where Mt. Blanc is the highest mountain. We do not generally think of the statement as semantically indexical.

One way of fleshing out Carnap's idea is to stipulate that singular terms are generally short for elaborate descriptions. This allows for a means of determining whether a singular term is ostensive. What we assume is that there is a primitive vocabulary in terms of which everything is ultimately defined; some parts of this vocabulary are ostensive and some are not. Now, a term is non-ostensive just in case it is short for a

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[16]See "Attitudes *De Dicto* and *De Se*" reprinted in Lewis (1983) for fuller discussion of these issues.

description whose primitive terms are entirely non-ostensive.

At least two things make this approach inadequate. The first is that it assumes that "Mt. Blanc" and such singular terms are covert descriptions. Most philosophers (in the norther hemisphere at least) doubt that people who master singular terms like "Mt. Blanc" also associate with them the complex descriptions needed to fix their reference.[17] The second is that it does not distinguish between semantics and foundational semantics. Once we make this latter distinction we can give a Carnapian notion of being foundationally indexical which does not depend on the idea that names are semantically equivalent to descriptions.

The basic idea is that a term is foundationally indexical just in case a person's only means of using it is ultimately through some form of demonstrative thought. Here's a simple example. I meet a woman next to me while watching *Cats*. I learn her name is Susan. I thus acquire the referring term "Susan." Yet it may be that the only way I can succeed in understanding this term is through my ability to think of *that* woman whom I met at *Cats*. In this case my term "Susan" is foundationally indexical since my mastery of the term depends upon a demonstrative thought.

We can imagine beings that do not have an indexical foundational semantics for any of their terms. These beings might have some basic stock of concepts which they have indexical-free mastery of. They think and communicate by forming representations out of these concepts. The content of their thought in no way depends upon their circumstances. Perhaps we can think of such beings as having epistemic contact with physical things in the same way that we have epistemic contact with logic and mathematics.

We are not like this however. Our knowledge is rooted in our own location and interests. Foundationally indexical thoughts utilize these to allow us to speak of things which we cannot identify by basic, non-demonstrative concept alone. We can talk of our location without knowing where we are; we can think of ourselves without knowing anything about ourselves; we can talk of objects in front of us without knowing much about them. It is reasonable to suppose that we pervasively rely on foundationally indexical representations.

It is worthwhile relating these comments to the well-known work on proper names

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[17]The defenders of descriptivism, include at various times and to various degrees, David Chalmers, Frank Jackson, and David Lewis.

and natural kind terms (e.g. Putnam (1975) and Kripke (1972)). Both Kripke and Putnam argue that our ability to speak of natural kinds does not depend on us holding descriptions which uniquely pick them out. Rather there must be some non-descriptive grasp—some way in which our reference to natural kinds depends not just on what we believe about them but also on our having made some sort of ostensive reference to them in our practice. I think the best way to understand Putnam's controversial claim that natural kind terms are indexical is in the foundational semantics sense that I put forward here.

The indexical foundational semantics of our representational capacities explains how we can think of things without uniquely identifying them. While some forms of indexicality, such as that of words like "I", "here", and "now", admit of easy semantic representation, other kinds may not.[18]

Let me relate this view of semantics, which I take to be a standard contemporary view, to the earlier worries about structural knowledge from Newman and Carnap. The master argument against structuralism was meant to show that to know something about the basic features of the world one must know something about them beyond their structure. This argument worked for Carnap because he wanted to eliminate all indexicality, foundational or semantic, from scientific knowledge. However, anyone who can countenance the foundational indexical nature of scientific reference need not be particularly bothered by this worry. For one may refer to scientific objects not just by knowing things about them but also ostensively. So the theory of reference does not show that we need to know more about a relation than its structure in order to refer to it. Moreover, such ostensive means of knowledge do not force us to think of the meaning of scientific terms as themselves ostensive.[19]

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[18]Two-dimensionalism might be understood as an attempt to semantically represent all foundational semantics as a second layer of meaning. The main philosophical meat of the program comes in with its claims about speakers implicit knowledge of the foundational semantics of their terms (see, for instance, Jackson, 2000; Chalmers, 2002).

[19]Many thanks to Robert M. Adams, Bas van Fraassen, Gilbert Harman, Stephan Leuenberger, and Jim Pryor for comments on earlier drafts or discussion of these issues.

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