Brit. J. Phil. Sci. **60** (2009), 135–171

Newman's Objection

Peter M. Ainsworth

ABSTRACT

This paper is a review of work on Newman's objection to epistemic structural realism (ESR). In Section 2, a brief statement of ESR is provided. In Section 3, Newman's objection and its recent variants are outlined. In Section 4, two responses that argue that the objection can be evaded by abandoning the Ramsey-sentence approach to ESR are considered. In Section 5, three responses that have been put forward specifically to rescue the Ramsey-sentence approach to ESR from the modern versions of the objection are discussed. Finally, in Section 6, three responses are considered that are neutral with respect to one's approach to ESR and all argue (in different ways) that the objection can be evaded by introducing the notion that some relations/structures are privileged over others. It is concluded that none of these suggestions is an adequate response to Newman's objection, which therefore remains a serious problem for ESRists.

doi:10.1093/bjps/axn051

Advance Access published on January 19, 2009

1 Introduction

The first fully elaborated statement of epistemic structural realism (ESR) can be found in the work of Russell ([1912], [1927]) (although Worrall [1989], [1994] argues that the doctrine can also be found in the writings of Duhem [1906] and Poincaré [1903]); Russell himself abandoned the position in the face of Newman's objection (Newman [1928]). The doctrine was revived four decades later by Maxwell ([1968], [1970a], [1970b]), who both coined the term 'structural realism' and introduced the Ramsey-sentence approach to the doctrine, which is adopted by most contemporary ESRists.

Demopoulos and Friedman ([1985]) and Ketland ([2004]) have put forward variants of Newman's objection aimed at the Ramsey-sentence approach to ESR and numerous authors (Cruse [2005]; French and Ladyman [2003]; Melia and Saatsi [2006]; Psillos [1999]; Redhead [2001]; Votsis [2003], [2004]; Zahar [2001], [2004]) have suggested a variety of ways in which one might attempt to evade the objection.

This paper consists of five main sections. In Section 2, a brief statement of ESR is provided. In Section 3, Newman's objection and its recent variants are outlined. In Section 4, two responses that argue that the objection can be evaded by abandoning the Ramsey-sentence approach to ESR are considered. In Section 5, three responses that have been put forward specifically to rescue the Ramsey-sentence approach to ESR from the modern versions of the objection are discussed. Finally, in Section 6, three responses are considered that are neutral with respect to one's approach to ESR and all argue (in different ways) that the objection can be evaded by introducing the notion that some relations/structures are privileged over others. It is concluded that none of these suggestions is an adequate response to Newman's objection.

2 Epistemic Structural Realism

The ESRist upholds two main theses. On the one hand there is the 'realist' thesis:

> Mature scientific theories provide us with a substantial amount of knowledge about both the observable and the unobservable world.[1]

[1] The qualification 'mature' is important: the ESRist, like the conventional realist, does not commit himself to realism with respect to all scientific theories. Moreover, the 'knowledge' that science is supposed to provide is taken to include claims that are not strictly true, but only approximately true. Spelling out what maturity and approximate truth are may not be easy (although Worrall [1989] has argued that it is straightforward to explicate maturity: he suggests that a theory is mature if and only if it correctly predicts an empirically confirmed result that it was not engineered to yield) but these issues will be held in abeyance throughout this paper.

On the other hand there is the 'structuralist' thesis, which, as a *very rough* first approximation, we may state as follows:

> All we know of the unobservable world is its structure.

2.1 Ramsey-sentences and ESR

From a formal point of view, languages are built out of two types of term:[2] logical terms and non-logical terms. In a language of second-order logic these two groups consist of the following:

[1] Logical terms:

(i) logical connectives ('¬', '&', etc.)

(ii) quantifiers ('∀', '∃')

(iii) individual and predicate variables ($x_1, x_2, \ldots$ and $X_1, X_2, \ldots$)

and possibly:

(iv) the identity predicate (' = ')

[2] Non-logical terms:

(i) a number of names ($a_1, a_2, \ldots$) denoting objects

(ii) a number of predicates ($P_1, P_2, \ldots$) denoting properties and relations.

