Russell's Response to The Newman Objection Reconsidered: A Defense of Russell's Scientific Structural Realism

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ABSTRACT: My central thesis is that Russell's structural realism ([AMt], 1927) was never vulnerable to Newman's objection. The defense of this thesis necessitates an in-depth explanation of Russell's structural realism, with the aim of clearing up persistent confusions from what I call: the current consensus. I contend that Russell's misunderstood 1928 response to Newman contains the key to understanding the deep interconnections between Russell's logic, metaphysics and philosophy of science within his structural realism (1927, 1948) which in turn vindicates his proposed solution. The paper goes over the details of Newman's objection in the context of Russell's work: his structural realism, philosophies of physics and mind. By piecing these elements together, in light of Russell's 1928 response to Newman, I argue that from what we know on model-theoretic arguments, Russell was right about what was required, in his assumptions, to avoid the problem. I show these assumptions were explicit in *The Analysis of Matter* ([AMt], 1927) and in turn presuppose his metaphysics of neutral monism. Lastly I show, against the general consensus, that Russell never abandoned structural realism, as evidenced by the fact that he returned to discuss Newman's objection in *Human Knowledge* ([HK], 1948), in a manner which preserves all key ingredients of his 1928 solution, something previous commentators have failed to notice. I argue that his resulting position, while contentful enough to avoid Newman's objection, does not collapse into either scientific realism or antirealism. This suggests that a Russellian approach to structural realism remains possible.

0. Introduction

According to the usual story Russell's structural realism ([AMt], 1927) is the view that our scientific knowledge of the world is nothing but knowledge of its logico-mathematical structure. Max Newman (1928) provided a decisive refutation of it from basic model-theoretic considerations. The Newman objection is that the central thesis of Russell's structural realism can be shown to be either false or trivial given model-theoretic considerations. The objection led to the collapse of Russell's ambitious structuralist research program, which Russell himself granted (1928). **In this paper I contend that this whole narrative is a piece of mythology**. My central thesis is that Russell's structural realism was never vulnerable to Newman's objection[1].

The Newman objection (1928) to Russell's structural realism ([AMt], 1927), retains enormous importance not only in Russell scholarship (Pincock, 2007; Landini, 2018), but for broader structuralist programs in philosophy of science (Frigg and Votsis, 2001; French, 2014; Saunders and McKenzie, 2015), philosophy of computer science (Copeland, 1996; Boccardi, 2008) and even contemporary metametaphysics given its connection to Putnam's model-theoretic

[1] Newman's objection was put forward in 1928 to Russell's AMt. My claim is precisely that even at that point Newman's objection failed to trivialize Russell's views. Indeed, one of my claims is that Russell's (1928) concession to Newman wasn't on the point of being refuted, but on the point of carelessness to formulate his views in AMt precisely. The defense of my claim is in Section 4. Thanks to Alejandro Pérez-Carballo for pressing me to clarify this point.

argument against realism (Sider, 2011; Bricker, 2020; Finocchiaro, 2021). Newman's objection and Russell's structural realism have both inspired a large literature on structuralist approaches to philosophy of science, but they are generally discussed in mere outline. It is often declared, (Demopoulos and Friedman, 1989; French, 2014; Saunders and McKenzie, 2015) that while Russell's structuralist approach to philosophy of science was insightful, it collapsed as soon as it appeared as a result of the decisive refutation by Newman. This is all the more reason to clear up remaining misunderstandings in the current consensus on the origin story of Newman's objection and its alleged refutation of Russell's structuralist philosophy of science (Demopoulos and Friedman, 1989).

In this paper, Newman's objection (1928) to Russell (1927) is investigated in its historical context, with the aim of demonstrating that Russell's structural realism was never vulnerable to it. I contend that Russell's misunderstood 1928 response to Newman contains the key to understanding the deep interconnections between Russell's logic, metaphysics and philosophy of science within his late work, which in turn vindicates his proposed solution. The paper goes over the technical details of Newman's objection in the context of Russell's philosophy: his structural realism, philosophies of physics and mind. By piecing these elements together, in light of Russell's 1928 response to Newman, I argue that from what we know on model-theoretic arguments, Russell was right about what was required, in his assumptions, to avoid the problem. I show all of these assumptions were explicit in *The Analysis of Matter* ([AMt], 1927) and that they in turn presuppose his metaphysics of neutral monism. Lastly I show, against the general consensus, that Russell never abandoned structural realism, as evidenced by the fact that he returned to discuss Newman's objection in *Human Knowledge* ([HK], 1948), in a manner which preserves all key ingredients of his 1928 solution, something previous commentators have failed to notice. I argue that his resulting position, while contentful enough to avoid Newman's objection, does not collapse into either scientific realism or antirealism. This suggests that a Russellian approach to structural realism remains possible.

The way in which I proceed to argue for the above claims is as follows. In **Section 1** I give a very general account of the context required to follow the paper plus my proposed solution. It goes into the general details of Russellian structural realism that most commentators have focused on when declaring it refuted by Newman. It includes an informal discussion of the Newman objection in the context of Russell's causal theory of perception and explains Russell's claim, within that theory, we have knowledge of the world's abstract structure.

In **Section 2** I motivate the importance of this research by going over the current consensus on these issues, in both philosophy of science and Russell Studies. The key point is the often repeated charge that Russell's structural realism was refuted by Newman (1928), as well as his giving up structural realism in his later work while never returning to address this problem. In **Section 3** I discuss Newman's objection in detail by offering a proof of the relevant theorem invoked by Newman and connecting it to the relevant philosophical underpinnings of Russell's causal theory of perception.

The bulk of the paper is focused on explaining in detail what Russell's structural realist view was: including its underlying metaphysics and methodology, **Sections 5 - 7**. In connection to this I examine a response to Newman in **Section 4** written by Russell (1928), which I argue has been mostly misunderstood. I argue we should take it seriously as a key piece of evidence by studying its contents in connection with Russell's work. I then argue that Russell couldn't have been too surprised by Newman's objection given his familiarity with strikingly similar results in connection to his early work on the logic of relations (Russell 1901; Russell 1903), the work which established his reputation as a logician. I then explain why the elements Russell highlights in his response to Newman were present in AMt and later works. I aim to show, consistent with taking Russell's 1928 response seriously, that the objection could be answered with philosophical assumptions and ideas Russell had advocated explicitly in AMt. I explain, in **Sections 5-6**, Russell's methodological and philosophical resources in detail, then defend that his response to Newman didn't invoke any ad hoc notions, but only views already introduced by Russell at that point. Much of this material is concerned with explaining how Russell's technical and philosophical assumptions fit together in a way that avoids the objection.

In **Section 7** I defend, against the scholarly consensus, two important claims: that Russell's structuralism, while being partial, is sufficiently distinct from realism in its generality to be deserving of the structuralism moniker[2] and that Russell essentially held on to his structuralism in his later work, including the details of his response to Newman. I defend the first claim by explaining the characteristics and motivations of Russell's structuralism that distinguish it from realism, while salvaging some structuralist intuitions. I defend the second claim by pointing out passages in Russell's HK (1948) that explicitly discuss Newman's objection which, to my knowledge, have been missed by both philosophers of science and Russell scholars tackling this question in the literature.

More specifically, throughout the paper I aim to defend the following claims:

I. **Russell's proposed solution in his response to Newman allows him to single out more specific structures.** Moreover, he already had more substantial metaphysical and epistemic commitments all along in AMt (1927), including his metaphysics of neutral monism. His written response to Newman didn't involve an ad hoc solution, developed in the spur of the moment. **It was his intended position all along**.

II. **Russell's gravest mistake was formulating his main structuralist thesis in an unclear way.** He doesn't mention the objection by name in later works –such as HK and *My Philosophical Development* ([MPD], 1959)–, even though he revisits it in HK (1948, p. 328 - 331); because he was, as he put it to Newman, ashamed at not having noticed an obvious mistake himself. This is because he was well aware since at least 1901, in his *The Logic of Relations*, that any structure could be imposed upon a set modulo cardinality constraints. Indeed, he remarks on that in that paper as well as in his *Principles of Mathematics* ([PoM]). He even entertains a related idea as early as *On Scientific Method in Philosophy* (1914), when he argues that there's always some possible theoretical function one can assign to the world at all times, no matter how

[2] Otavio Bueno specifically brought up this worry to my attention during a talk I gave on Russellian space-times at the Understanding Defectiveness in the Sciences (2019) conference.

gerrymandered, but that these shouldn't be considered scientific laws in any reasonable sense. Only some functions are distinguished as laws. These tend to be simple.

III. **Russell never abandoned his brand of structural realism.** He concentrated in later works on making his commitments more explicit, in order to circumvent Newman's objection in an explicit fashion, as well as in developing these commitments further in his later philosophy (Cf. Bradie, 1977; Russell 1936, 1948). **Indeed, this is supported by the fact that he returns to the exact same points made in his 1928 letter to Newman when developing his position in HK** (1948), thereby responding to the objection by explicitly incorporating these commitments to his structural realism.

IV. **The resulting structural realism, while partial, is structural realism enough.** Whereas this weakens the generality of the view, it still leaves a large constructive role for mathematical logic and minimizes theoretical commitments: both ontological and ideological. This was Russell's specific philosophical goal at the time, consistent with his philosophical methodology, i.e., the regressive method.

The importance of defending **I-IV** relates to the importance of taking Russell's response to Newman seriously, something that, as I argue in what follows, most commentators have failed to do. Their criticisms and misunderstandings explicitly reject one or all of **I** through **IV**. It is for this reason that defending those claims is crucial for placing Russell's Structural Realism and one of its most famous problems in their proper context.

1. Setting the Stage: Understanding the Problem and the Proposal

1.1 Preliminaries

The structural realist research program has been very influential in the last couple of decades, setting agendas from philosophy of science in general, to philosophy of physics, philosophy of economics and even metaphysics. In the course of that, philosophers have gone back to the history of this research program, trying to dig up both objections to it and arguments for it. Among the discussions they have dug up there's the early development of Russell's structural realism and its alleged demise at the hands of a powerful objection by Max Newman. It has acquired the status of a founding myth of structural realism.

In this section I aim to contextualize Russell's structural realist position within the broader realism debate in philosophy of science. To that end I explain in broad outlines his structural realism, Newman's objection to it and then give a general account of his response to that objection. All of this to lay the groundwork for a far more substantive and detailed analysis of all these issues. It is for this reason as well that one of my aims in this section is to begin laying a foundation to explain Russell's structural realism, together with the methodological and metaphysical assumptions that are instrumental to understanding his response. This section therefore introduces the main themes of the paper that are expanded in further sections.

In contemporary philosophy of science scientific theories are broadly regarded in the following three ways:

a. As making approximately true claims about the world's ontology and structure by scientific realists.
b. As making, at most, empirically adequate or instrumentally useful claims by scientific anti-realists.
c. As making approximately true claims only about the structure of the world by structural realists.

Structural realists, so the story goes[3], represent a middle ground between the realist and antirealist camps. They grant to antirealism that we have no good reason to accept the ontology, properties and relations, posited by science, but they also grant to realism that we have good reason to believe our theories get at least something right about the world: its structure, in the broadest possible sense.

Russell's ([AMt], 1927) is these days heralded as introducing 'Epistemic Structural Realism' (Cf. Votsis, 2004; French, 2014) into the philosophy of science i.e., the view that of the physical world we can know at most its abstract structure. Indeed, in AMt , Russell expressed the structural realist thesis in a clear cut way –in the chapter "Structure in Scientific Inference":

> Thus it would seem that, wherever we infer from perceptions, it is only structure that we can validly infer; and structure is what can be expressed by mathematical logic, which includes mathematics. (AMt, 1927, p. 254)

Philosophers such as Demopoulos and Friedman (1989), in arguably the most influential discussion of Russell's Structural Realism in the literature, regard Russell's view as a theory of scientific theories, that is a theory about what scientific theories are about: the structure of the world. They correctly emphasize the importance of the criticism of the view put forth by Max Newman (1928), both for its importance to philosophy of science and its impact on Russell's philosophy. The passage from Russell highlighted above is quoted by Newman himself (1928, p. 141) as a clear cut statement of Russell's structuralist thesis and it is that thesis that Newman aims to undermine with his objection.

