WHY RUSSELL WAS NOT AN EPISTEMIC STRUCTURAL REALIST

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Bertrand Russell's work in philosophy of science has been identified as a progenitor of structuralism in contemporary philosophy. It is often unclear, however, how the philosophical problems facing contemporary structuralist programmes relate to the problems of philosophy as Russell saw them. We contend that Russell has been mistakenly identified as an epistemic structural realist. The goal of this essay is to clarify the relationship between Russell's programme and contemporary structuralist projects. In doing so, we hope to display the motivation for a broad, truly Russellian structuralist project in the philosophy of science.

1. INTRODUCTION

The much-discussed structuralist tendency scholars have found in Russell's philosophy stemmed from his application of mathematical logic to problems in the epistemology of science.[1] He wished to provide an account of perceptual evidence for our

[1] Indeed, Russell says in his 1925 "The Philosophical Analysis of Matter" that the "natural order" in studying the problem of matter goes: "logic, epistemology and

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common sense and scientific knowledge of the external world, and he was convinced that the logic which had demonstrated the logical nature of mathematics could be applied fruitfully to the analysis of human knowledge, including our knowledge of what had traditionally been called "matter" in physics. A key concern of Russell's was to bridge the apparent gap between the world of experience and the world of physics, one that seemed widened by the vastly different character of percepts and non-percepts:

> The problem arises because the world of physics is, *prima facie*, so different from the world of perception that it is difficult to see how the one can afford evidence for the other.… (*AMa*, p. 6)

This way of putting the problem goes all the way back to his 1912 *Problems*, where he jokes that the scientific account of the real table as "a vast collection of electric charges in violent motion" is "scarcely less wonderful" than Leibniz's view that the real table is "a community of souls" (*PP*, p. 24).

Scholars have suggested that, in his philosophy as it developed after 1918, Russell shares with contemporary structuralists a broadly "naturalist" approach to philosophy and conceives of philosophical reflection as continuous with and drawing from science.[2] This is supported by his philosophical practice: his work on neutral monism shows engagement with then-current scientific theories such as relativity theory in physics and with behaviourism in psychology.

What kind of scientific structuralist, though, was Russell? The aim of this essay is to connect the positions that Russell took on classic epistemological problems in the 1910s with his scientific epistemology that, following his 1918 incarceration in Brixton Prison, emerged in

ontology successively" (*Papers* 9: 276). This makes good sense: his considered view is that matter is "an immensely elaborate logical construction" that "preserves the truth of physics, while making a minimum of extra-logical inference" (*ibid.* p. 284). One of course must begin with logic before one is in a position to classify inferences as extra-logic. For autobiographical data supporting the point that Russell's structuralist tendencies towards construction rather than inferences grew from their original application in mathematical logic into other fields, see "Logical Atomism" (1924); **26** in *Papers* 9: 164, 165–6).

[2] See GARVIN, "Russell's Naturalistic Turn" (1991); O'GRADY, "The Russellian Roots of Naturalized Epistemology" (1995); STEVENS, "Russell's Repsychologising of the Proposition" (2006); and KITCHENER, "Bertrand Russell's Naturalistic Epistemology" (2007).

the 1920s and was further developed through the 1940s. Yet even during this period, Russell's work retains a clear connection with traditional problems of philosophy and retains some non-naturalistic epistemological commitments.

Current structuralist positions in the philosophy of mathematics and science are motivated by current topics and trends in philosophy, mathematics, and science, including Putnam's No-Miracles argument for scientific realism and by challenges posed by pessimistic inductions on scientific progress.[3] As a result of these disparate motivations, philosophers of science, philosophers of mathematics, and metaphysicians sometimes have very different ideas and assumptions about structure. The various structuralist positions in the philosophy of mathematics and empirical science have been motivated by, for example, naturalization projects with discipline-specific concerns. It is often unclear how the philosophical problems facing contemporary structuralist programmes relate to the problems of philosophy as Russell saw them. This essay will present Russell's structuralism as an integrated response to traditional problems of philosophy and as a unified philosophical treatment of scientific knowledge.

II. INFERENCE, CONSTRUCTION, AND STRUCTURE

We claim that in understanding Russell's structuralism, it is crucial to place it within the context of his engagement with the traditional philosophical problems posed by Berkeleian idealism. Russell's refutation of Berkeleian idealism rests on his rejecting any sharp divide between the mental and the physical.[4] Part of how Russell replies to Berkeleian

[3] *Scientific realism* is the view that we are justified in positing the theoretical entities, whether observable or not, of our best scientific theories. Putnam's No-Miracles argument for scientific realism is that the allegedly extraordinary success of the empirical sciences cannot be unexplained, that is, seemingly miraculous; and that the best explanation of the empirical sciences' success—or, more strongly, that the only explanation that does not make this miraculous—is that these scientific theories are true. The challenge to this view is an argument known as the pessimistic induction on scientific theories: most past scientific theories are partly or entirely false, so probably all our best scientific theories are at least partly false. (For further discussion, see, for example, Worrall, "Structural Realism" [1989], pp. 100–4, 109–13.)