The claim that 'all we know of the external world is its structure' might suggest that the ESRist thinks that our knowledge of the external world is purely structural (that it consists of only logical terms). Despite the way they sometimes talk, this is not a view held by any serious contemporary ESRist, but it is a view sometimes imputed to ESRists by their critics.

The Ramsey-sentence approach to ESR was first proposed by Maxwell ([1968]) and is adopted by most (but not all) modern ESRists. Let an observational term be a non-logical term that refers to an observable object, property, or relation and a theoretical term be a non-logical term that refers to an unobservable object, property, or relation. The Ramsey-sentence of a theory is obtained from a sentence expressing the theory by first replacing the theoretical terms (names and predicates) in the sentence with new variables (using the same variable for each occurrence of the same term, and different variables

[2] Sometimes logicians use the word 'term' as a synonym for 'name'. Throughout this paper it is used in a broader sense, as explicated here.

for different terms). The resulting formula is then turned into a sentence (the theory's Ramsey-sentence) by binding the variables with the appropriate existential quantifiers (placed at the start of the formula, so that every occurrence of the same new variable is in the scope of the same quantifier). Note that, in general (as long as the original sentence contains at least one theoretical predicate) constructing the Ramsey-sentence of a theory will require a language of second-order logic.[3]

Maxwell provides an example (Maxwell [1970a], p. 186). Consider the 'theory' expressed by the sentence:

$$\forall x([Ax\&Dx] \rightarrow \exists yCy),$$

where 'A' and 'D' are 'theoretical' predicates such that 'Ax' means 'x is a radium atom' and 'Dx' means 'x radioactively decays', and 'C' is an 'observational' predicate such that 'Cx' means 'x is a click in a suitably located Geiger counter'.[4] Its Ramsey-sentence is:

$$\exists X \exists Y \forall x([Xx\&Yx] \rightarrow \exists yCy).$$

The ESRist (if he takes the Ramsey-sentence approach to ESR), elaborates his structuralist thesis as follows:

> A theory's Ramsey-sentence is as much as a theory reliably tells us about the world.

Notice that, when it is elaborated this way, the ESRist's structuralist thesis has the following corollary:

> The knowledge provided by our mature scientific theories consists (in its ultimate form) of statements constructed using only logical and observational terms.

This corollary is a claim the instrumentalist would also endorse. ESR remains distinct from instrumentalism because the instrumentalist claims that our theories provide knowledge only about the observable world, whereas the ESRist maintains that the Ramsey-sentences of our theories provide knowledge about both the observable world and about the structure of the unobservable world.

[3] Zahar ([2001], p. 236) points out that we can construct an equivalent sentence using a first-order language that contains the predicates 'being a set' and '∈'. However, we would of course have to leave these unRamseyfied, and it is hard to see what justification there could be for that, unless one was prepared to take them as logical predicates, like ' = '.

[4] Of course this doesn't express any real 'theory' and is, moreover, false: if a radium atom decays on Mars, there will not be a click in a suitably located Geiger counter, because there will not be a suitably located Geiger counter, but it will suffice to give the general idea.

At first sight, it may seem that as Ramsey-sentences are constructions formed using only logical and observational terms, they could not tell us anything about the unobservable world. This is certainly not true. As van Fraassen ([1980], p. 54) notes, the claim that 'there are entities that are not O_1 and not O_2 and …', where each O_i is an observational predicate and the sentence ascribes to the entities it refers to the negation of every O_i in the language, successfully makes the claim that there are unobservables (which is a claim about the unobservable world) using only logical and observational vocabulary. (However, the essential claim of Newman's objection is that Ramsey-sentences can't tell us anything *substantial* about the unobservable world.)

Given that ESR has been explicated in terms of Ramsey-sentences, one may wonder if ESR is any more 'structural' than conventional scientific realism: after all, the Ramseyfied version of a sentence is no more closely linked to the structures that satisfy it than is the original sentence. However, although there isn't any particularly intimate relation between structural realism and structures (in the set-theoretic sense) the term 'structural' is not totally inappropriate: the ESRist maintains that theoretical predicates (and the sets that provide the extensional interpretation of these predicates) should not be given an intensional interpretation, but should be treated purely extensionally, i.e. treated in a purely mathematical or 'structural' way.