Newman's (1928) objection to Russell's view is that Russell's structuralist thesis, quoted above, is trivial given a sufficient number of objects: the world's cardinality. This can be shown to follow from a theorem of mathematical logic with some minimal assumptions about sets (or pluralities). I offer a proof of this theorem in section 3.2:

Newman's Theorem: Assume we have as given some set S together with some relations $R_1...R_n$ over the set: a concrete structure (S, $R_1...R_n$). Assume furthermore that there is another set S' that has the same cardinal number as S i.e., there is a function f which is bijective

[3] James Ladyman (2014) for example, specifically begins his discussion of the view as recovering the best of both worlds, realism and anti-realism. This opinion was explicitly defended for the first time by Worrall (1989). Russell himself (1948) considered the view as helping us reconcile prima facie incompatible ontologies e.g., the wave vs particle ontologies in physics.

between S and S'. It will then follow that there is a structure with S' as domain which is isomorphic with $(S, R_1...R_n)$.

Newman's objection results from applying the above theorem to Russell's careless claim that the structure of the world mirrors the structure of our percepts and showing that the result is unacceptable. It follows from Newman's Theorem that the claim that from our percepts we can know at most know the world's structure, amounts to the claim that we can know at most how many objects the world has. Any structure, such as the structure of our percepts, can be imposed upon the world as long as it has enough objects. But surely, so the objection goes, science reveals more about the physical world than its cardinal number. But then the claim that the structure of percepts gives us knowledge of the world for it mirrors its structure is shown is trivialized.

The consensus reading of Newman's criticism (Cf. Newman, 1928; Demopoulos and Friedman, 1989; Saunders and McKenzie, 2015) comes down to pointing out, as seen above, that the way Russell (1927) characterizes his view i.e., that of the physical world we can know at most its abstract structure, leads to the view being trivialized, since any structure can be imposed upon a set modulo cardinality constraints. [4] Therefore, as long as the world has enough objects, it can be said to have any compatible structure whatever. Given that Russell's theory of theories is intended to be informative, this result is unacceptable.

Another way of putting it is to say that the physical structure of the world shouldn't be said to be knowable as a matter of logic alone, it is a substantive empirical issue. Indeed many widely read Russell scholars and philosophers of science (see Demopoulos and Friedman, 1989; Monk, 2001; Grayling, 2003; Votsis, 2003; French, 2014; Saunders and McKenzie, 2015; Bueno, 2017) discuss the objection as if it had been a devastating blow to the whole project and have regarded Russell as abandoning Structural Realism.

1.2 An Outline of The Solution

Russell responded in 1928 to Newman's objection in a letter which has been reprinted in his *Autobiography* (1975). The gist of his response, which I will revisit in great detail in Section 4 below, is that he had not intended to say what he did say: that nothing but the structure of the physical world can be known; that he had always assumed co-punctuality between percepts and non-percepts; that this last relation itself is perceptible and therefore known in a more concrete way. His idea is that if his structuralist claim is made in reference to a specific relation, that should avoid Newman's objection. Co-punctuality is a relation Russell introduces in AMt to both construct points out of events and generate space-time order out of those points. Since for him percepts are also events, his claim here is that that same relation holds between non-perceived events, perceived events and combinations of those.

[4] There are Russell scholars who believe that the standard reading of the objection cannot be the right one, such as Gregory Landini (2018). In this paper I won't outline in detail specific objections to the main reading of Newman's objection. I will mostly focus on defending the standard reading and interpreting Russell's response in light of that.

For Russell, the world has a distinguished physical structure which holds between physical events independently of us: our perceiving, knowing or thinking of it, he is a realist about structure. Furthermore, for Russell physical structure is causal structure. He assumes throughout his work that there are similarities between objects which are more natural than others, grounded in how the world is independently of us, as illustrated by his continued attachment to universals and their the role they play to ground resemblance[5]. Russell accepts that there's a difference between abundant and sparse properties, at least as early as *Principia Mathematica* ([PM], 1910), with his distinction between universals and propositional functions, where the latter can be manufactured for any well-formed open sentence somewhere in the theory of types (Cf. Klement, 2015, 2018).

Not all objective similarities for Russell, however, necessarily are expressed with commitments to universals, he also has a theoretical criterion of minimum vocabularies which, though not explicitly articulated until HK (1948), underlies implicitly much of the epistemology of his philosophical methodology since the 1900's: the regressive method (1907/1973). Russell's concept of "minimum vocabularies" (1948) plays a similar role to Quine's (1951) notion of ideology.

> Given a theory, one philosophically interesting aspect of it into which we can inquire is its ontology: what entities are the variables of quantification to range over if the theory is to hold true? Another no less important aspect into which we can inquire is its ideology (this seems the inevitable word, despite unwanted connotations): what ideas can be expressed in it? (Quine, 1951, p. 14)

These are the primitives that go into the axioms and postulates of our best theories and their role is to give these theories expressive power. Since physics is an empirical science it must have experiential primitives among its minimum vocabularies. In Russell's work these are co-punctuality (AMt, p. 314, 385) and compresence (HK, p. 329): different terms for the same notion. The use of the concept of "minimum vocabularies" is more prominent in Russell's later philosophy. However his discussion of the method of analysis, as applied to the interpretation of our best theories (1908, 1910, 1918, 1927, 1948, 1959), illustrates the importance of this type of primitive, even at that time. This goes as much for their metaphysical import as for the epistemological relevance he attaches to them.

The concept of "co-punctuality", mentioned above, has a technical definition in *The Analysis of Matter* and is one of Russell's primitives or minimum vocabularies in the logical analysis of physics (AMt, HK). The relation of co-punctuality is connected to experience and the physical world in the right way to bridge the gulf between percepts and the physical world. Russell

[5] He explicitly discusses this theoretical role for universals as far back as *On The Relation Between Universals and Particulars* (1911), then he intermittently reaffirms in his commitment throughout his writings from *The Problems of Philosophy* passing through a quick mention in AMt to MPD (see Russell 1912, 1913, 1918, 1927, 1936, 1948, 1959). Russell called his retreat from mathematical realism, a retreat from Pythagoras, not a retreat from Plato. In HK (1948) in fact, he characterizes particulars in terms of a bundle theory where universals play a central role (Cf. Klement, 2018).

introduces this notion to construct space-time points out of events of finite magnitude in such a way that his construction works for a four-dimensional manifold. To understand what Russell is saying here intuitively, however, we can think of co-punctuality as similar to the mereological relation of overlap: x overlaps y iff there is a z, such that z is a proper part of x and z is a proper part of y. “Percepts” which are data the subject is aware of e.g., sounds, visual inputs and so on, are regarded by Russell as the end point of causal chains (from the epistemic standpoint), which begin in physical objects. Points in causal chains are constructed out of maximal series of overlapping events (maximally co-punctual series): series such that any event e overlaps at least one another event e’ in the series and no event f outside the series overlaps every event in the series. A causal line, understood as a time-like geodesic (a time-like trajectory in space-time), literally has links all over it connecting the percept in the subject to the physical object, every event in a causal line is co-punctual with another and so on from physical object to percipient.

What Russell is saying is that such relations are not merely abstract, but specific and known directly in perception i.e., their qualitative properties are known as perception reveals intrinsic qualities. Moreover, he is claiming that there will be events e and e’, co-punctual, such that they are part of the same series i.e., some points at the end of the causal chain will have as members both percepts and non-percepts. Russell’s metaphysics in *The Analysis of Matter* is a variant of neutral monism i.e., where neutral monism is the thesis that matter and mind are structures built up of more basic stuff he calls “events”. Metaphysically, the import of neutral monism to the tenability of his solution is that its truth is a sufficient condition for accepting that the exact same relation can hold between physical events and mental events. In a neutral monist metaphysics both percepts and non-percepts are space-time events in physical space-time, while percepts also inhabit their own phenomenal space-time. Therefore, overlap or rather compresence (and its four-dimensional form, co-punctuality) really link non-percepts with percepts hence bridging the gulf.

Russell’s structuralist thesis isn’t then that there’s structure in the physical world isomorphic to a perceptual structure, which is what the Newman objection trivializes. Rather that there’s a perceptual structure arranged by “co-punctuality” (& derivative relations) and some portion of the physical world is isomorphic, under that same relation, to that perceptual structure. Not just any structure will do for that claim. This is the essence of his response, even in *The Analysis of Matter*, which I will revisit in detail in the relevant sections.

I believe that even though Russell’s response is very direct, it has been mostly misunderstood by almost everyone in philosophy of science and Russell scholarship, as I will argue in Section 3. The reason for this, I believe, is that philosophers of science have neglected important details of Russell’s philosophy required to make sense of his response (such as his metaphysics of neutral monism), while Russell scholars that have addressed the issue have, for the most part,

either not taken the objection seriously[6] or have taken it too seriously, as a devastating blow. The former do so because they believe that, as traditionally understood, it's obviously not a death blow to Russell's position, whereas the latter focus on the fact that Russell's Structural Realism is really not the sort of purest form of structuralism there is and therefore have been too quick to diagnose Russell's letter as an admission of defeat.

Given the importance of Newman's objection to the realism debate in philosophy of science, it's not surprising that a number of commentators (Demopoulos and Friedman 1989; Votsis 2012; Pashby 2015; Bueno 2017; Landini 2018) have put forward their own interpretations of the objection and Russell's response. In this paper I accept the traditional understanding of the Newman objection outlined above and detail how Russell thought of it in a way that takes his letter to Newman seriously.

2. The Impact of Newman's Objection on Russell's Structural Realism: The Current Consensus

Structural realism is an important research program in contemporary philosophy of science, which has gradually become more impactful in other areas of philosophy. It is a family of views which emphasize the importance of structure in scientific theories. Science reveals worldly structure, according to such views. Furthermore this structure (when it is discovered) is mind-independent and survives theory-change. Since Russell's AMt is one of the founding documents of this research program and the Newman objection one of their persistent problems (Ainsworth 2009, French 2014, Votsis 2003, Zahar 2007), the relationship between Russell's theory and the Newman objection is systematically revisited to impart the hard lesson that structural realism must be an improvement on Russell's or fall to Newman.

Let us remember that some core realist commitments are the following:

a. **Mind-Independence:** There is a world whose existence is independent of being known, thought-about or perceived.

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[6] I believe this is Gregory Landini's (2018) case. His discussion of this debate, while informed, exceedingly interesting and insightful, starts off by arguing that the standard formulation of the Newman objection simply couldn't have been taken seriously by Russell, since it's very easy for him to respond to it within his philosophy. I think actually that this is an entirely correct diagnosis, Russell had the resources to neutralize the objection already in *The Analysis of Matter*, as I argue here. However, Landini then argues that Russell took Newman's trivialization challenge to be different from what is standardly assumed. I think Landini is mistaken in this respect. What Russell felt dismayed about was his carelessness when formulating his own doctrine, since the Newman result was one he was already familiar with and should have seen this problem coming miles away, but didn't.

[7] An exception to this trend among Russell scholars is Elkind and Shipley, 2020. Elkind and Shipley correctly emphasize both that Russell considered spatio-temporal relations perceivable (Ibid, p. 9) and that he discusses this in AMt, however their argument is weakened by their claim that Russell's view in AMt is essentially the same as the one he had when he had subjects and acquaintance as primitive (Ibid, p. 8-9). So for them the dramatic change in Russell's metaphysics ends up not as central to Russell's AMt position as I argue below. As a consequence, the philosophy of physics and the metaphysics of Russell's non-trivial structuralism, his response to Newman and how the objection is avoided aren't explained and brought together in a manner that strongly supports my main thesis: that Russell's structuralism was never vulnerable to Newman's objection.

b. **Truth:** Our claims about reality are true in virtue of what this world is like.
c. **Theoretical Entities:** We should be committed to the reality of the ontology, relations and properties ascribed to the world by our best scientific theories.

According to the passage highlighted in the earlier section Russell, in *The Analysis of Matter*, is committed to denying **Theoretical Entities**. He instead is read by Newman and others as putting forward:

d. **Structure:** What is known of the ontology, relations and properties of the world, through our best science, is only their logico-mathematical structure i.e., the structure of the world.

If **Structure** holds this suffices to account for **Truth** and **Mind-Independence**, but in a trivial way given Newman's theorem. Indeed a number of philosophers of science and Russell scholars have repeated ad nauseam the claim that Russell's structural realism, as set forth in AMt, falls victim to the Newman objection starting with Demopoulos and Friedman:

> We believe there are insurmountable difficulties with the theory of theoretical knowledge just outlined. So far as we are aware these difficulties were first raised by M. H. A. Newman in an article published in Mind in 1928. (Demopoulos and Friedman, 1989, p. 187)

In his wide-ranging discussion of structural realism and its current applications *The Structure of the World* (2014, p. 72 - 73) philosopher Steven French points out that:

> Unfortunately Russell's 'abstract' structuralism was soon to be the subject of a powerful criticism by mathematician Newman that has become the basis for the rejection of structuralism in general. [...] In a classic Homer Simpson "Doh!" moment Russell concedes the point and admits to Newman that he didn't intend to say what he did say.