[4] Indeed, this rejection is of both any epistemological divide and any metaphysical one. The rejection of any epistemological divide is discussed below. The rejection of any metaphysical divide can be seen not just in his embrace of neutral monism, but

idealism is by insisting on the mind's capacity to be aware of objects other than itself:

> The faculty of being acquainted with things other than itself is the main characteristic of a mind. Acquaintance with objects essentially consists in a relation between mind and something other than the mind; it is this that constitutes the mind's power of knowing things. If we say that the things known must be in the mind, we are either unduly limiting the mind's power of knowing, or we are uttering a mere tautology.
>
> (*PP*, pp. 66–7)

In the *Problems*, Russell held that matter lies outside our acquaintance. Nonetheless, the field of our acquaintance includes real spatio-temporal relations such as hold between objects in space-time:

> Among universals … it is clear that among those which can be so known [by acquaintance] are sensible qualities, relations of space and time, similarity, and certain abstract logical universals. (*PP*, p. 171)

These relations, Russell says, are known to us even though the physical objects that are their relata are not directly known to us:

> Thus we find that, although the *relations* of physical objects have all sorts of knowable properties, derived from their correspondence with the relations of sense-data, the physical objects themselves remain unknown in their intrinsic nature.… (*PP*, p. 54)

This basic picture is what enables him to reject Berkeleian idealism: he is able to maintain, on the one hand, that the mind characteristically can be acquainted with things other than itself, and, on the other hand, that mind is in fact acquainted with concrete spatio-temporal relations such as ground, in combination with our knowledge of sense-data and their relations and our logical knowledge, our descriptive knowledge of the world of matter.[5] Despite the many substantive

even earlier in his 1914 "The Relation of Sense-data to Physics"—there, Russell defines the terms "mental" and "physical" in such a way that objects might be both mental and physical: "The word 'physical', in all preliminary discussions, is to be understood as meaning 'what is dealt with by physics'.… I shall call a particular 'mental' when it is aware of something …" (*Papers* 8: 8).

5 As Russell says in the chapter titled "Physical and Perceptual Space-Time" in *The*

changes in Russell's metaphysics and epistemology from 1912 through the 1940s, including abandoning acquaintance epistemology and the sense-data theory, plus embracing neutral monism and an ontology of events, this basic picture—according to which we are aware of physical objects' relations without being aware of physical objects—remains intact.[6]

Russell's acceptance of neutral monism, set against the backdrop of the classical problems of epistemology, is the key to understanding his scientific structuralism. Thus, while accepting Berkeley's rejection of the primary-secondary quality distinction, Russell maintains that we have a primary awareness of concrete spatial and temporal relations. Unlike Berkeley and Locke, Russell rejects the Cartesian assumption of a fundamental mental-physical divide and employs an account that leverages the structural similarity between the sensible world and the world of physics, our knowledge of which is grounded in awareness of the relevant structuring spatial and temporal relations. Hence, when Russell says that our scientific knowledge is structural knowledge he should be taken to mean that it is knowledge about spatial and temporal relational structures of percepts and of non-percepts, where the structuring relations are in our field of acquaintance. Again, this basic picture is present from the *Problems* through the 1940s, including his 1948 *Human Knowledge*, even though the underlying metaphysics and epistemology change dramatically.[7]

This view is contrary to the influential interpretation of William Demopoulos, who suggested that Russell's structuralism fills a gap in

Analysis of Matter, "This argument … gives the ground for supposing that our perceptual space has some objective counterpart, *i.e.* that there is some relation between the camera and the table corresponding to the relation between the co-ordinates of our percepts of them.… We cannot know the intrinsic quality of the events at the camera which cause the photograph, but we can infer a certain similarity of structure between these events and our percept of the photograph" (*AMa*, p. 335).

6 Compare with *The Analysis of Matter*: "I shall call a relation 'perceived' or 'perceptual' if the fact that this relation holds between certain terms can be discovered by mere analysis of percepts. Thus before-and-after is a perceptual relation, when it occurs between terms both of which belong to the specious present. Spatial relations within the visual field are perceptual; so are those between simultaneous tactual sensations in different parts of the body" (*AMa*, p. 278). And, Russell insists, percepts are physical events such as stand in space-time relations and can stand in such relations even with non-percepts (*ibid.*, p. 384).

7 See HK_2, pp. 229–30, quoted below on p. 12.

a generally Kantian philosophical framework by using structural similarity to provide an account of the kind of correlation that can hold between phenomena and noumena:

> Russell's picture of how this application to Kant should go seems to have been something like this: The noumenal world, not being given in intuition, cannot, apparently, be required to have properties in common with the phenomenal world. This leaves us with the problem of understanding how to formulate any conception of what the noumenal world is like, and of understanding how it can fail to be unknowable. But because structural similarity has a purely logical characterization, it is independent of intuition. The noumenal world thus emerges as an isomorphic copy of the phenomenal world, one which we may suppose has the requisite similarity with the world of phenomena without thereby committing ourselves to the idea that it shares any intuitive properties of the phenomenal world.[8]

Demopoulos interprets Russell as making an abductive inference to a transcendental world of physics based on the idea of structural similarity. As Demopoulos points out, this inference is flawed because "a claim of structural similarity … is a significant claim only when the relations being compared are given independently of the mapping which establishes their similarity" (*ibid.*, p. 398). In other words, we cannot know the world of physics using structural similarity alone because this would only get us knowledge of its abstract relational structure. On Demopoulos' reading, Russell is in a bind: nothing in our experience could be used to justify our knowledge of the world of physics because we do not experience even the relations of the world of physics.