2.2 WESR and SESR

ESR can be subdivided into two doctrines: weak ESR (WESR) and strong ESR (SESR) (as they will be called in this paper). SESR presupposes a particular metaphysical and epistemological doctrine called 'indirect realism'. This is the view that although the external world exists, we do not have direct access to it. It implies that there is a distinction between the 'internal world' of our own consciousnesses, to which we have direct access, and the external world, to which we do not (this internal/external distinction is sometimes called the phenomenal/noumenal distinction or the mental/physical distinction).

It is important to separate the internal/external distinction from the observable/unobservable distinction. Within the indirect realist framework the observable/unobservable distinction may be *roughly* characterized as a distinction between those external objects, properties, and relations (e.g. tables, redness[5]) that have a direct counterpart in internal experience and those external objects, properties and, relations (e.g. quarks, strangeness) that do not. Because the phrase 'direct counterpart' is so vague this characterization does

[5] In fact, the indirect realist might say that we need to distinguish two 'redness' predicates: one that refers to the redness of internal objects (sense-data) and another that refers to the redness of external (physical) objects.

not succeed in unambiguously drawing the intended distinction, but hopefully the general idea is clear enough.

The essential difference between WESR and SESR is that while the WESRist thinks that theoretical terms (i.e. terms referring to unobservable objects, properties, and relations) need to be Ramseyfied (leaving Ramsey-sentences containing only logical and observational terms), the SESRist thinks that external terms (i.e. terms referring to external objects, properties, and relations) need to be Ramseyfied (leaving Ramsey-sentences containing only logical and internal terms). The version of ESR outlined in the previous section is thus WESR. The SESRist's structuralist thesis can still be stated as:

> A theory's Ramsey-sentence is as much as a theory reliably tells us about the world.

But because of his different approach to Ramseyfication, the SESRist's structuralist thesis has a somewhat different corollary, viz:

> The knowledge provided to us by our mature scientific theories consists (in its ultimate form) of statements constructed using only logical and internal terms.

In fact, although the example of Ramseyfication that was given in the previous section is Maxwell's own and it suggests WESR, he himself was a SESRist. He makes this quite clear when he states that 'My own view [. . .] is that all items should be considered theoretical [meaning that terms referring to them should be Ramseyfied] unless they occur in direct experience; since I reject any form of direct realism, this means that the observable [meaning the things referred to by terms that do not need to be Ramseyfied] is instantiated only in inner events of observers' (Maxwell [1970a], p. 181).

On the face of it, however, Ramseyfying all terms except those that refer to items of internal experience will result in the Ramsey-sentences of most (if not all) theories being purely formal, and thus entirely devoid of empirical content, because, on the face of it, most (if not all) theories do not deal with items of internal experience at all. Take for example the toy theory given above. Clicks in suitably placed Geiger counters are not items of internal experience, so (taking the SESRist line) the predicates referring to them should also be Ramseyfied away, leading to the following Ramsey-sentence for the theory:

$$\exists X \exists Y \exists Z \forall x([Xx \& Yx] \rightarrow \exists y Zy),$$

which is purely formal, and therefore has no empirical content.

The proponent of SESR can avoid this unwelcome conclusion by arguing that although most theories, in themselves, are not directly about internal experience, they are nonetheless connected with internal experience by auxiliary theories, which are always implicitly held. For example, we implicitly hold that we will have an experience of a sense-data Geiger counter click only if, (i) there is a (real) Geiger counter click, (ii) we are hallucinating Geiger counter clicks, (iii) we are dreaming about Geiger counter clicks, (iv) somebody is playing a practical joke, ... alongside the theory:

$$\forall x([Ax\&Dx] \rightarrow \exists yCy);$$

we would thus also hold:

$$\exists x(C^*x \,\&\, Eax) \rightarrow (\exists y[Cy] \vee Ha \ldots),$$

where a is a constant referring to oneself, 'C^*x' means 'x is a sense-data Geiger counter click', 'Exy' means 'x experiences y', 'Cx' means the same as before and 'Hx' means 'x is hallucinating Geiger counter clicks'. The combined theory we hold is thus expressed by the sentence:

$$\forall x([Ax \,\&\, Dx] \rightarrow \exists yCy) \,\&\, (\exists x[C^*x \,\&\, Eax] \rightarrow [\exists y(Cy) \vee Ha \ldots]).$$