Votsis (2003) who is otherwise sympathetic to Russellian ESR (and has put forward his own solution to the Newman objection), also claims that:

> Shortly after the publication of Newman's paper, Russell wrote him a letter acknowledging that he was wrong in saying that only the structure of the physical world can be known (see Russell 1968, 176). Russell abandoned pure SR in his subsequent work (see for example Russell 1948), and never returned to address Newman's problem. (Votsis, 2003, p. 885)[8]

[8] Notice that the references Votsis gives is for Russell's response to Newman in his *Autobiography* and his HK (1948). This is important because I can prove textually that Russell addressed this problem in HK in a manner which leaves no doubt that he has Newman's Objection in mind (1948, p. 330).

Among Russell scholars Grayling (2006), in an otherwise admirable reconstruction of Russell's epistemology of science, claims that Russell's acceptance of Newman's point is a concession of the defeat of his structural realism:

> This theory has a fatal flaw, which was quickly recognised by the mathematician M.H.A. Newman and set out in an article published soon after the appearance of AMt. It is that since our knowledge of the structure of events is not a mere result of our stipulating them, but is manifestly non-trivial, it follows that our inferential knowledge cannot be limited solely to questions of structure. (Grayling, 2006, p. 468)[9]

Saunders and McKenzie (2015), while summarizing the interconnections between mathematical logic and philosophy of physics, return to Newman's Objection. They discuss the purported demise of Russell's theory at its hands, almost repeating what Votsis (2003) said word for word.

> It seems therefore that if structuralism is true, only cardinality questions are open to empirical checks: anything further can be made true a priori. Russell granted the point and never returned to defend his original claims regarding perceptual knowledge. As a general epistemic thesis in the form Russell gave it, structuralism was clearly unsustainable. (Saunders and McKenzie 2015, p. 129)

The objection has made it as far as the philosophy of computation (Boccardi, 2008; Copeland, 1996) given that there's a related problem in that subject about what it is for a system to implement a computation. We want to rule out that any relation on a physical system counts as implementing a computation (Chalmers, 1996), but if computing is characterized abstractly, every physical system will, by Newman's objection, implement a computation modulo cardinality constraints. Copeland (1996, p. 339) like many others, stresses the collapse of Russell's structural realism at the hands of Newman's "devastating objection".

It seems there's quite the consensus on the issue. But even among those who believe Russell was aware of some avenues for response there is disagreement about how Russell responded to the objection[10], as well as on whether Russell either gave up his structural realism in subsequent work or never returned to address the problem. About this Demopoulos and Friedman (1989) put forward the following dilemma:

> To our knowledge, Russell never discusses the puzzle in any of his later work. He seems to give up the idea that our knowledge of the physical world is purely structural, but there is no account of how, on his theory of knowledge (e.g., the theory developed in Human Knowledge: Its Scope and Limits [1948]), such nonstructural knowledge can arise. Yet all the elements of the earlier and later theories are the same—the only

[9] Grayling (2006, p. 468) then proceeds to attempt to explain the details of Newman's Objection unsuccessfully.

[10] As I mentioned above, Landini (2018) is of the view that Newman's Objection and Russell's Response should be radically reinterpreted. I do not respond specifically to Landini in this paper, but attempt to argue directly for my interpretation of the objection and Russell's response.

> difference is in the conclusion drawn. Thus either the original claim (that we are restricted to purely structural knowledge) was theoretically unmotivated or the argument of the later theory contains a lacuna. (1989, p. 192)

The correct reading of Russell's structural realism is stronger than **Structure** above since that thesis is the conjunction of two theses: we know at least the logico-mathematical structure of the physical world and that's all we know about the physical world. But Russell's thesis is that we know the logico-mathematical structure of the physical world plus the relation of co-punctuality, which is a perceptible relation that also holds between physical events. Metaphysically, the import of neutral monism to the tenability of this solution is that its truth is a sufficient condition for accepting that the exact same relation can hold between physical events and mental events.

Russell's thesis contains sufficient elements to preserve **Truth** and **Mind-Independence**. I would formulate his thesis as follows:[11]

e. **Russellian Partial Structure:** What is known of the ontology of the physical world through our best science is its logico-mathematical structure i.e., the structure of the world. But our total knowledge of the world is not purely structural. At least one relation binding unperceived space-time events is known in perception: compresence or co-punctuality, this relation itself obtains between a proper subset of the events, percepts, whose nature is known for Russell. Co-punctuality is a causally distinguished relation.

The truth of **Russellian Partial Structure** suffices to account for **Truth** and **Mind-Independence**, it is a realist view. However it leaves room for humility about the qualitative properties of physical events outside one's body and the specific nature of relations not perceived in experience, it is a structuralist view.

Furthermore, I believe that **Russellian Partial Structure** is strongly supported by Russell's views in both *The Analysis of Matter* and *Human Knowledge*, so that his response to Max Newman should be taken at face value. If this is true, it would also show that he remained a structural realist in his late works and that he in fact returned to address the issue explicitly. But of course, what I will argue in what follows is that the ingredients to his response are already explicitly defended in much of *The Analysis of Matter.*

3. The Newman Objection in the Context of Russell's Causal Theory of Perception

3.1 The Causal Theory of Perception

Epistemic Structural Realism has been discussed in the contemporary philosophy of science literature (Votsis, 2004; Frigg and Votsis, 2011) as dividing into two strands: the downward strand (Poincaré/Worrall), history of science shows structure is preserved, and the upward

[11] Thanks to Alejandro Pérez-Carballo for advice on how to formulate this in a more rigorous manner.

strand (Russell), perception gives structural knowledge of the physical world. The downward strand is inspired by considerations involving the retention of structure throughout the history of science[12], the upward strand on the other hand is supported by considerations related to indirect theories of perception. So it is that Russell's structural realism cannot be made sense of outside of the context of his causal theory of perception. Given the importance of perception to Russell's upward structural realism, I will in the rest of this section introduce the theory so as to better make sense of the Newman objection in the context of an indirect theory of perception. I will return to some of the other assumptions underlying Russell's theory of perception when I outline how to respond to Newman from within the resources of *The Analysis of Matter*.

Russell's causal theory of perception[13] is an indirect theory of perception. What this means is that in Russell's theory, material objects are not perceived directly i.e., perception isn't a direct relation between a subject and a material object. Perception is an indirect causal relation between a mind, which is a certain structure of neutral stuff i.e., basic entities with some spatio-temporal volume, and matter, which is another type of structure of neutral stuff[14]. To further elaborate, perception is a relation between structures: mental structures and material structures built out of the same basic stuff, events (short-lived particulars in physical space-time), but differently arranged and connected through further material structures overlapping these end-to-end, referred to as causal chains. Subjects and material objects are not part of the basic furniture of the world, but logical constructions out of more basic events and their arrangements.

In Russell's causal theory the notion of "percept" is a specific technical term introduced by Russell (AMt) to refer to the data of perception. He no longer uses the term "sense-data", as that notion was connected with the ontology of subjects and objects that he no longer accepts at that point, given his abandonment of subjects as metaphysically fundamental. In his mature theories of perception, from the periods we are concerned with (that is from 1927 to 1948), Russell gets rid of the subject altogether.

Russell regards the problem of skepticism about the external world as a boundary problem (AMt, p. 24)[15] i.e., a problem that arises as a result of the fact that causal information about the physical world becomes data for humans inasmuch as it registers in their sensible surfaces e.g., their eyes, skin, nose, tongue, etc:

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[12] Interestingly Russell (1927, p. 195) remarks on the retention of structure in science and observes that relativity has required a profound revision of our fundamental physical concepts, contrary to many structural realists these days.

[13] Russell had held a causal, indirect theory of perception earlier in *The Problems of Philosophy* (1912) but had also at different points (1914, 1917) considered matter not as a hypothetical to be inferred from perception, but as a derivative add-on to ontology to be constructed from sense-data and sensibilia. This was his so-called phenomenalist phase, which was influential in works such as Carnap's *Aufbau* (Pincock, 2002).

[14] While Russell's neutral monism plays a central role in his philosophy of physics, indeed a crucial role if his structural realism is to be salvaged (as I argue below), the specific details of his construction of mind are not crucial to understand the relevance of neutral monism for this project. For that reason I won't discuss these in detail.

[15] See Nicholas Griffin's introduction to *The Cambridge Companion to Russell* (2003), where he draws attention to this point.

> In last analysis all our knowledge of matter is derived from perceptions, which are themselves causally dependent upon effects on our body. (1927, p. 37)

Indeed, in his mind the problem about inferring the structure of the external world is exactly analogous to the problem of inferring whatever is going on in closed voluminous objects, whose only observable features manifest themselves on their surface e.g., the Sun.

There is a thought experiment Russell delineates to illustrate the analogy he has in mind. He asks us to imagine a sphere in whose interior there are energy emissions. Our position regarding the interior of the sphere is one of ignorance. He believes that in this case we will have several hypotheses regarding what is happening inside the sphere. As long as they are consistent and predict what will happen on the surface of the sphere, we can consider all of them legitimate. Then Russell asks us (AMt, p. 28) to imagine the sphere growing in size until it covers everything including the surface of our bodies. In this scenario the only thing we could know with certainty would be what happens on the surface of our bodies and we could only resort to inference in order to know anything about the cause of those changes. This, Russell believes, is our position with respect to the physical world.

It should be clarified that, while Russell accepts the logical consistency of solipsism (AMt, p. 199), he considers that the desire for a simple explanation of our experience leads us to posit causal laws. Moreover, his task, as he sees it, is not to question the general validity of science, but to investigate what are the assumptions and more general properties underlying scientific theorizing: specifically in physics[16]. He believes his theory of perception can, while taking into account these posited causal laws and being consistent with them, explain in a simple way our perceptions of the external worldby linking these with our knowledge of that external physical world. Indeed, Russell believes physics is concerned with knowing the causal skeleton of the world (AMt, p. 391).[17]

It also must be said that, having rejected solipsism as a philosophically fruitful hypothesis, Russell accepts the general validity of testimony (AMt, p. 193). Given the acceptance of testimony Russell's theory is meant to make sense of true counterfactuals (e.g., how space would have looked like if I were standing over there instead of over here); make sense of accepted testimony of what others see, or hear from their vantage points, etc. The argument to support that there are causal lines leading to perception emerges, essentially, from physics and presupposes the testimony of other minds (AMt, p. 98-99).

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[16] Russell was never a foundationalist in epistemology. This is one pernicious myth (among others) perpetuated by Quine (1969), Ayer (1971) and Pears (1972). It is very clear that, at least as far back as 1908, when Russell wrote *The Regressive Method of Discovering the Premises of Mathematics*, he had no foundationalist inclinations.

[17] The phrase "external world" is taken by Russell to refer to whatever is outside each subject's bodily surface. It can therefore only be perceived indirectly, via the percepts which are non-inferential datums registered in each subject's body. Bodies however are analyzed in terms of compresence structures of events, where those structures are involved in typical physical causal chains themselves. (AMt, p. 193)

We can imagine a series of individuals, each one at a short distance from the other, such that they are all perceiving an event, let us say, an approaching car. If we were to ask each of them what they perceive, their answers would show that there are slight differences in their perceptions, all of which are explainable once certain hypotheses are accepted: for example, the laws of perspective, that light emanating from an event e will be judged as moving at the same speed by any observer, regardless of their state of motion; that energy radiates from 'centers' –physical objects in objective space-time–, etc. All of this ought to incline us, in Russell's view, towards accepting the existence of separable (distinct and distinguishable) causal lines originating from physical objects.

The importance of "perspectives" to establish the plausible hypothesis of "centers", from which different distinguishable causal lines radiate, leads Russell to insist that we could substitute individuals with cameras or recorders for observers (AMt, p. 267). These would photograph images or record sounds that could be contrasted with those captured by cameras and recorders at different distances. This reinforces the hypothesis that different data, recorded in different perspectives, are better explained as products of a causal chain whose final link is the camera and whose origin is a group of events which "radiate" from a center.

What then is known or the physical world from perceptual data according to this theory? For a particular subject at a time (a location in four-dimensional space-time), they can be said to know their own percepts and relations between them. Of the physical world, using only their percepts and under the assumption of separable causal lines radiating from centers, these subjects would also know the structure of neighboring (in space-time) physical stimuli. Stimuli in turn is connected to causal centers, via causal lines, regions of emanation or reflection of energy. With the further assumptions that throughout the causal-line the structure of events is preserved and that there are no greatly distorting mediums, knowledge of the structure of more distant objects is also possible. Accepting both testimony and that there's perspectival continuity (as would be exhibited by photographic evidence) then there's more data from specific regions plus the possibility of inferring what the world would look like from regions lacking subjects by perspective and continuity assumptions.