We think this interpretation misplaces the role of structural inference in Russell's later scientific epistemology. In writing his 1927 *The Analysis of Matter*, Russell was surely aware of the issue underlying Demopoulos' criticism, namely, that of finding a meaningful correlation between percepts and non-percepts, because he was aware of it, and explicitly discusses it, in his epistemological works in the 1910s. We propose to interpret his later epistemology of science in a way that is more diachronically consistent. Indeed, as we saw above, Russell

[8] Demopoulos, "Russell's Structuralism and the Absolute Description of the World" (2003), pp. 397–8.

had for years maintained that we experience space-time relations and that these same experienced relations obtain among the unexperienced objects of physics.[9] In "The Relation of Sense-Data to Physics", Russell acknowledges the following general argument concerning any sort of correlation, structural similarity presumably included, between percepts and an essentially imperceptible world:

> But how is the correlation itself ascertained? A correlation can only be ascertained empirically by the correlated objects being constantly *found* together. But in our case, only one term of the correlation, namely the sensible term, is ever *found*: the other seems essentially incapable of being found. (*Papers* 8: 5)

It is for this reason that Russell insists, in that essay, that "Whenever possible, logical constructions are to be substituted for inferred entities" (*ibid.*, p. 11): this includes entities posited for the empirical sciences. The procedure is not one of discovering first that some structure obtains among percepts, then inferring, by transcendental or abductive argument, that there is an isomorphic imperceptible correlate. Rather, Russell begins with the convictions of common sense and established science, abstracts the logical structure that their truth implicitly assumes, then aims to construct, from experienced spatio-temporal relations holding among percepts and non-percepts, classes and series of events which satisfy that structure (without positing classes or series). Russell hopes that this will philosophically justify our knowledge of physics on the basis of our experience. The details of this programme are modified in subsequent writings, but we don't think the core motivation or methodology is abandoned.[10]

Russell would not have accepted the need for a "refutation of idealism" in exactly Kant's sense because he has by 1912 already rejected the Berkeleian presupposition, *esse est percipi* (*PP*, Ch. 4). That is, while acknowledging a physiological argument that percepts depend *causally* on the processes of perception, he rejects the conclusion that percepts

[9] He also maintains this in *The Analysis of Matter*: "There is therefore no inconsistency in the view that the physical event differs from the percept in the way suggested by physics, since the difference consists in attributing more structure to the physical event, not in denying to it those elements of structure which are possessed by the percept" (*AMa*, p. 340). See also below, pp. 19–20.

[10] See, for example, the extended discussion of the primary-secondary quality distinction and of Berkeleian idealism in *AMa*, pp. 213–14, 339.

are non-physical objects that depend *logically* on the existence of minds; indeed, he rejects a fundamental divide between mind and matter altogether. Hence, we do not think that Russell's structuralism plays the Kantian role given to it by Demopoulos of getting us by inference to the allegedly noumenal world of physics.

The famous dictum to replace inferred entities with constructs is respected in Russell's later works (viz., *The Analysis of Matter* [1927] and *Human Knowledge* [1948]), even where it is perhaps sometimes obscured in ways that suggest another interpretation. For instance, one finds statements like the following in *Human Knowledge*, which might seem to suggest Demopoulos's interpretation:

> If physical events are to suffice as a basis for physics, and, indeed, if we are to have any reason for believing in them, they must not be *totally* unknown, like Kant's things-in-themselves. In fact, on the principle which we are assuming, they are known, though perhaps incompletely, so far as their space-time structure is concerned, for this must be similar to the space-time structure of their effects on percipients. E.g., from the fact that the sun looks round in perceptual space we have the right to infer that it is round in physical space. We have no right to make a similar inference as regards brightness, because brightness is not a structural property. (HK_2, pp. 229–30)

Passages such as these may look like the sort of flat-footed abduction to which Demopoulos objects and which Russell ought to have known to avoid. Furthermore, in *Human Knowledge* there is inadequate emphasis on the dictum that such inferences are provisional, and to be replaced by constructions.

However, in later chapters Russell sets out a programme of construction of points, instances, and particles, and we can understand passages like the above as presenting inferences to entities that are to be eliminated by substituting logical constructions in their stead. This alternative reading emphasizes aspects of the earlier programme that remain in the later one, namely, that Russell specifies not *only* that we know the abstract structure of non-percepts but that we *also* know, specifically, their space-time structure. This presupposes experience of spatio-temporal relations, which can hold between both percepts and non-percepts.