Taking the SESRist approach to Ramseyfication, one obtains something like the following Ramsey-sentence of the combined theory:

$$\exists W\exists X\exists Y\exists Z \ldots \forall x([Wx \,\&\, Xx] \rightarrow \exists yYy) \,\&\, (\exists x[C^*x \,\&\, Eax] \rightarrow [\exists yYy \vee Za \ldots]),$$

which does contain some non-logical terms ('C^*', 'E' and 'a') and thus does not fail to make an empirical claim for lack of them.

3 The Objection

3.1 Newman's version

Newman ([1928]) takes Russell's ESR to imply that the most that we can know about the external world is its structure. He ascribes this view to Russell on the basis of passages like the following (which Newman quotes in [1928], p. 144): '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' (Russell [1927], p. 254), 'The only legitimate attitude about the physical world seems to be one of complete agnosticism as regards all but its mathematical properties' (Russell [1927], p. 270). Newman then launches the following objection to this view:

> Any collection of things can be organised so as to have the structure W [where W is an arbitrary structure], 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, original emphasis)

For example, being told that a system has domain $D = \{a, b, c\}$ (where a, b, and c are arbitrary names for three distinct but unspecified objects) and instantiates a relation $R = \{\langle a, b\rangle, \langle a, c\rangle, \langle b, c\rangle\}$ tells us no more than that the system consists of three objects, because some elementary set-theory reveals that any three objects instantiate seven non-empty one-place relations, 511 non-empty two-place relations (of which R is one) and 134,217,727 non-empty three-place relations.[6] Being told that they instantiate R is both trivial (insofar as it follows from some elementary set-theory) and perversely specific (insofar as R is just one of the 134,218,245 non-empty relations they instantiate). Thus being told that the system has structure $\langle D, R\rangle$ is being told no more than that it contains three objects, because any system containing three objects can be taken to have this structure, along with a vast number of other structures (any tuple whose first member is D and whose other members are amongst the 134,218,245 relations instantiated by the members of D is a structure that can be taken to be possessed by any system containing three objects).

The objection arises because our purely structural knowledge gives us only extensional information about the structure of the system: if we had an intensional interpretation of R, we would not have this problem. For instance, if we knew that R was the 'heavier than' relation (restricted to the system) then we would have some more useful information: we would know that the three objects in the system were of unequal weights. However, the claim that we have any such intensional information about the external world is exactly what Newman thinks that Russell denies.

Newman considers two possible responses to this objection. The first is to distinguish 'real' relations from 'fictional' relations and assume that when the Russellian tells us what relations hold in a system he is talking only about real relations. A fictional relation is defined as 'one whose only property is that it holds between the objects that it does hold between' (Newman [1927], p. 145). By this Newman does not mean to call real only those relations that have interesting formal properties (such as reflexivity, transitivity etc.) because the Russellian would presumably not wish to ignore all relations that lack interesting formal properties (for example, all one-place relations lack interesting formal properties, but the Russellian would presumably not wish to ignore all one-place relations). Rather he means that real relations are those that are the extensions of intensionally interpreted predicates. At first it seems that the problem here is that all relations are fictional for Russell, because, according to Newman, he denies that our knowledge claims about the external world involve any intensionally interpreted predicates (except perhaps equality). However,

[6] A set of n objects has $2^n - 1$ non-empty subsets. n objects can be arranged into a set of n.n distinct pairs, which has $2^{n.n} - 1$ non-empty subsets. n objects can be arranged into a set of n.n.n triples, which has $2^{n.n.n} - 1$ non-empty subsets.

Newman claims that the problem is just the opposite, i.e. that all relations are real, because, having named the objects in the domain, each relation will be the extension of some intensionally interpreted predicate. In the above case, for example, R is the extension of the relation that holds between x and y just in case (x = a and y = b) or (x = a and y = c) or (x = b and y = c).