3.2. Newman's Objection

Philosophical Context and Technical Aspects

Having explained the main features of Russell's causal theory of perception I can now present Newman's objection, which historically was put forward specifically against Russell's theory of perception in connection with its structuralist commitments. In this section I discuss some of Russell's structuralist assumptions which, taken in isolation, are seen to be problematic in light of Newman's objection. I then focus on explaining the formal features of this objection and prove a result, Newman's Theorem, along the way for the purposes of illuminating the power and simplicity of the objection.

There are a number of assumptions in Russell's *The Analysis of Matter*, but of particular relevance to understand the way Newman (1928) posed his objection are the following:

a. **Helmholtz-Weyl Principle:** Different percepts imply different causes.[18]

The intuition behind **Helmholtz-Weyl** is that perceptual differences are grounded in differences of causal-stimuli. We should understand it to refer to tokens of percepts/causal stimuli. Of course different perceptual tokens could result from the same type of causal-stimuli, however Russell individuates particular percepts/stimuli via their relations with other events (AMt, p. 186). For Russell, the notion of objects and common-sense things cannot be part of what is known in an analysis of perception and there's no physical ground for supposing there are such things. Perceiving a dog shape involves a percept of dog-shape at a time and the assumption there there's a particular stimuli, at that time, impinging on the corresponding visual surface.

According to Russell structure is important since:

> When two relations have the same structure (or relation-number) their logical properties are identical. (AMt, p. 251)

Russell claims that for perception to give us knowledge then, assuming that perceived relations between percepts have correlate relations in the physical world with the same structure, via the result quoted above we get:

b. **Mirroring Relations:** The logico-mathematical properties of the relations between percepts mirror the logico-mathematical properties of the relations between their worldly causes.

Russell's assumption that there are correlating relations in the physical world corresponding to relations between perceptions, in perceptual space, is supposed to be substantive. Indeed in his *Introduction to Mathematical Philosophy* (1918, p. 61-62) he already has strong structural realist leanings. He specifically claims that, given these assumptions involving correlates for perceived relations, we can know much more of the physical world than Kant supposed. Newman's objection is that assumptions that there are correlating relations for perceived relations between events can be shown to be satisfied easily by pure logic, plus assumptions Russell has already built in.

> These statements 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 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

[18] Votsis (2003) lays stress upon these important assumptions in Russell's work. As Bradie (1977) points out though, these are only some of the many assumptions Russell makes, explicitly and implicitly, regarding structural posturales, many of which are crucial to his results.

> 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 organised so as to have the structure W, provided there are the right number of them. Hence the doctrine that only 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)

The specific claim in Russell's *The Analysis of Matter* that comes under attack by Newman is that of the physical world we can know at most its abstract structure. If the central claim of Russell's structural scientific realism is that of the physical world we can know at most its abstract structure, then it can be shown with minimal formal assumptions that the world can be said to have any structure modulo cardinality constraints. It will be true that the world will have a given structure, as long as that is consistent with how many objects the world has: its cardinal number.

What Russell had in mind by abstract structure can be further expanded upon by considering the relation-arithmetic developed by Whitehead and himself in PM (1910). This is a theory of relations in extension, where relation-types, classes of classes of structures, are thoroughly investigated and their arithmetical properties are demonstrated. For the sake of expediency I will discuss the objection in the language of set theory, but of course the formal theory Russell himself used was not a set theory. Russell has no sets in *Principia Mathematica*, given that it is a no-class theory.

Let S be a non-empty set and $R_1...R_n$ some relations on S, understood as subsets of S^n. A concrete structure will just be S together with $R_1...R_n$, $(S, R_1...R_n)$. An abstract structure, which is what Russell claims can be known of the physical world, is a set of all concrete structures isomorphic to a given concrete structure. To elaborate, take our structure $(S, R_1...R_n)$, that structure will be isomorphic to other concrete structure $(S', R'_1...R'_n)$ iff there is a bijective function f, such that for all $x_1...x_n$ in S and arbitrary Ri in $R_1...R_n$, $R_i(x_1...x_n)$ iff $R_i'(f(x_1)...f(x_n))$, where the $f(x_1)...f(x_n)$ are the images of S under f. We say that two isomorphic concrete structures are similar. An abstract structure is then a set of similar concrete structures: these are the aforementioned relation types.

Theorem: Assume we have as given some set S together with some relations $R_1...R_n$ over the set: a concrete structure $(S, R_1...R_n)$. Assume furthermore that there is another set S' that has the same cardinal number as S i.e., there is a function f which is bijective between S and S'. It will then follow that there is a structure with S' as domain which is isomorphic with $(S, R_1...R_n)$.

Proof: Since they have the same cardinality, let g be an injective function from S to S', it will have an inverse g' from S' to S[19]. Just define $R_1'...R_n'$ in S' such that $y_1...y_n$ are in R_i' if $g'(y_1)...g'(y_n)$ are in R_i: since $(S, R_1...R_n)$ is given there will be such g'(y)s. Moreover since R_i' is

[19] We could also use a bijection between S and S', since they have the same cardinality that comes down to there being a function f which maps S to S' and is both one-one and onto. I am going with an injection since, intuitively, the original objection involved taking the structure of percepts and push-through a copy of it to the physical world.

arbitrary this holds for every R_i subset of S_n. Therefore (S, R_i...R_n) is isomorphic to (S', R_1'...R_n'). If S' is strictly larger than S this will hold for D, the image of an injective function g from S to S' with D the range of the function g and a proper subset of S'[20].

Hence, any concrete structure can be imposed upon a set modulo cardinality constraints and more relevantly, knowing the abstract structure of the world comes down to knowing the relation-type of the world. This last comes down to knowing that our percepts and the world (or some proper part of it) are isomorphic with regards to structure, but this last result is trivial to acquire a priori just as long as the world (or some proper part of it) has as many objects as our percepts. It will be guaranteed by logic that there is a structure in the world which is of the same isomorphism-type as the structure of my percepts.

4. Taking Russell's 1928 Response to Newman Seriously

Shortly after the publication of *The Analysis of Matter*, in response to Newman's critical paper,[21]Russell sent him a letter, reprinted in his *Autobiography* (Russell, 1975) responding to the sharpest point in that paper. I quote in full:

> Dear Newman,
>
> Many thanks for sending me the off-print of your article about me in Mind. I read it with great interest and some dismay. 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.
>
> It is of course obvious, as you point out, that the only effective assertion about the physical world involved in saying that it is susceptible to such and such a structure is an assertion about its cardinal number. (This by the way is not quite so trivial an assertion as it would seem to be, if, as is not improbable, the cardinal number involved is finite.[22],[23] This, however,

[20] This is my own proof of the result. Similar proofs have been put forward in Ketland (2002) and Votsis (2003). Thanks to Kevin Klement for discussing the details of the proof with me and helping me come up with my own version of it. It certainly enhanced my understanding of what it involves.

[21] Newman receives acknowledgements from Russell in the preface of *The Analysis of Matter* for his help with regards to "certain portions of the work". Perhaps his help was confined to the more mathematical sections of the book or he only thought of the criticism afterwards.

[22] Interestingly, Bueno (2017) suggests Russell should respond by embracing the finiteness claim. Since order-type for finite cardinalities is categorical and therefore finding out the cardinality of the world suffices to get its unique order-type, up to isomorphism, right. Thanks to Kevin Klement for discussion of this point.

[23] Landini (2018) believes that Russell took the objection to be that: if there are an infinite number of objects in the domain, then the relation-type of the world is underdetermined, but not so if there are a finite number of objects, for in that case the relation-type of the world is trivially unique. So Russell (AMt) must have had in mind an ontology with a transfinite number of objects in order to avoid the trivialization of his view. Indeed, Landini brings up Russell's assumption that recovering space-time order from events requires the existence of at least aleph 0 objects (Landini, 2018, p. 295) in support of his contention that Russell's ontology already falsifies the possibility of finite events. Russell's 1928 response to Newman, on Landini's view, contains a typo to the effect that Russell says it is highly unlikely that the number of objects in the world is "not finite" (Landini, 2018 p. 293) and therefore that

> is not a point upon which I wish to lay stress.) It was quite clear to me, as I read your article, that I had not really intended to say what in fact I did say, that nothing is known about the physical world except its structure. I had always assumed spatiotemporal 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.
>
> I have not yet had time to think out how far the admission of co-punctuality alone in addition to structure would protect me from your criticisms, nor yet how far it would weaken the plausibility of my metaphysic. What I did realise was that spatio-temporal continuity of percepts and non-percepts was so axiomatic in my thought that I failed to notice that my statements appeared to deny it.
>
> I am at the moment much too busy to give the matter proper thought, but I should be grateful if you could find time to let me know whether you have any ideas on the matter which are not merely negative, since it does not appear from your article what your own position is. I gathered in talking with you that you favoured phenomenalism, but I do not quite know how definitely you do so.
>
> Yours sincerely,
>
> Bertrand Russell

The opening paragraph has been widely misunderstood as an admission of defeat, as discussed in Section 1. Perhaps it is the way Russell expresses himself here, claiming he felt “dismayed” and “ashamed”. But then he goes on in the second paragraph to say that “it is of course obvious” that structural assertions of the sort he makes in some parts of the book, such that of the physical world we can only know its abstract structure, involve only assertions as to the cardinality of the world.

I believe that Russell’s dismay and shame, while quite real, owe more to the fact that he was aware, in the realm of pure logic, of the Newman result, but failed to see that his carelessness in expressing his view made him susceptible to that objection in this case. Indeed, it was perfectly obvious to him, since he himself had pointed out strikingly similar results in his own work. Russell distinguished himself early on as a logician precisely by working out the properties of relation-types. His work in relation-arithmetic, the general theory of relation types, he regarded

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cardinality itself doesn’t fix the order-type of the world. But this is a misreading of the triviality complaint. The worry raised by Newman (1928) and popularized by Demopoulos and Friedman (1989) is that Russell’s thesis entails that our knowledge that the world has structure S is, modulo cardinality constraints, true a priori on the basis of pure logic alone, but scientific knowledge is surely both substantive and a posteriori.

as some of the most important in PM (cf. MPD, 1959), with applications both in pure and applied mathematics, as well as philosophy. For example, in his PoM.[24]

> Two series s, s′ are said to be correlated when there is a one-one relation R coupling every term of s with a term of s′, and vice versâ, and when, if x, y be terms of s, and x precedes y, then their correlates x′, y′ in s′ are such that x′ precedes y′. Two classes or collections are correlated whenever there is a one-one relation between the terms of the one and the terms of the other, none being left over. Thus two series may be correlated as classes without being correlated as series; for correlation as classes involve only the same cardinal number, whereas correlation as series involves also the same ordinal type—a distinction whose importance will be explained hereafter. In order to distinguish these cases, it will be well to speak of the correlation of classes as correlation simply, and of the correlation of series as ordinal correlation. Thus whenever correlation is mentioned without an adjective, it is to be understood as being not necessarily ordinal. Correlated classes will be called similar; correlated series will be called ordinally similar; and their generating relations will be said to have the relation of likeness. Correlation is a method by which, when one series is given, others may be generated. (PoM, *The Correlation of Series*, p. 374)

He then immediately goes on to comment on an abstract result such that if one has a series with a generating relation P, together with a one-one relation between a term in the series and another class, then it will be possible to generate another series in that class having the same order-type as the original. What this comes down to is that from one series (with a given order) one can define an ordinally correlating relation to a class modulo cardinality constraints, such that they will share “complete ordinal similarity” in his own words. But this is similar to what Newman shows can be established between a perceptual structure and a set, so long as there’s a bijection between them, except Newman’s result is more general since it deals with any structures, not just order-types. Newman’s result couldn’t have been shocking news to Russell by any stretch of the imagination. When Russell mentioned the obviousness of Newman’s observation he was being entirely earnest. [25]

Russell then goes on to, in a most casual manner; state his solution to the problem. But this simply comes down, as we will discuss in the next section, to making explicit what he actually says in other parts of AMt. That is:

a. He had always assumed spatiotemporal continuity between the physical and non-physical world i.e., co-punctuality between percepts and non-percepts.
b. One can go from one end of a causal chain to the other in a finite number of steps through compresence.
c. Co-punctuality is a perceptible relation.