According to this alternative reading, Russell is committed to

holding that some concrete relations holding among the manifold of events in unperceived physical space are known perceptually. In experiencing an object in perceptual space, one is acquainted with instances of spatial and temporal relations that can be used to construct the non-logical structures that non-percepts have; in experience, one has direct cognitive access to the basic spatio-temporal relations and is able to use these relations to infer the existence and features of concrete structures in the world of physics. The view that we rightly may infer the structure of given relations is to be distinguished from the flat-footed abduction that we infer the existence of an unknown relation possessing a given structure.

Moreover, admitting structural inferences about known relations will not commit one to any inferred entities, so it is consistent with the famous dictum to replace inferred entities with logical constructions wherever possible. We should sharply distinguish between structural inferences about a given relation from abductive inference to the existence of an inferred relation: the former sort of inference better supports Demopoulos' broader characterization of Russell's structuralism as deriving an "absolute" description of the world from perspective descriptions than does the view that Russell is abducting structurally isomorphic inferred entities.

The problem posed by Demopoulos for the view he attributes to Russell has a close affinity with a problem posed by Berkeley for Locke's account of primary qualities. For Russell the problems that arise with jettisoning the primary-secondary quality distinction were never supposed to be solved simply by putting structural properties in the place of primary qualities and re-entrenching a traditional metaphysics having matter as a substance. As he puts it in *The Analysis of Matter*:

> This problem has two parts: to assimilate the physical world to the world of perceptions, and to assimilate the world of perceptions to the physical world. Physics must be interpreted in a way which tends towards idealism, and perception in a way which tends toward materialism. I believe that matter is less material, and mind less mental, than is commonly supposed, and that, when this is realized, the difficulties raised by Berkeley largely disappear. (*AMa*, p. 7)

Admittedly, Russell does not clearly make the sort of distinction

between structural inference about a fixed relation and abduction to the existence of an inferred relation that we are now pressing. All the same, we think that the framing of the Newman–Russell controversy around this antecedent metaphysical dissolution of the Berkeleian problems makes plain that it is misleading to characterize Russell as employing the notion of abstract structural similarity in a Kantian refutation of idealism as Demopoulos supposes.

Furthermore, note that it should have been obvious to Russell that a *purely* structural description could not be assured to single out some particular concrete structure. Indeed, Russell says that this is "obvious" in his 24 April 1928 letter to Newman:[11]

> You make it entirely obvious that my statements to the effect that nothing is known about the physical world except its structure are either false or trivial, and I am somewhat ashamed at not having noticed the point for myself. (Quoted in Grattan-Guinness, p. 23)

Purely structural descriptions can, at most, be said to obtain categoricity, *i.e.*, uniqueness up to isomorphism. Theses expressed in purely structural terms, therefore, have specific cognitive significance only in a given interpretation. For example, the Dedekind–Peano axioms are a kind of purely structural description, which Russell maintains are most importantly interpreted in the succession of Frege–Russell cardinals but which are also true of other ordered domains. Analogously, also in *The Analysis of Matter*, Russell emphasizes the application of geometry to physical space as its important interpretation, explicitly recognizing this very distinction.[12]

A passage in *The Analysis of Matter* may seem to contradict our interpretation. In the chapter "Importance of Structure in Scientific Inference", Russell writes:

> There is a space into which all the percepts of one person fit, but this is a constructed space, the construction being achieved during the first months of life. But there are also perceived space-relations, most obviously among visual percepts. These space-relations are not identical with

[11] The four letters exchanged between Russell and Newman are published in Grattan-Guinness, "Logic, Topology and Physics" (2012), pp. 23–9.

[12] See *AMa*, pp. 4–5, where Russell explicitly discusses interpretations in this sense.

> those which physics assumes among the corresponding physical objects, but they have a certain kind of correspondence with those relations.
>
> (*AMa*, p. 252)

We first note that Russell, two pages after this passage, makes the claim that perceptual and physical time *are* identical, thus holding to the givenness at least of time relations used to construct both perceptual and physical time: "Psychological time may be identified with physical time, because neither is a datum, but each is derived from data by inferences of the sort we have found elsewhere …" (*AMa*, p. 254). Furthermore, it is possible to regard the above passage as indicating non-identity of the instances of a given relation, which is consistent with type-identity of the relations holding among percepts with those holding among non-percepts. We can reinforce this interpretation by noting that the implied type-identity of the relations of perceptual and physical space can be read into the identification of each as *space* relations. Indeed, the type-identity of inner and outer space relations seems to be required by Russell's assertion in a later chapter that "[t]he whole of our perceptual world is, for physics, in our heads, since otherwise there would be a spatio-temporal jump between stimulus and percept which would be quite unintelligible" (*ibid.*, p. 336; see also 252–3). One may think of constructed subjective space and the objective space of physics as arising from perceptual space, wherein fixed relations are given to the perceiver, and as having an inferred structural similarity to each other.

There is some ambiguity in the text of *The Analysis of Matter*, as Russell admits to Newman: Russell says that he "appeared to deny" the "spatio-temporal continuity of percepts and non-percepts" despite this being "so axiomatic in my thoughts that I failed to notice that my statements appeared to deny it."[13] The interpretation we have proposed is, however, as well supported as Demopoulos' interpretation, if not more so, and our interpretation has the advantage of affording diachronic coherence among Russell's commentaries on the traditional problems of epistemology and the new problems of scientific epistemology emerging in the twentieth century.