This leads Newman to consider a second possible response, which is to distinguish between 'important' and 'trivial' relations and assume that when the Russellian tells us what relations hold in a system he is talking only about important relations. Newman dismisses this response as follows:

> we should have to compare the importance of relations of which nothing is known save their incidence (the same for all of them) in a certain aggregate. For this comparison there is no possible criterion, so that 'importance' would have to be reckoned among the prime unanalysable qualities of the constituents of the world, which is, I think, absurd. (Newman [1928], p. 147)

Although Newman thought that this response was absurd, a number of philosophers have put forward variants of it. These will be discussed in Section 6.

However, isn't there a much more obvious response to Newman: hasn't he misunderstood the position he attacks? Newman imputes to Russell something like the following claim:

> Our knowledge of the world is purely structural (i.e. it consists of claims constructed using only logical terms).

However, it may be that Russell actually held only the following (weaker) view:

> Our knowledge of the world consists of claims constructed using only logical and internal terms.

It is true that the passages of Russell that Newman quotes seem to suggest he would go along with the former (stronger) of these claims, but elsewhere Russell is quite explicitly committed to the view that we know how external objects are connected with internal experience, which he allows us to legitimately describe with non-logical terms. For example, Russell says that 'My knowledge of the table is of the kind which we shall call "knowledge by description". The table is "the physical object which causes such-and-such sense-data"'. (Russell [1912], p. 26). This seems to imply that he held only the latter (weaker) claim. If we understand Russell this way then it seems that Newman has misunderstood his position.

However, Russell did not respond to Newman this way (Russell's response is discussed in passing in Section 5.2, as it relates to Cruse's [2005] response). It is difficult to believe that Russell just missed such an obvious rejoinder. Perhaps the reason he did not offer it is that he could see that although Newman's objection, as Newman states it, is not strictly speaking to the point, nonetheless Newman's line of thinking does lead one to the conclusion that ESR is not significantly distinct from standard antirealism. This point has been made by Demopoulos and Friedman ([1985]) and Ketland ([2004]) with respect to the Ramsey-sentence approach to ESR and is discussed in the next subsection.

3.2 Demopoulos and Friedman's and Ketland's versions

Demopoulos and Friedman (anachronistically) impute to Russell a form of the Ramsey-sentence approach to ESR (Demopoulos and Friedman [1985], p. 622) whereby the knowledge a scientific theory provides is expressed by the Ramsey-sentence of that theory, which will contain non-logical terms that refer to either internal objects, properties, and relations (for the SESRist) or observable objects, properties, and relations (for the WESRist) but will in either case not be purely structural. They claim (although without substantial argument) that if 'our theory is consistent, and if all its purely observational consequences are true, then the truth of the Ramsey-sentence *follows* as a theorem of set theory or second-order logic, provided our initial domain has the right cardinality' (Demopoulos and Friedman [1985], p. 635, original emphasis). Although Demopoulos and Friedman do not really back up this claim, Ketland ([2004]) does provide a strong argument for (a slight variant of) the claim.

To understand Ketland's argument we must distinguish between intended and arbitrary interpretations of a language. An intended interpretation is a function from the non-logical terms of the language to the objects, properties, and relations in a structure that respects the intended meanings of the non-logical terms. For example, under its intended interpretation, the name 'Julius Caesar' is assigned the person Julius Caesar. Similarly, under its intended interpretation, the predicate 'larger than' is assigned the set of pairs $\langle x, y \rangle$ such that x is larger than y. An arbitrary interpretation does not respect intended meanings in this way. In an arbitrary interpretation, the name 'Julius Caesar' might be assigned any arbitrary object and the predicate 'larger than' might be assigned any arbitrary set of pairs.

Ketland assumes that we have a two-sorted second-order language. A two-sorted language (see, for example, Enderton [2001], pp. 295–6) has two types of individual variables that range over two different domains. Many-sorted languages are harmless in the sense that they can be reduced to standard one-sorted languages without loss (except of convenience) (see Enderton [2001], pp. 296–9). In this case the two domains (in the intended interpretation of the language) are observable objects and unobservable objects.