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[24] In his even earlier, *The Logic of Relations* (1901) Russell mentions many of the same results discussed in that section of PoM (1903). Importantly, he mentions a related general theorem about order-types (L&K, p. 26).
[25] Thanks to Kevin Klement for discussion on this point.

After that he clarifies he hasn't considered some of the consequences of being explicit about a, b and c. Both in circumventing the objection and in preserving his key structuralist and metaphysical theses. However, as I will argue in detail below, in light of the exposition of the Newman Objection in Section 5 these three constraints, plus the structural assumptions they entail and are also discussed in AMt, are sufficient to single out distinguished structures.

Recall that the Newman Objection is a model-theoretic argument. What it shows is that, given how relations in extension are defined in set theory as n-tuples of objects, then as long as some unstructured set has enough objects and given some prior structure, as a set together with relations in extension defined on it (sets of n-tuples), it will be possible to define a mapping from the unstructured set to this prior structure[26]. It will be such that the elements in the unstructured set are members of some n-tuple iff their images under the mapping are in their respective n-tuples, which exist as they were given antecedently. This will be so regardless of any concrete details about the structured set.

These sorts of arguments are called push-through constructions (Button and Walsh, 2018) and are well understood not only in model-theory, but in the philosophical literature on these since Putnam (1980). A realist solution to these arguments must involve some distinction between admissible and inadmissible models. Lewis (1984) famously puts forward the notion of naturalness as a constraint on models (or interpretations). Only natural interpretations are admissible, where naturalness stands for some objective feature of reality: that is, only models which represent reality via natural properties and relations are admissible. Regarding Putnam's similar model-theoretic argument Lewis writes:

> Putnam's thesis (the bomb) is that, in virtue of considerations from the theory of reference, it makes no sense to suppose that an empirically ideal theory, as verified as can be, might nevertheless be false because the world is not the way the theory says it is. The reason given is, roughly, that there is no semantic glue to stick our words onto their referents, and so reference is very much up for grabs; but there is one force constraining reference, and that is our intention to refer in such a way that we come out right; and there is no countervailing force; and the world, no matter what it is like (almost), will afford some scheme of reference that makes us come out right; so how can we fail to come out right? (Lewis, 1984 p. 221)

Change reference and truth for percepts and worldly structure above to recover the analogy. While Putnam's model-theoretic argument Lewis is attempting to respond to is not the Newman objection, it is in spirit (and form) close enough that a similar solution works for both (Bricker, 2020; Demopoulos and Friedman, 1989). The key difference between them is that whereas Putnam's argument shows that, as long as two theories are elementary equivalent up to isomorphism, then you can always find a gerrymandered interpretation of your theories names

[26] The inverse of a mapping from the structure to the set, which should exist as long as both have the same cardinality or one (bijection) can be embedded in the other (injection).

and properties which preserves truth, Newman's objection is more general[27]: by the push-through construction a structure can be copied to any set so long as they have the same cardinality. If the thesis that the structure of percepts mirrors the structure of the world is to be substantive, percepts and non-perceptual events need a metaphysical glue.

The way this family of solutions work is by constraining interpretations to natural ones i.e., interpretations grounded in some objective features of the world being more natural candidates for reference than others.[28] For the similar case at hand, Russell shouldn't claim that percepts stand in some relation R and there exists a structure in the physical world, with physical events R' related in it, isomorphic to the percepts under R. This result will hold a priori modulo cardinality constraints, given Newman's argument. Instead Russell should say percepts stand in some relation R and there is a specific structure C, in the physical world, with events R related in it, isomorphic to the percepts under R, where R is in fact the same relation in both sets, co-punctuality. The claim that is obtained by logic alone is the general claim. The specific claim is non-trivial but non-demonstrable, *i.e*, we have at most abductive reasons for accepting it.

How can we know that there's such a specific structure C? This is where Russell's structural postulates come in, postulates such as **Helmholtz-Weil** and **Mirroring Relations**. But, as I have pointed out, Russell makes use of far more postulates in AMt (Cf. Bradie, 1977). These postulates have exactly the same status for him as the axioms and primitives of PM (Russell, 1908; Whitehead and Russell, 19010). We should believe in them inasmuch as their truth enables a simple systematization of our theoretical knowledge that is fruitful. However, they are synthetic assumptions as to the structure of the physical world. Indeed, on this point he says about the evidence for his causal theory.[29]

> [...] that it links together a number of known facts, that it does not have any demonstrably false consequences, and that it sometimes enables us to make predictions which are subsequently verified. All these tests the causal theory fulfils; it must not be assumed, however, that no other theory could fulfil them. (AMt, p. 199)

Russell is adamant that what he has to offer in his philosophy will never amount to a proof that the world must be so and so. Indeed, he points out regarding induction and the possibility of synthetic a priori knowledge that:

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[27] Landini (2017) claims contra Demopoulos and Friedman (1989) that since Russell's mathematical logic is higher order, he doesn't fall to these sorts of model-theoretic arguments (another reason for him to give a non-standard interpretation of the Newman objection). But Landini is thinking solely about Lowenheim-Skolem model-theoretic types of argument, on which a first order language cannot fix the cardinality of its models. The model-theoretic argument at stake is the push-through construction style of arguments (Button and Walsh, 2018) discussed in Section 2, on which mere abstract structure can be "copied" to any set of the same cardinality. The switch from first order to higher order doesn't affect these arguments.

[28] See Sider (2011, p. 23) for an overview of these solutions for the specific problem of reference in light of model-theoretic arguments.

[29] Similarly, on the reasons to reject solipsism: "First, there can be no question of logical proof. A certain collection of facts is known to me by perception and recollection ; what else I believe about the physical world is either the effect of unreasoning habit or the conclusion of an inference. Now there cannot be any logical impossibility in a world consisting of just that medley of events which I perceive or remember, and nothing else." (AMt, p. 199)

> Whether there is a priori knowledge or not, there undoubtedly are, in a certain sense, a priori beliefs. We have reflexes which we intellectualize into beliefs; we blink, and this leads us to the belief that an object touching the eye will hurt it. We may have this belief before we have experience of its truth; if so, it is, in a sense, synthetic a priori knowledge i.e. it is a belief, not based upon experience, in a true synthetic proposition. Our belief in induction is essentially analogous. But such beliefs, even when true, hardly deserve to be called knowledge, since they are not all true, and therefore all require verification before they ought to be regarded as certain. These beliefs have been useful in generating science, since they supplied hypotheses which were largely true; but they need not survive untested in modern science. (AMt, p. 175)

Instead of attempting any kind of proof Russell argues that, if perception gives information about the physical world indirectly, knowledge by perception is possible only if the world satisfies certain structural postulates and we can individuate the relation that bridges the gap between non-perceptual and perceptual events, that is we can single it out as a specific relation. Crucial to the possibility of empirical knowledge, within his philosophy, are the following d. - g. I will introduce them here, but will discuss them in great detail in **Section 6**.

d. Separable or semi-separable causal lines (that is, distinct and distinguishable causal lines), linking unperceived physical events to percepts, obeying principles of continuity and perspective (AMt, pp. 314, 315). Russell assumes all causal lines converge on centres, that is regions of emanation of energy in physical space (whether the energy is reflected there or originates there), which needn't be the same for different percepts (AMt, p. 322). Causal lines are space-time geodesics of physical events, so they are literally geometrical objects.
e. Links in a causal line are always co-punctual with other links (AMt, p. 304). Spacetime points, in effect, are constructed as maximilly co-punctual classes of events (AMt, p. 299).
f. Effects and causes must resemble each other in at least one way, being of the same relation-type (AMt, p. 266, 321, 323), that is some structure is preserved between them (e.g., the similarity between the structure of a musical performance and our experience of it in terms of number of sounds, temporal distribution between them, intensity of sounds and so on). But “being of the same relation-type” is a distinguished relation, since this is relative to perceived co-punctuality.
g. Causal chains which give empirical information about the world must, a fortiori, have a final link which is a percept. Relations between percepts are also perceived (AMt, pp. 278, 338). Co-punctuality is also a relation between percepts (AMt, pp. 314, 315).

Structural claims such as these are contingently true, if true. But if true they ground the truth of a. through c. in his response to Newman. If the specific relation R within my percepts also holds for non-perceptual space-time events, then saying these events have specific structure C, relative to R, is a very specific, contentful and non-trivial claim. Nor does the truth of these

claims require that one give up structuralism with regards to ontology or even most relations. The resulting view is however not pure structural realism, but partial structural realism as defined in Section 3, that is, a view on which not all knowledge of the physical world boils down to its abstract structure, some relations/particulars are known, but epistemic humility about the underlying quality of much of the physical world is still the norm.[30]

Since Russell accepts, in broad outlines, the truth of our scientific conception of the world (L&K, p. 339), then the argument for his structural assumptions is that, if they are true, we can vindicate the truth of our scientific knowledge in a way which links it to perception. More importantly, all four claims are explicitly articulated and defended in AMt. This suffices to show that Russell's response to Newman was sincere. These theses were so basic to his philosophy in AMt that, even when he puts them forward in that book, he also formulates one of his main theses in a way which appears to deny these claims. This is no doubt a mistake which embarrassed him, but it is a different mistake to formulate a thesis carelessly so that it can be shown to entail a falsehood than to put forward a whole philosophy of physics susceptible to Newman's objection. The latter mistake isn't Russell's, since formulating his structuralist view more carefully fits perfectly with the rest of what is defended in that work.

Just as with the rest of his philosophical output, Russell's general argument for his most fundamental assumptions with regards to our percept-based structural knowledge of the physical world, are their simplicity and fruitfulness. In what follows I explore the role his methodology plays in setting out his metaphysical assumptions, the nature of these assumptions in connection with perception and structure, as well as the more fine grained details of his solution.

5. Russell's Regressive Method: The Contribution of Minimum Vocabularies

To understand Russell's structural realism and its development from AMt to HK it is necessary to discuss his philosophical methodology, since it underpins all his theoretical choices. Russell's regressive method is important for understanding the philosophical methodology behind his work from (at least) *The Regressive Method of Discovering the Premises of Mathematics* (1908) to his last major philosophical work, HK (1948).

The regressive method takes philosophy to be a sort of reverse engineering of concepts central to the sciences, such as number, order, space, time, causality, matter and mind (Cf. Russell, 1924). The aim is to find the minimal number of axioms and primitives needed to rigorously recover, with the resources of mathematical logic, the structure of the domain we are interested in, but with assumptions and primitives explicitly laid out. Russell's favorite illustration is the Peano axiomatization, which, together with mathematical logic, allows us to recover the theory of the natural numbers. He saw himself as taking this analysis further and showing how Peano's

[30] Specifically, as I will detail below, whatever falls outside the boundaries of the physical body minus the relation of co-punctuality, which distinguishes causally salient physical structures, is something about which we know only its abstract structure and not its qualitative features.

primitives are themselves susceptible to logical analysis, so that in the need we find out there's no reason to suppose mathematics requires even the primitive concept of "number".

Primitives in Russellian regressive analysis are sometimes pragmatically chosen, we can never be sure we have reached the end of analysis, however they are more rigorously arrived at, have more importance at a foundational level and are closer to capturing objective resemblances than concepts from pre-philosophical analysis (Cf. Bradie, 1977).

The primitives in Russell's philosophical analysis of physics are not merely structural (see HK, p. 247), in the sense of mathematical logic. There are presuppositions in the selection of the laws involving simplicity. The primitives of these structural postulates[31] (the assumptions in Russell's theory) (see Bradie, 1977), when it comes to empirical science, involve unanalyzed notions of contiguity and resemblance (see AMt, p. 80-81) which single out causal lines (Cf. AMt, p. 322-323): these causal lines moreover, impose some existence and uniqueness requirements on the world which, as Russell is well aware, might not be satisfied (1927, p. 175). [32]

The central idea is that foundational knowledge, or philosophical knowledge, goes in the opposite direction to typical scientific knowledge. It is not concerned with proving or predicting new results from what is already known, but investigating what are the fundamental primitives and principles underlying our most secure mathematical and scientific theories. As pointed out by Hager (2003):

> A major component of Russell's philosophical work was the development of a distinctive method of philosophising, which, though he consistently applied it throughout his career, has been largely ignored. This lack of understanding of Russell's method has been a main cause of the still widespread perception that the progress of his philosophy is fragmented and erratic.

The regressive method is concerned with the analysis and elimination of vague, imprecise and incomplete notions (and principles) behind scientific reasoning as a first stage. As a second stage it aims at the synthesis of more accurate, parsimonious, powerful concepts and principles to be substituted for those. Russell's typical examples (1908, 1919, 1925, 1927, 1948) are Peano's axioms as a regressive analysis and synthesis of the primitives and principles of arithmetic, as well as the analysis of those in turn afforded by his and Whitehead's mathematical logic.