[13] Quoted in Grattan-Guinness, pp. 23–4.

III. THE NEWMAN OBJECTION

We next relate the foregoing comments to the objections raised by the mathematician M. H. A. Newman to Russell's application of the concept of structure in *The Analysis of Matter*. At issue is the idea of a "structural description" of the world, so we first clarify what makes a description strictly structural.

By a *description*, we just mean an open formula. A description will be *structural* when the only (singular or relational) terms it contains have strictly logical definitions such as only involve variable terms. So, *structural descriptions* contain only variable terms, whether singular or relational. Note that a structural description may include free variables, say, or relation terms for formal properties of relations, like transitivity or reflexiveness, but not terms for concrete relations like simultaneity, spatial overlap, or love. The former relational terms, *is transitive* and *is reflexive*, are amenable to strictly logical definitions that involve only variable terms, e.g., such definitions as the following (where R is a free variable for a relation):

$$R \text{ is transitive} =_{\text{df}} (\forall x)(\forall y)(\forall z)([\mathrm{R}(x, y) \,\&\, \mathrm{R}(y, z)] \rightarrow \mathrm{R}(x, z))$$
$$R \text{ is reflexive} =_{\text{df}} (\forall x)(R(x, x))$$

In contrast, the relational terms *is simultaneous with*, *spatially overlaps with*, and *loves*, among others, do not have any purely logical definition using only variable terms (not so far as we know, at least).

Now structural descriptions are open to various interpretations and applications. To take Russell's example from *Introduction to Mathematical Philosophy* (1919), the Dedekind–Peano axioms for arithmetic, for example, could be equally interpreted as applying to the series 0, 1, 2, …, to the series 0, 2, 4, …, or to the series 100, 200, 300, …, and so on: there are in fact infinitely many interpretations of the Dedekind–Peano axioms for arithmetic (*IMP* , pp. 7–8). Just so, all purely structural descriptions are variously interpretable and applicable: as Hilbert famously quipped "It must always be possible to substitute 'table', 'chair' and 'beer mug' for 'point', 'line' and 'plane' in a system of geometrical axioms."[14] Indeed, any concrete interpretations of structural descriptions, or applications of them to the physical world, must

[14] Reid, *Hilbert* (1996), p. 57.

employ non-logical terms and relations that are cognitively available, if only to distinguish among the available interpretations of purely structural descriptions.

As the example of the Dedekind–Peano axioms indicates, structurally similar relations may satisfy the same structural descriptions under different interpretations. In this case they have the same "relation number", which is *Principia*'s generalization of ordinal numbers to relations that are similar ordinally to each other.[15] As Newman understood it, Russell's project in *The Analysis of Matter* was to provide a description of the world using only "relation numbers", *i.e.*, a purely structural description of the world. Newman's objection amounts to the observation that it is unclear how a description in purely structural terms can be said to be *of the world*, since such a description will not determine a unique model even when defined from categorical axioms.[16] First, the bare claim that there exists a relation structurally isomorphic to a given relation between percepts holds trivially in any domain of adequate cardinality, because given a large enough domain the logical principles of *Principia* guarantee that there is a relation satisfying the relevant structural description. Second, it is in fact possible to define multiple relations satisfying the modest formal constraints of any given structural description.

Newman raises these as serious problems for Russell's view. One way of understanding Newman's concern is that his reading of the passage in *The Analysis of Matter* (pp. 226–7) takes Russell to have replaced the primary-secondary quality distinction with a quality-structure distinction. Newman summarizes Russell as follows:

> Briefly: of the external world we know its structure and nothing more. We know, about things that are *not* percepts, the kinds of things a blind man could be told about a picture, as opposed to the additional knowledge of intrinsic quality that we have of percepts.
>
> (Newman, p. 142)

We think that careful reading of the passage from *The Analysis of Matter* that Newman thus summarizes leaves room for interpretation.

[15] Two relations Q and R are *similar ordinally* if there is a one-one correlating relation S such that the *campus* (field) of Q equals the converse domain of R and $R = S|Q|\breve{S}$. For a discussion and references to *Principia*, see *AMa* , pp. 249–50.

[16] Demopoulos and Friedman, 1985; Newman, 1928.

Russell says that we may infer from qualitatively presented perceptual events and their relations that there are qualitatively unknowable *events*, *i.e.*, events whose "intrinsic characters" are knowable, constituting the stimulus. Russell does not also say that the *relations* holding between qualitatively unknowable events are also inferred entities, nor that the relations between percepts and non-percepts are inferred entities. So, again stressing that Russell should have well understood the basic Berkeleian problem described above and that, especially in *The Analysis of Matter*, his solution (adopting neutral monism and rejecting a fundamental mental-physical divide) was metaphysical rather than epistemological, we think an alternative interpretation is warranted.