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[31] Moreover simplicity is linked by Russell to the desire for simple causal laws (1927, p. 200). There are ineliminable primitives such as the concept of comprensence which, in AMt, serves as a link between any two topologically overlapping causal lines.

[32] Russell speaks of contiguity in connection with relativistic worldlines (1927, p. 80; p. 313). However, given quantum mechanical considerations he also says causal lines sometimes involve discrete events, where the criterion of causal connection is "inferrability" under the assumption of irradiation from a center. I think this latter criterion is problematic, as it threatens to make Russell's metaphysical account of causality, as understood in terms of time-like geodesics involving overlap, circular.

In Russell's methodology one starts out with some vague truths and notions e.g., that "1+1=2" or that "an object far away looks smaller than a closer object". Through a process of abduction and analysis one then seeks principles and primitive concepts from which one can derive them. Science settles for principles which are powerful enough to encompass many diverse facts under a few laws but philosophy, which is in principle continuous with science, takes up the task of analyzing that knowledge further until the greatest amount of conceptual and axiomatic parsimony is reached. The evidence for these often complex principles and the usefulness of these concepts in turn is inductive, in the sense that the most intuitive, easiest to grasp truths can be deduced from these very general, abstract concepts and principles. The primitives will be minimum vocabularies, the principles axioms. There's no self-evidence for them, they acquire their credentials by their usefulness in our best synthesis and axiomatization of scientific knowledge.

> When pure mathematics is organized as a deductive system i.e., as the set of all those propositions that can be deduced from an assigned set of premises, it becomes obvious that, if we are to believe in the truth of pure mathematics, it cannot be solely because we believe in the truth of the set of premises. Some of the premises are much less obvious than some of their consequences, and are believed chiefly because of their consequences. [...] With the empirical sciences this is evident. Electro-dynamics, for example, can be concentrated into Maxwell's equations, but these equations are believed because of the observed truth of certain of their logical consequences. (L&K, p. 325)

Obviously Russell does not have Quine's (1951) concept of ideology, but he has a similar concept of his own corresponding to the most fundamental principles and minimum notions one can reach via the regressive method: the concept of minimum vocabularies. Moreover, he ascribes metaphysical import to these minimum vocabularies in connection to our most fundamental theories. They are whatever is most fundamental in the relevant scientific branch. Russell places a huge weight on simplicity, as a criterion for the selection of principles and primitive concepts (Cf. AMt, p. 229), given their role in recovering synthetic general and scientific (arithmetical) laws. It must be considered an unstated assumption of his that these concepts will have some degree of naturalness[33]. As we saw, he emphasizes that scientific laws must be simple and inferentially powerful, but that cannot be had without a distinction between primitives (and related properties)[34].

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[33] I am not claiming that Russell had a conception of naturalness, in its contemporary usage. But he definitely had the distinction between metaphysically distinguished structure and structure adopted out of pragmatic convenience, applied both to predicates (monadic universals) and structures (relations). See for example, L&K, (p. 331). In that paper Russell also discusses how relations ought to be symbolized in an ideal language in order to avoid Bradley type-regresses. This is strikingly similar to Lewis's (1983) argument that instantiation shouldn't be analyzed in the way other dyadic relations are.

[34] A distinction might be introduced which is purely interest based or pragmatic; indeed, Russell has a role for those. But at the end of the day Russell was a realist who believed the physical world has a distinguished structure and the business of science is to discover that structure (Bradie, 1977, p. 458).

Importantly, primitive vocabularies for empirical sciences, unlike those for pure mathematics, must make some reference to experience, which is a basic feature of some material structures for Russell[35]. Since minimum vocabularies single out structures in the relevant theories, those defined in terms of them, when it comes to the empirical sciences they contribute to distinguishing empirically relevant structures. Otherwise physics would be a branch of pure mathematics.

> Physics as a pure science i.e., apart from methods of verification would seem only to require a fourdimensional continuum containing distributions of varying amounts of energy and electricity. Any fourdimensional continuum will do, and energy and electricity need only be quantities whose mode of change of distribution is subject to certain assigned laws. When physics is brought to this degree of abstraction it becomes a branch of pure mathematics. It thus appears that if physics is regarded as a science based in observation, not as a branch of pure mathematics, and if the evidence for physical laws is held to be part of physics, then any minimum vocabulary for physics must be such as to enable us to mention the experiences upon which our physical beliefs are based. (HK, p. 247)

But compresence or co-punctuality is a relation which, as in Russell's response to Newman, exists both among groups of percepts, groups of percepts and non-percepts and groups of non-percepts. This is explicitly pointed out in both *The Analysis of Matter* and *Human Knowledge*, as I will argue below. It is part of the primitive vocabulary of physics as an empirical science. But if physical structures and notions are defined in terms of formal notions plus perceived co-punctuality, then for them to be singled out the world must contain supporting structures. These will be Russell's causal lines, his plenum of events of finite diameter, the objective order-type of the world and so on: his structural postulates[36].

These are the elements and assumptions in Russell's Structural Realism which, even in *The Analysis of Matter*, single out a non-trivial physical structure for the world, given further additional assumptions involving how these causal lines give rise to perceptual knowledge. The structuralist claim intended all along is not about a purely abstract relation R, such that the world can be arranged R-wise modulo cardinality constraints: R is a particular known relation. This might not be the limiting case view of structural realism that commentators, both Russell scholars and philosophers of science, have saddled Russell with but, as I will argue, it is structural realism enough.

6. Explaining Russell's Response to Newman:

[35] Brains for Russell are just co-punctual groups of percepts, the percepts are basic events which just happen to be members of the sort of structures that give rise to complex mental life, however as events they are basic stuff whose intrinsic qualities we know via perception. Brains are higher-level material structures composed out of them.

[36] Bradie's (1977) discussion of Russell's structural posturales throughout his later philosophy is the most comprehensive paper on this in the literature. However, Bradie misses the fact that Russell regards objective space-time as having an ordinal structure (AMt, p. 56), but this is crucial for all of Russell's space-time constructions out of events and co-punctuality, compresence.

Compresence, Percepts and Events Within Neutral Monism

The purpose of this section is to flesh out the metaphysical and epistemological elements in Russell's structuralism needed to respond to Newman's objection and give textual evidence that these elements were all present in AMt, so as to show that his response to Newman wasn't ad hoc. Specifically, this section develops points d. - g. from Section 4 in great detail, which as I observed there, are the main assumptions Russell needs to justify a. - c. in his response to Newman: the claim that he had always assumed co-punctuality between percepts and non-percepts, that it is a relation that can connect events and percepts at different ends of a causal line and that it is a perceived relation.

I begin with a discussion of the concepts of co-punctuality and compresence and from there proceed to a discussion of the role these play in connecting physics and perception, given neutral momism plus independent assumptions Russell has about the structure of space-time.

6.1 Co-punctuality and Compresence

Demopoulos and Friedman (1989), when considering what Russell says in his letter to Newman about our perceptual knowledge of co-punctuality, raise the misplaced objection that Russell's old notion of acquaintance couldn't bridge the gap between the non-mental and the mental, but it now turns out that conveniently there's a relation "perceived co-punctuality", that can. On the one hand, Russell retreated from his old epistemology because he saw difficulties that neutral monism offered resources to respond, stemming from the primitive distinctions between subject and object. His change in position isn't ad hoc, it is a key move in his reconceptualization of ontology. On the other hand co-punctuality isn't put in by hand conveniently. It is not a novel ad hoc notion, rather it is a notion that has had an evolution from its role in Russell's project of logical construction (OKEW, 1914) to his inferentialist project in AMt, making an appearance in its new guise as a crucial primitive in Russell's *The Philosophical Analysis of Matter* (1925).

As explained above Russell's compresence and compunctuality are really the same type of relation, intuitively of event overlap. In *The Analysis of Matter* compresence is reserved for the temporal series, similarly to OKEW (1914).

First, a discussion of the one-dimensional temporal series. Russell introduced, as early as OKEW, the notion of compresence for the purposes of constructing temporal instants out of events. This is a relation he keeps in AMt and can still do the same work, since worldlines of material objects in special relativity obey all the standard axioms of order for temporal sequences, but each material object has its own proper time. Compresence should be understood intuitively as temporal overlap.

> **Definition.-** A group of events is compresent iff any two members of the group are compresent.

Definition.- A compresent group of events is maximally compresent iff it is not possible to enlarge the group without it ceasing to be comprensent i.e., there is no event outside the group compresent with all of them.

Definition.- A compresent group of events is an instant iff it is maximally compresent.

Assuming a plenum of temporal events and that they can be well-ordered Russell (OKEW, AMt) claims we can recover instants. This allows for the possibility that two events can be compresent without being members of an instant e.g., my perception of the computer screen is compresent with the noise of a dog barking and with some motorcycle passing by, but the motorcycle passing by and the dog barking are non-compresent. Since the motorcycle passing by isn't compresent with the dog barking, it's not a member of a maximally compresent group and therefore not a member of the instant that has the dog-barking as a member. Comprensence in perception is just simultaneous perception. If a number of events are perceived at the same time this means that there are causal lines starting from those events that overlap temporally in the subject.

Co-punctuality is compresence fit for constructing points in a four-dimensional manifold (AMt, p. 295). As Russell points out, it is possible for any three spheres of finite radius in dimensions above two to overlap without sharing a common region, so we need to revise our definitions. For the construction of four-dimensional space-time Russell assumes a plenitude of events i.e., no gaps between events. Events are physical entities with a finite spatio-temporal volume, much like the notion of a ball in Real Analysis[37] applied to four dimensions. The only difference is that balls in real analysis are sets or regions of space-time points, whereas for Russell events are ontologically prior. Co-punctuality is spatio-temporal overlap of at least five events.

Definition.- A group of events is co-punctual iff any five of them are co-punctual.

Definition.- A group of events is maximally co-punctual iff it is not possible to enlarge the group without it ceasing to be co-punctual i.e., iff there's no event co-punctual with all of them.

Definition.- A group of events is punctual iff it is maximally co-punctual.

Punctual events are four-dimensional space-time points. Moreover Russell assumes physical space-time has aleph nought events (AMt, p. 297) and an antecedently given order-type. From that he argues we can also recover space-time order (AMt, p. 303) for these events. He then defines related relations of co-linearity (intuitively, classes of points that form lines), co-superficiality (intuitively, classes of lines that form 2D and 3D surfaces[38]) and so on, where

[37] The formal definition is: Let (M, d) be a metric space, namely a set M with a metric (distance function) d. The open (metric) ball of radius $r > 0$ centered at a point p in M, usually denoted by $B_r(p)$ or $B(p; r)$, is defined by: $B(p) = \{ x \in M \mid d(x, p) < r \}$, with less or equal for closed balls. (Rosenlicht, 1968)

[38] This suggests we can construct relativistically important Cauchy-surfaces from co-punctual structures. S is a Cauchy surface iff it is a maximal, space-like three-dimensional surface that partitions space-time two disjoint chronologically distinct regions: its absolute past and its absolute future. Cauchy-surfaces are the closest things to

co-punctuality gives you both points and fusions of points (co-linearity is the transitive closure of co-punctuality). Causal lines, or material paths in space-time, are co-linear classes of points and therefore connect different regions in space-time through the relation of co-punctuality e.g., a distant causal source with a percept. Since co-punctuality is a topological relation, stretching or curving the space-time preserves co-punctuality relations as required by general relativity.

Since PoM until MPD Russell remained committed to the view that relations are real. In *Logical Atomism* (1924) he writes on the empirical grounds for belief in the reality of relations (and pluralism about basic entities):

> My own decision in favour of pluralism and relations is taken on empirical grounds, after convincing myself that the a priori arguments to the contrary are invalid. (L&K, pp. 338-339)

Co-punctuality, the generalization of compresence, is a perceptually known relation in Russell's philosophy of physics. When I say the relation is known I mean that its intrinsic nature is known in perception, through the perception of spatio-temporally overlapping percepts e.g., I perceive a blue region of the sky for a second (in perceptual space), together with a region containing a cloud for two seconds and a person walking by below for three seconds, a cat just ahead for 2 seconds and my hand for five seconds. All of these spatio-temporal events in perceptual space overlap and therefore are co-punctual. To recap, a group events can be co-punctual without being maximally co-punctual.

Since events can be co-punctual without being members of the same point, these perceived co-punctual events are themselves rich in structure in perspectival space. That structure involving spatio-temporal overlap, distances, sizes, changes in position through time and so on is also topological and metrical structure that, according to Russell, gives information about physical structure in its immediate neighborhood. However, since one of Russell's assumptions is that neighboring events have similar structure and since causal lines are connected via co-punctuality, perception gives also information about more distant events, though subject to errors introduced by intervening mediums.

Consider for example a subject observing some stars at a time, their percepts at time t (in their reference frame) are co-punctual, their simultaneity is evidence of stimuli reaching the body at that point-instant. But there's more information: the spatial information in perspectival space, the number of luminescent dots perceived, that they are some distance apart in the visual field, that they are ordered in the visual field in some manner, some above or below others, some to the right or left. Since by assumption they are connected to separable causal-lines (which preserve structure along the way) this suggests the objects from which they originate are some unclear distance apart, are the same in number and in some relative position to that point-instant where the subject is located, matching the spatial order in perspectival space in which they registered.

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absolute times in relativistic space-time. There's no privileged way of foliating a space-time into Cauchy surfaces (Cf. Gilmore, Costa and Calosi, 2016).

All of these inferences to the ever more distant causal sources subject to error introduced by intervening mediums.

Since Russell assumes continuity and laws of perspective, neighboring regions where a camera could have been placed will also have causal traces. If a camera had been there a contrast of information between the perspectives would have shown changes in the angle of inclination between the luminescent dots, with similar order, number and so on. The sort of contrasts that even the ancients used to apply the method of parallax, which measures small changes in angles of inclination from different perspectives, to measure ever more precise distances between astronomical objects. All of this is consistent with Russell's assumptions, but precision requires more and more data points.

Co-punctuality is the fundamental relation in his epistemology of physics, given that it is a relation which can exist between non-percepts, percepts and non-percepts and pure percepts. It is a known relation, in the sense that its nature is known. This suffices to single out physically relevant structures binded by that same or derivative relations (such as co-linearity) and together with some purely mathematical assumptions about events, suffices to construct space-time points and a space-time order out of these events. It is this relation that bridges the gap between perception and the physical world.

> A number of simultaneous percepts-e.g., the letters of a word we read at a glance- are to be regarded as "co-punctual" in the sense of our two preceding chapters. (AMt, p. 314)
>
> I hold, therefore, that two simultaneous percepts of one percipient have the relation of compresence out of which spatiotemporal order arises. It is almost irresistible to go a step further, and say that any two simultaneous perceived contents of a mind are compresent, so that all our conscious mental states are in our heads. (AMt, p. 385)

This relation is not just any old abstract relation, such that by the Newman argument the world can be shown to trivially be isomorphic to it, given cardinality constraints. Rather, it is a specific relation R, such that if percepts are R-related and are causally connected to their causes, where causal connection also involves R-relations throughout the causal line, then the structure of the causes will be isomorphic to the structure of the percepts, under R. Percepts and their relations are known:

> A "percept", considered as the epistemological basis of physics, must be a "datum". It must be something noticed. Obviously, therefore, whatever may be true of percepts in general, those which afford empirical premises for physics have to be "known". But it is unnecessary for us to define "knowing": for physics, only the percepts are important, and our relation to them may be taken for granted. (AMt, p. 257)
>
> Part of this knowledge is obtainable by analysis of percepts, part depends upon inferences involving unperceived entities. 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. There is also, I should say, a perceived relation of simultaneity. (AMt, p. 278)

The relation of co-punctuality works well as a metaphysical glue between the non-perceptual and the perceptual, as well as throughout the physical world. It is a distinguished mereo-topological relation: it is specific, since it is the same relation that is perceived directly holding between groups of percepts; it involves overlap, thus it can link percepts with causal sources via the co-linearity (through causal lines) allowing for the singling out of casual time-like geodesics: a proper subset of which connect mental structures (people), with non-mental structures e.g., stars, mountains, tables and chairs.

6.2 Physics and Perception

Russell devotes chapter VIII of *The Analysis of Matter* entirely to the concept of geodesic. A geodesic is typically defined as a function from the real numbers to a set of connected points in a differential manifold. Differential manifolds, which are mathematical structures used to represent space-time, have topological structure and metrical structure, such that the properties of continuity and distance can be defined in them. Russell's main interest in discussing geodesics is not so much the function, but the image of it, the path in the manifold. Every causal path in a relativistic manifold is time-like and constrained to the interior region of the light-cones of any space-time event it intersects: at any point in a relativistic space-time there's a light-cone structure that divides events between those that are time-like, space-like and light-like. Time-like paths are the paths any material object must take since none can travel faster than light. Causal lines, in Russell's philosophy of physics (AMt, p. 314) are just time-like paths that preserve, through every overlapping link in the chain, distinguished physical structure[39]. Particles are in effect nothing but geodesics, four-dimensional biographies, which preserve structures relevant to physics via simple laws[40].

> Geodesics are geometrical, but they are also the path of material particles. It is hardly correct to say that a particle moves in a geodesic; it is more correct to say that a particle is a geodesic (thought not all geodesics are particles). (AMt, p. 313)

> The substitution of space-time for space and time has made it much more natural than formerly to conceive a piece of matter as a group of events. Physics starts, nowadays, with a fourdimensional manifold of events, not, as formerly, from a temporal series of threedimensional

[39] "Thus the string of events constituting one material unit is distinguished from others by the existence of an intrinsic causal law, though this law is only differential." (AMt, p. 246)

[40] On simplicity and the fact that we are lucky to live in a world where physical laws are simples, for otherwise science would be impossible see the chapter The Belief in General Laws, in AMt (p. 229).

> manifolds, connected to each other by the conception of matter in motion. Instead of a permanent piece of matter, we have now the conception of a world-line, which is a series of events connected with each other in a certain way. (AMt, p 244)[41]

Indeed, Russell regards knowledge by perception as impossible without assuming semiseparable causal chains:

> Knowledge of the physical world would be impossible without semi-independent causal chains. (AMt, p. 314)

There's textual evidence that Russell was partly swayed by the conventionalist spirit of the time with regards to the structure of the physical world (though agnostic til the end). This comes out specifically during his discussion of the Eddington-Whitehead debate (AMt, pp. 76-79) regarding whether the metric of spacetime, as well as its curvature, were conventional elements adopted for the sake of expediency or actual features of space-time[42].

> It is not quite clear why the man who uses forces with a conventional geometry should be regarded as making a "mistake", while the man who says that free particles travel in geodesics, and to justify himself has a queer geometry, is thought to be saying something substantially more accurate. (AMt, p. 76)

While he is agnostic about that debate Russell is convinced that the topological structure of the world, its order-type, is a real feature of it and not conventionally imposed. Co-punctuality then can link space-time events, regardless of whether the metric of space-time is fundamental or conventional, since the topology is physically real and the continuity relations require only topological structure. It's an objective, worldly relation in Russell's metaphysics.

> Certain relations of order among the coordinates represent properties of the points of space-time, and are presupposed in the assignment of coordinates. The accurate statement of what is involved can only be made in terms of limits, but the correct meaning is conveyed by saying that neighbouring points must have neighbouring coordinates. The exact nature of the ordinal presuppositions of a relativistic coordinate system will occupy us in a later chapter; for the present I merely wish to emphasize that the space-time manifold, in the general theory of relativity, has an order which is not arbitrary, and which is reproduced in any legitimate coordinate system. This order, it is important to realize, is purely ordinal, and does not involve any metrical element. (AMt, p. 56)

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[41] Indeed, I have argued in my "Contradictions in Motion" (2017, co-authored with Emiliano Boccardi), that Russell in this book introduces a new four-dimensional theory of motion, which takes the place of his former at-at theory. This against Calosi and Fano (2014), who were under the impression that they were introducing this theory to the literature.

[42] Incidentally, it is not clear given this passage why Demopoulos and Friedman (1989, p. 183) charge Russell with being uninterested in the issue of conventionalism. Perhaps they simply mean in connection to Reichenbach's (1927) work on this, which isn't discussed by Russell.

As mentioned earlier, there are no subjects in the basic ontology of *The Analysis of Matter*. At this stage Russell has given up the distinction between subject and object in his epistemology. Acquaintance is not an epistemic primitive for Russell in AMt, instead co-punctuality is meant to do that work. That's partly one of the promises of neutral monism[43], the possibility of getting rid of the old ontology of psycho-physical dualism and the epistemology that came with it. Unfortunately, the way matter and mind are meant to emerge from the fundamental neutral ontology in Russell's metaphysics is rather sketchy, as pointed out for example by Lockwood (1989). But some key ingredients are the thesis that "matter" and "mind" are really names for types of structures: it relates to what a structure can do.

The events that enter into mental or material structures are neutral events, they are neither material nor mental, but can be members of both types of structure, depending on which arrangements they are elements of. An event is a percept or a non-percept, merely as a result of which structure it is a member of. It can be both a percept and a physical event (a member of a material structure), since it can overlap both types of structures (by being a member of both): this overlapping is none other than co-punctuality. A mind is nothing other than a brain: it is a set of events which are members of several co-punctual mental structures, but they are also members of several co-punctual physical structures. They are seen to be members of either structure when their roles as nodes in causal networks are considered in terms of what these types of structures, mental or material, do. For a subject S to be acquainted with some datum D about the physical world is nothing over and above there being a structure of percepts, including D, which is co-punctual with both memories (the subject S) and a causal-line beginning in a physical object, the latter being also a set of co-linear space-time events of which D is also a member, where co-linearity is the transitive closure of co-punctuality:

> We do not know much about the contents of any part of the world except our own heads; our knowledge of other regions, as we have seen, is wholly abstract. But we know our percepts, thoughts and feelings in a more intimate fashion. (AMt, p. 319)

The fundamental argument for identification here is this: given the presumed causal proximity between what is perceived and the immediate surrounding physical events, in accurate perception, we are led to regard these as involving the same causal line and therefore as spatiotemporally connected. Hence, by theoretical economy, the last link in the chain, a percept, will be identified as a brain event. The events in the mental structures are identical to those in the physical structures. There is no substance dualism, only types of arrangements.

> Whoever accepts the causal theory of perception is compelled to conclude that percepts are in our heads, for they come at the end of a casual chain of physical events leading, spatially from the object to the brain of the percipient. We cannot suppose that, at the end of this

[43] The thesis that mind and matter are arrangements (structures) of underlying neutral stuff, not terms for fundamental substances. For more on the metaphysics of neutral monism see: Russell, 1927; Lockwood, 1989; Tully, 2003; Landini, 2010 and Wishon, 2015.

> process, the last effect suddenly jumps back to the starting point, like a stretched rope where it snaps. (AMt, p. 320)

If all of that is true, then it is the co-punctuality between non-percepts, percepts and non-percepts and pure percepts, which links these arrangements throughout the physical world (e.g., a physical event partially overlapping the surface of the body that's registered by this sensory surface), from material objects through causal lines, to minds. Given the inference that a person's mind and brain can be regarded as the same set of events, but considered under different arrangements, the assumption that perceived co-punctuality is the same as non-perceived co-punctuality (they are the same relation), since they have the same formal features, is eminently natural. But of course it is one of a host of very substantial assumptions Russell has in AMt about the physical world and our epistemic access to it. This is a relation he keeps in HK, while in the most explicit manner he explains its use in his epistemology in a manner which echoes his earlier response to Newman so directly there can be no reasonable doubt that it is put forward with that problem in mind, as we'll see in the next section.

The relation of compresence, and its generalization to four-dimensional manifolds "co-punctuality", maintains a key constructivist role in Russell's logical construction of space-time events. It also underlies the notion of causal line and its geometric counterpart, the geodesic. It manifests perceptually as sensory overlap of memories, sounds, visual input, sensory input and so on. Structural knowledge of the physical world is, immediately, of co-punctual structures of stimuli in the sensory surfaces and structures of stimuli under relations that are derived from co-punctuality (co-linearity, co-superficiality) and through structural-similarity in separable causal-lines, mediately of distant causal sources and related co-punctual (co-superficial, co-linear) structures.

Russell's 1928 response to Newman should therefore be taken at face value: he considered the objection obvious and moreover his most serious mistake was formulating his thesis carelessly. *The Analysis of Matter* already had all the resources he cited to Newman, connected in the right ways, to vindicate his Structural Realism in that book as a substantive thesis.

To summarize, my aim in this section was to explain how d. - g., crucial to Russell's response to Newman, can be accounted for in Russell's philosophy, as well as giving textual evidence that he had all those elements already in AMt. Given that d. - g. require an account of co-punctuality, its role in connecting perception and the physical world plus showing that Russell regards the relation as having basis in mind-independent reality (for his structuralist view is realist), I sought to give textual evidence for those points. As for illustrating his realist Russell's assumptions vis a vis co-punctuality, I argued that, according to him, it is a plausible assumption that the world has aleph nought events of finite spatiotemporal volume, that it has an order-type and that causal lines can be interpreted as co-linear (transitive closure of co-punctuality) classes of points. These are all realist assumptions about the causal profile of co-punctuality.