We may more clearly understand the matter at hand by considering the proposal that Russell's structuralism can be made more precise by adopting the Ramsey-sentence approach outlined in Ramsey's "Theories". That approach supposes a distinction between observation and theoretical terms in a language. A theory's *Ramsey sentence* is an existential generalization over its theoretical terms. Recall from *Our Knowledge of the External World* the dictum to replace inferred entities with constructs. We were to begin with the inferences of common sense, abstract the logical structure implicit in the inferred theory, then provide empirically based constructions satisfying that structure. Crucially, the last step is to be constrained by a notion of empirical import or cognitive significance. If the final, constructive step were simply an abstract verification of the Ramsey sentence formed from the inferred theory, then *any* construction would suffice; and it would be hard to see how this is a process of empirical verification or how Russell is providing an account of the foundation of our knowledge of physics in perception. For example, if we were to form the Ramsey sentence of some physical theory and then construct an interpretation in ZF set theory, this would clearly not satisfy the aims of Russell's programme. For Russell's account demands that our words describe real structures not merely as a matter of convention: the Russellian approach requires some way of specifying some construction as the "important" or intended empirical interpretation through its tie to real physical structures. But this specification looks like it can only be done by specifying the very inferred entities that were to be replaced by the constructs. Either we can't specify what makes a given construction important or we can, but if we have (already) the vocabulary to specify the interpretation, and we have knowledge of the relational structure

that must hold in the interpretation, then the constructions are unnecessary. We may doubt the value of honest toil when we can only state the fruit of our labour with stolen words.

The distinction we have drawn between what we have called the flat-footed structural abduction and the potentially more legitimate structural inference about given relations will be helpful. If we understand structural inference as an inference about the structure of a relation like co-punctuality to which we have prior cognitive access rather than an inference to inferred entities, then the problem does not arise. This, essentially, is Russell's point in responding to Newman's objection that he had "always assumed" co-punctuality and compresence as relations that hold among percepts as well as among physical events that are not percepts and would be "perceptible" relations:

> I had always assumed spatio-temporal continuity with the world of percepts, that is to say, I had assumed that there might be co-punctuality between percepts and non-percepts, and even that one could pass by a finite number of steps (from one event to another compresent with it) from one end of the universe to the other. And co-punctuality I regarded as a relation which might exist among percepts and is itself perceptible.
>
> (Quoted in Grattan-Guinness, p. 23)

Russell says that his admission of perceived spatio-temporal relations like co-punctuality and compresence prevents the worry to which Newman points from arising for his view. And it is hard to disagree with Russell that he had all the pieces required to block this worry. He indeed admits perceptible spatial relations in *The Analysis of Matter*, enumerating some perceptible spatio-temporal relations and noting that this list is incomplete.[17] His general suggestion that one can perceive a relation "if the fact that this relation holds between certain terms can be discovered by mere analysis of percepts" seemingly applies to compresence, since percepts can be co-punctual and compresent.[18] Similarly, he had assumed spatio-temporal continuity of

[17] The first quotation in note 6 continues: "There are perceived relations between a percept and a recollection, which lead us to refer the latter to the past. There are perceived relations of comparison.... There is also, I should say, a perceived relation of simultaneity. I do not suggest that the above list is complete, but it indicates the kinds of cases in which relations can be perceived" (*AMa*, p. 278).

[18] "Any two events which we experience together—*e.g.* a noise and a colour which we perceive to be simultaneous—are 'compresent'" (*AMa*, p. 336; see also p. 299, where

events.[19] Finally, he has assumed that co-punctuality could relate percepts and non-percepts, for he assumes that all events are in the field of compresence.[20]

There is also textual evidence for Russell's remark that the above assumptions were "so axiomatic" in his view that he failed to see that some of his statements appeared to deny them: as we saw above in discussing the *Problems*, Russell had insisted at least since 1912 that some spatio-temporal relations are perceptible and link us to the unobservable world of physics through our knowledge of their structure. Granted, his 1912 metaphysics of the physical world was very different then—in particular, a mental-physical divide *was* embraced—but before and after his embrace of neutral monism, the overarching epistemological strategies bear a striking resemblance. The point remains that Russell had earlier insisted on perceived spatio-temporal relations that equally could hold among the perceived world and the unperceived (even imperceptible) world of physics. No doubt it was axiomatic to him, as drawing out the traditional epistemological context—*e.g.*, the Berkeleian context—of Russell's view shows.

These points are worth emphasizing. Discussing Russell's response to Newman, Christopher Pincock in his essay "Carnap, Russell, and the External World" has noted a way of blocking the Newman objection (the constant E denotes the external world):

> The view described in the letter would adequately respond to Newman's objections as long as Russell could either explain how co-punctuality was perceptible or define his key relation of co-punctuality in terms of the clearly perceptible relation of compresence. For, on this amended view, scientific knowledge is not merely "There is some relation R and formal properties S_1, …, S_n such that $S_1|R|$ & … & $S_n|R|$ & $R|E|$" but rather "$S_1|C|$ & … & $S_n|C|$ & $C|E|$" where C is a definite relation whose intrinsic properties we are aware of in experience. This non-structural claim is no longer trivial. It remains to a certain extent structural, as it is consistent with our ignorance of some of the intrinsic properties of E, but the fixed relation C blocks Newman's set-theoretic construction.[21]

Russell explicitly speaks of co-punctuality of events).