7. Russell Never Abandoned Structural Realism

7.1 Interpretation, Logical Construction and Partial Structural Realism

As we saw in Section 3, the charge has been laid against Russell that, after Newman's objection, he gave up structural realism and never returned to address the problem brought up by Newman. This section and the following aim to respond to these charges. The textual evidence indicates that these two claims are false. Not only did Russell not give up structural realism, he also explicitly addressed Newman's objection in HK, his last major philosophical work as discussed in the next section. Russell's view, as I've argued above, was actually never intended to be a form of pure structural realism. His concern was always with physics as an empirical science. For this reason I will argue that his partial structural realism is still a structuralist position. He never gave up his structuralist leanings. Indeed early on in AMt he says:

> The evidence for the truth of physics is that perceptions occur as the laws of physics would lead us to expect e.g., we see an eclipse when the astronomers say there will be an eclipse. But physics itself never says anything about perceptions; it does not say that we shall see an eclipse, but says something about the sun and moon. The passage from what physics asserts to the expected perception is left vague and casual; it has none of the mathematical precision belonging to physics itself. We must therefore find an interpretation of physics which gives a due place to perceptions; if not, we have no right to appeal to the empirical evidence. (AMt, p. 7)

His concern in outlining the project in *The Analysis of Matter* is to address the problem of in what sense physics is an empirical science. The issue of how to interpret the mathematical primitives in physics is foremost in his mind, in line with his methodology. The business of philosophical analysis is to formulate explicitly the premises of science: its principles and primitives and then reconceptualize it in terms of them.

Seeking an interpretation of physics as an empirical science enables him to reject out of hand any interpretation of the formalism in terms of any abstract domain, since these are not the important interpretations. Important interpretations must be carried out making use of empirical material i.e., interpreting the primitives of physics in terms of elements of the empirical world. This dispenses with interpretations in terms of abstract ontologies. The lesson from Newman however, is that even an ontology of physical objects doesn't suffice to fix the important interpretation. For that we need the metaphysical glue afforded by co-punctuality.

Indeed, the concern with interpretation is a recurring concern from Russell since his work in OKEW (1914) and RSDP (1917), through AMt (p. 2) until *Human Knowledge*. In HK Russell mentions that the problem of the applicability of mathematics to the physical world has been neglected by philosophers, in spite of the fact that there's a wide gulf between the formal precision of mathematical structures and the vagueness of the sensible material. It is the fact that, regardless of any unknown intrinsic qualities in the materials of the empirical world,

mathematical logic can manufacture structures out of these, which underpins much of Russell's structural realism.

Given his method of analysis, Russell's minimum vocabularies for empirical science must be such that not only are the formalisms interpreted in terms of physical objects. The principles of physics, considered as an applied science, must make explicit the connection between perception and the physical world. Moreover, the aim of interpretation is the preservation of structure with less dubious inferences. It is an essential ingredient in Russell's brand of structural realism.

> The question of interpretation is of importance for almost every philosophy, and I am not at all inclined to deny that many scientific results require interpretation before they can be fitted into a coherent philosophy. The maxim of 'constructions versus inferences' is itself a maxim of interpretation. But I think that any valid kind of interpretation ought to leave the detail unchanged, though it may give a new meaning to fundamental ideas. In practice, this means that structure must be preserved. (L&K, p. 340)

Russell's maxim of scientific philosophy is that whenever the ontology of a theory appears to involve neat logical properties, we must always seek an interpretation where that ontology is substituted by logical constructions. In the context of the interpretation of physics, what this means is that both spacetime and spacetime points should be regarded as artifacts.

Indeed, Russell considers three interpretations of space and time: phenomenal space and time, physical spacetime and spacetime as an artifact in physics. Spacetime as an artifact is part of our physical theory, a means to represent and predict empirical reality. It makes contact with actual spacetime via perception through causal lines and the relation of co-punctuality, but still has many artifactual elements such as coordinates. However as long as there's a plenum of events, in Russell's sense, as well as some objective ordinal relations between them, it will be possible to manufacture both spacetime points and spacetime order out of them using only mathematical logic. In *Logical Atomism* (1924) he writes:

> One very important heuristic maxim which Dr. Whitehead and I found, by experience, to be applicable in mathematical logic, and have since applied in various other fields, is a form of Ockham's razor. When some set of supposed entities has neat logical properties, it turns out, in a great many instances, that the supposed entities can be replaced by purely logical structures composed of entities which have not such neat properties. In that case, in interpreting a body of propositions hitherto believed to be about the supposed entities, we can substitute the logical structures without altering any of the detail of the body of propositions in question. (L&K, p. 326)

As mentioned above, percepts in Russell's metaphysics and their relations are known. While they exist within perceptual space they are also spacetime events, located in physical

spacetime. Co-punctuality (generalized compresence) is the same relation within unperceived spacetime events and perceived events and bridges the gap between them. Moreover Russell believes that this relation, together with his structural postulates, suffices to construct the ontology and structures of science. Furthermore all these notions, with slight changes in terminology (e.g., complete complex of compresence instead of maximal co-punctual series) are retained in *Human Knowledge*.

This might be partial structural realism, as discussed (and characterized) in section 4, but if successful, it still does most of its work with the barest minimum of resources. It recognizes that the world has non-trivial structure but our knowledge of it reduces to its mathematical properties plus a known relation. This is not a position that collapses into either scientific realism or antirealism and preserves the structuralist spirit of humility with regards our knowledge of the physical world's entities and most of its properties and relations.

7.2 Russell Revisited the Newman Objection in *Human Knowledge* (1948): A Key Piece of Evidence

In this subsection my aim is to respond specifically to the charge, discussed in Section 3, that Russell never returned in his later philosophy to address this problem. There seems to be a consensus that Russell retained many of the elements of his AMt philosophy in later work, but without ever properly revisiting Newman's point or clarifying points of departure from his earlier views.

The most salient differences between HK and AMt are that, in the former work a comprehensive overview of Russell's philosophy is discussed with regards metaphysics of science, language, mind and matter, whereas the latter work is solely focused on philosophy of physics. HK is concerned with making all structural assumptions Russell has as explicit as possible. I believe that this is in response to Newman's objection, not so much because the objection was devastating. It never was. Rather, it was because it made Russell aware of the importance of being explicit in order to be able to state his views precisely, so as to avoid any suspicion of trivialization. Indeed, Russell discusses the problem explicitly in HK, twenty years later:

> *Now of every class of c entities we can assert every kind of geometry* in which there is a one–one correspondence between a position and a finite ordered set of real numbers (coordinates). *Therefore to specify the geometry of a manifold tells us nothing unless the ordering relation is given.* Since physics is intended to give empirical truth, the ordering relation must not be a purely logical one, such as might be constructed in pure mathematics, but must be a relation defined in terms derived from experience. *If the ordering relation is derived from experience, the statement that space–time has such-and-such a geometry is one having a substantial empirical content, but if not, not.* (HK, p. 328. My emphasis)

This passage is undoubtedly a direct reference to Newman's objection. If the claim is only that there's some abstract structure R, such that the geometrical structure of the world with respect

to R is C, then any structure can be imposed upon the world as long as it has the right cardinality. That is what Russell means when he says that we can assert every kind of geometry for every class of c entities (where c is the cardinal number of the class), unless the ordering relation is given. That the relation must be a given one is a nod to Newman's objection. But then he immediately says that the relation must be given in experience, if claims about the structure of space-time are to have content. It's clear that he is seeking to be very explicit as to his claims in order to be able to assert something contentful. Assertions about the nature of the physical world will be contentful only if the ordering relation is given in experience.

That he has Newman's objection in mind is further confirmed by the following passage, which follows directly after the one just discussed.

> *I suggest that the ordering relation is contiguity or compresence*, in the sense in which we know these in sensible experience. Something must be said about these. Contiguity is a property given in sight and touch. Two portions of the visual field are contiguous if their apparent distances and their angular coordinates (up-and-down, right-and-left) differ very little. Two parts of my body are contiguous if the qualities by which I locate a touch in the two parts differ very little. Contiguity is quantitative, and therefore enables us to make a series of percepts. -- In this way, by means of spatial and temporal contiguity, our experiences can be arranged in an ordered manifold. We may assume that this ordered manifold is a part of the ordered manifold of physical events, and is *ordered by the same relation*.
>
> *For my part, however, I prefer the relation of "compresence"*. If we use this relation, we suppose that every event occupies a finite amount of space–time, that is to say, no event is confined to a point of space or an instant of time. *Two events are said to be "compresent" when they overlap in space–time; this is the definition for abstract physics. But we need, as we saw, a definition derived from experience.* —- All these percepts, recollections and expectations are happening to me now; I shall say that they are mutually compresent. *I assume that this relation, which I know in my own experience, can also hold between events that are not experienced, and can be the relation from which space-time order is constructed*. This will have as a consequence that two events are compresent when they overlap in space-time, which, *if space-time order is taken as already determined*, may serve, within physics, as the definition of compresence. (HK, p. 329-330. My emphasis)

It is remarkable that Russell here explicitly claims many of the most important theses I connected earlier to defend the view that his position in AMt was never trivialized by Newman. Theses such as an assumed structure of space-time order, plus a perceptually known relation of compresence or co-punctuality, bridging the perceptual and non-perceptual domains out of which space-time order is constructed by logical methods. The exact same response he gave to Newman in 1928, except far more developed and explicitly formulated.

As mentioned earlier, compresence simply is the general name of the relation of event-overlap Russell has in mind. Co-punctuality is simply the specific form compresence takes for events of spatio-temporal radius r, necessary to construct points for a four-dimensional manifold. Indeed, Russell makes it clear in HK that he is still satisfied with the discussion of how to construct points out of events that he undertook in AMt (HK, p. 281)[44]. Newman, while in Russell's mind, isn't mentioned here as bringing forth a powerful objection, because it was a possibility Russell was aware of since his early days as a logician. As argued above, he just failed to make the connection between his general result about correlations and this specific application.

HK is a substantive contribution to philosophy which aims to synthesize Russell's late philosophies of matter, mind and language in one book. It is also a work aimed at explicitness with regards to stating all the structural commitments Russell needs to support scientific non-demonstrative inference. His postulates of separability of causal lines, spatio-temporal continuity, quasi-permanence and common causal origin make explicit what was often spelled out obscurely in some corners of AMt. The intent surely to avoid obvious mistakes such as the one pointed by Newman. The argument moreover for these postulates, which aren't known to be true, is straightforwardly Russellian, as they are obtained via regressive analysis. It is that they make scientific knowledge possible, just as long as such structures do hold in reality. But as to this Russell had said in AMt decades earlier that:

> Science must continue to postulate laws, since it is coextensive with the domain of natural law. But it need not assume that there are laws everywhere; it need only assume what is evident since it's a tautology, that there are laws wherever there is science. (AMt, p. 237)

8. Concluding Remarks

In this work I have aimed at defending theses **I-IV** laid down in the introduction. I consider that the textual support for **I-IV** is very strong, moreover placing Russell's assumptions in the context of his method as well as his metaphysics of neutral monism allow us to see how his response works in a more fine grained manner. Therefore I conclude that Russell's position in AMt was never trivialized by Newman, indeed it never was a form of pure structural realism. I also conclude that there's clear evidence that this was also the explicit gist of his proposal in HK, that he addresses Newman's objection explicitly in that work and never gave up structural realism.

Most interestingly, I conclude that his structural realism is structural realism enough, as its presuppositions with regards known primitives are still remarkably thin. Russell's structural realism salvages the notion that there is a mind-independent world and structural claims about that world are true in virtue of physical structure, but still leaves room for epistemic humility about the qualitative properties of events not overlapping minds and physical relations between

[44] Thomas Mormann (2009) and David Bostock (2010) have pointed out some shortcomings in Russell's general construction of space-time points out of events. Both agree however, that with some modifications it is possible to achieve Russell's intended constructions. Since this is in principle possible and the specifics of the formal construction do not affect Russell's main argument I overlook those details here.

these other than co-punctuality. It does not collapse into either scientific realism or scientific anti-realism.

I believe for these reasons that, while many contemporary philosophers of science find it useful to look at Russell's structuralism as history, their examinations have so far remained at a surface level. Russell's view doesn't belong in a distinguished museum of anachronistic takes, it is alive and well. The physics and formal resources just require a bit of updating and maybe some group theory.[45]

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