[19] "For the present, therefore, I assume space-time to be continuous" (*AMa*, p. 376).

[20] "'Events' are defined as the field of the relation of compresence" (*AMa*, p. 377).

[21] Pincock, "Carnap, Russell, and the External World" (2007), pp. 121–2.

Despite Pincock's claim that this is an "amended" view, our contention is that Russell already had such relations like *C* in his philosophy of science that could do this work of blocking Newman's objection; in particular, Russell already had cognitively available space-time relations like co-punctuality.[22] If we so understand Russell as embracing an inference about a space-time structure constituted by relations holding among physical events, from perceptual knowledge of the same relations when they hold between percepts, then he has more than merely logical structures with which to reconstitute our knowledge of physics. This interpretation, furthermore, allows us to take Russell seriously in regarding points, instants, and particles as logical *fictions* and reconcile this with scientific realism. He will be a realist about the inferred space-time structure of given relations, while the constructed fictions will be eliminable in the manner Pincock describes above.

According to this interpretation, Russell never endorses a flat-footed abduction from the structure of perception to the structure of an otherwise unencountered world of things-in-themselves, nor does he accept an analogous inference from the logical structure of our common-sense commitments and scientific theories to the structure of some inferred terms and relations. His first idea is to replace inferred entities with constructions, but this approach tends toward positivism, as Newman (and later Putnam) pointed out. However, a reading of Russell's subsequent works that emphasizes the growing role of structural inference about a fixed relation provides an understanding of Russell's structuralism that preserves a core motivation of his constructivism (*viz*., the rejection of inferred entities).[23] Furthermore,

[22] This point has also been made in LANDINI, *Russell*, pp. 302–3. Landini, however, rejects our interpretation, suggesting that Russell does not hold that we directly perceive spatio-temporal relations whose instances can relate percepts or (inclusive) non-percepts. However, we find that the passages above (pre-*AMa* and in *AMa*) support our reading, and that the evidence that Landini cites is better interpreted as warning against identifying either physical space with perceptual space or the space-time order of percepts with that of non-percepts. Landini and we agree, though, on the broader point that "Russell never changed his mind about his structural realism" and that Newman's objection "had very little, if any, long-term impact on him" (*ibid*., p. 306).

[23] This is part of what Russell alludes to in his 1959 *My Philosophical Development*: "There is one major division in my philosophical work: in the years 1899–1900 I adopted the philosophy of logical atomism and the technique of Peano in mathematical logic.… The change in these years was a revolution; subsequent changes have

since Russell's refutation of Berkeleian idealism critically depends on his denial of a metaphysically fundamental divide between the mental and the physical, the possibility of a fixed relation, which may hold between physical events that are percepts as well as between non-percepts, is salient throughout his writings on the relation of sensation to our knowledge of physics. Finally, we may note that this reading of Russell makes his realism about the structure of space-time consistent with his maxim of eliminating inferred entities.

IV. SCIENTIFIC STRUCTURAL REALISM

We turn now to more recent debates over structuralism in the philosophy of science and the distinction between epistemic and ontic structural realism. The epistemic structural realist holds that structuralism expresses a limit of knowledge to structural properties that requires scepticism about the intrinsic qualities of the entities comprising the structure. The ontic structural realist denies the existence of non-structural properties of physical systems. The former is a sceptic, but the latter insists that there is nothing to not know. Epistemic structural realism has been developed as a proposed middle ground in the philosophy of science, accepting a No-Miracles argument for realism about structure but accepting a pessimistic meta-induction for scepticism concerning the fundamental natures of things (see note 3). Ontic structural realism also accepts a no-miracles inference, but hopes to incorporate motivations from the philosophy of physics, such as the invariance of measurable properties of quantum states under permutation of like particles, and a programme of scientific conciliation to make the realist's abduction less flat-footed.[24] The epistemic structuralist holds that we know *only* of the structure of the world. Ontic structuralism wonders what sense it makes to think there is more to know.

It is immediately clarifying to raise the issue of commitment to a cognitively given fixed relation. The epistemic structural realist who does not allow specification of a fixed relation cannot distinguish between competing models. In that case, it is hard to say what

been of the nature of an evolution" (*MPD*, p. 11). The rejection of inferred entities, of course, comes up in his 1924 "Logical Atomism" from his neutral monist period (*Papers* 9: 164).

[24] Ladyman and Ross, *Every Thing Must Go* (2007).

distinguishes the view from constructive empiricism. But if the epistemic structural realist accepts a fixed relation, then we are due an epistemology of this non-structuralist component of her view. Epistemic structural realism either depends on a non-structural component or becomes indistinguishable from non-realist alternatives; but to account for the non-structural component the epistemic structuralist incurs the epistemic burden of traditional realism, to which it was meant as an alternative. Worrall, in fact, endorses Ramsification, and this has proven problematic. In a survey of attempts to refine the Ramsey-sentence approach to epistemic structural realism in a way that overcomes this dilemma, Peter Ainsworth has recently concluded:

> It has been argued that none of the attempts that have been made to evade Newman's objection is successful. Consequently, Newman's objection remains a very serious problem for the ESRist. Of course, one cannot rule out the possibility that ESRist may in the future come up with a satisfactory reply, but in the absence of such a reply it seems that the sensible attitude towards his position is one of considerable scepticism.[25]

This is perhaps not the last word, but the scholarly consensus is that the problem posed by Newman for epistemic structural realism is deep and difficult to resolve.

Because ontic structural realism is motivated by the permutation invariance argument for the under-determination of individuation of particles in physics, the position has been articulated in terms of a structure-object dichotomy. The lesson taken from the permutation argument has been that structure is ontologically prior to the objects or individuals comprising the structure. Ladyman and Ross's recent book *Every Thing Must Go* clarifies the status of relations in structures as conceived by the ontic structural realist. First, they reject an "extensional account of relations," thereby hoping to block the construction of arbitrary relations that drives the Newman objection:

> Worrall's approach to structural realism with its emphasis on the Ramsey sentence of a theory and the distinction between observational and theoretical terms is thoroughly embedded in the syntactic view of theories that adopts first-order quantificational logic as the appropriate form for the representation of physical theories. Since ontic structural realism is

[25] Ainsworth, "Newman's Objection" (2009), p. 169.

> not formulated in these terms, the Newman problem does not arise for ontic structural realism. In particular, we will eschew an extensional understanding of relations without which the problem cannot be formulated. According to Zahar (1994, 14) the continuity in science is in the intension not the extension of its concepts. (Ladyman and Ross, p. 128)

Second, they adopt the metaphysical thesis that relations may be prior to their relata:

> To be an alternative to both traditional realism and constructive empiricism, structural realism must incorporate ontological commitment to more than the empirical content of a scientific theory, namely to the "structure" of the theory. We have argued that relational structure is ontologically subsistent, and that individual objects are not. However, the idea that there could be relations which do not supervene on the properties of their relata runs counter to a deeply entrenched way of thinking. The standard conception of structure is either set-theoretic or logical. Either way it is assumed that a structure is fundamentally composed of individuals and their intrinsic properties, on which relational structure supervenes. The view that this conceptual structure reflects the structure of the world is called "Humean Supervenience" by Teller … and by Dipert.… It has been and is endorsed by many philosophers, including, for example, Aristotle and Leibniz. (*Ibid.*, p. 148)

The foregoing comments pertain to the thesis of "Humean supervenience": the thesis that relata and their intrinsic properties are ontologically prior to relations. Ontic structural realists reject this thesis.

While rejection of Humean supervenience may be independently motivated, asserting the ontological priority of relations over relata is not the same as asserting the priority of structures themselves over *both* relations and relata. That is, the debate over Humean supervenience is separate from the question of commitment to what we have been calling a fixed, cognitively given relation. In a paper Michael Esfeld and Vincent Lam have developed a view they call moderate structural realism.[26] Following ontic structural realism, they reject Humean supervenience. However, they specify that their structural realism is a realism about the structure of spatio-temporal relations, therefore accepting a concrete structural component of structural

[26] Esfield and Lam, "Moderate Structural Realism about Space-Time" (2006).

realism. On our interpretation, this view, and not epistemic structural realism, is closest to the position held by Russell for decades.

V. CONCLUSION

Russell's views are commonly associated with epistemic structural realism. As we have argued, this is not the best interpretation. There are passages which, taken in isolation, seem to express a version of epistemic structuralism. However, the metaphysics that Russell developed in opposition to idealism allow him to speak of spatio-temporal relations holding between percepts and non-percepts. Consideration of the earlier Berkeleian context supports taking Russell at his word when he tells Newman that he had always assumed compresence and co-punctuality are among such relations. As such, Russell's legacy is not to be found in epistemic structuralism: Russell's view seems closer to Esfeld and Lam's moderate structural realism.

Furthermore, Russell can clearly be seen to have anticipated much of what Ladyman and Ross have claimed. Russell writes:

> The [quantum] theory requires modifications in our conception of space, of a sort not yet quite clear. It also has the consequence that we cannot identify an electron at one time with an electron at another, if in the interval, the atom has radiated energy. The electron ceases altogether to have the properties of a "thing" as conceived by common sense; it is merely a region from which energy may radiate.[27]

Hence, while reading Russell as a realist about spatio-temporal relations and the associated structures, we also find an anticipation of the ontic structural realist's views on quantum particles via his (eliminatavist) logical constructionist views about instances, points, and particles.

For this reason and others, the legacy of Russell's structuralism deserves to be recognized. Russell clearly wrestled with problems of interest to contemporary proponents of structuralist programmes in the philosophy of science. The fruit of his honest toil should not be too hastily dismissed as endorsing the flat-footed abduction of epistemic structural realism and the Ramsey-sentence approach to theories.

[27] *Philosophy* (1927), p. 106. Quoted in LANDINI, *Russell*, p. 335.

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