The language is also assumed to have three types of predicates: observational predicates, which (in the intended interpretation of the language) refer to observable properties and relations (which Ketland takes to be sets [of tuples] of observable objects), theoretical predicates, which (in the intended interpretation of the language) refer to unobservable properties and relations (which Ketland takes to be sets [of tuples] of unobservable objects) and mixed predicates, which (in the intended interpretation of the language) refer to mixed relations (which Ketland defines as sets of tuples such that each tuple contains at least one observable object and at least one unobservable object).[7]

Let $\langle D_O, O_1, O_2, \ldots \rangle$ be the structure associated with the intended interpretation of the observational part of the language, i.e. let D_O be the set of observable objects in the world and let O_1, O_2 etc. be (the sets corresponding to) the observable properties and relations referred to by the observational predicates of the language.

We can now define what it means for an arbitrary structure for the language, $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ to be empirically correct ($\langle D_1, D_2\rangle$ is an arbitrary two-sorted domain, each $R_{1.i}$ is an arbitrary interpretation of an observational predicate over D_1 (i.e. a subset of D_1 or a subset of $D_1 \times D_1$ etc.), each $R_{3.i}$ is an arbitrary interpretation a theoretical predicate over D_2 (i.e. a subset of D_2 or a subset of $D_2 \times D_2$ etc.) and each $R_{2.i}$ is an arbitrary interpretation of a mixed predicate over $D_1 \cup D_2$ (i.e. a subset of $D_1 \times D_2$ or a subset of $D_2 \times D_1$ etc.)). We do this as follows:

> Definition 1: $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is *empirically correct* if and only if its reduct $\langle D_1, R_{1.1}, R_{1.2}, \ldots\rangle$ is isomorphic to $\langle D_O, O_1, O_2, \ldots\rangle$. (cf. Ketland's 'Definition E' [2004], p. 296)

In other words, a structure is empirically correct if and only if the appropriate reduct of the structure is isomorphic to the structure of the observable world (relative to some choice of predicates). This definition of empirical correctness is in line with van Fraassen's ([1980]) notion of empirical adequacy: van Fraassen says that 'a theory is empirically adequate exactly if [...] [it] has at least one model that all the phenomena fit inside' (van Fraassen [1980], p. 12). We will

[7] Ketland himself notes that the characterization of observable (etc.) properties and relations as sets (of tuples) of observable (etc.) objects has some counter-intuitive consequences. In particular he notes that 'many scientifically significant relations and quantities (e.g. various space–time relations and quantities, various scientific quantities such as mass, length, duration, location, etc.) will "decompose" into three strangely distinct relations, depending on the observational status of their relata' (Ketland [2004], p. 289, footnote 5). Cruse ([2005]) argues that the ESRist (or at least the WESRist) can respond to Ketland's version of Newman's objection by denying that this is an accurate characterization of the observable/unobservable distinction that he wishes to draw. This response is discussed in Section 5.2.

return to the issue of how this definition of empirical correctness compares with other notions of empirical correctness (or adequacy) later. Let's assume that the Ramsey-sentence of a theory in this language is obtained by Ramseyfying away the mixed and theoretical predicates that appear in the theory (cf. Ketland [2004], p. 292). It follows that:

> Theorem 1: The Ramsey-sentence of a theory A is true if and only if there is some sequence of relations $R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots$ such that $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle \models A$ (cf. Ketland's 'Theorem 4' [2004], p. 293)

where D_T is the set of unobservable objects in the world. (Ketland gives a proof of this result; this has been omitted, as the result itself seems intuitively obvious.) We need one more definition:

> Definition 2: $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is *T-cardinality correct* if and only if $|D_2| = |D_T|$. (cf. Ketland's 'Definition G' [2004], p. 298)

and we can then prove:

> Theorem 2: The Ramsey-sentence of a theory A is true if and only if A has a model that is empirically correct and T-cardinality correct. (cf. Ketland's 'Theorem 6' [2004], p. 298)

The proof is in two steps:

> [1] Left-to-right: Suppose the Ramsey-sentence of A is true. Then, by Theorem 1, there is some sequence of relations $R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots$ such that $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle \models A$, i.e. $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is a model of A. Clearly, $\langle D_O, O_1, O_2, \ldots\rangle$ is isomorphic to $\langle D_O, O_1, O_2, \ldots\rangle$, so $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is empirically correct (by Definition 1). Equally clearly, $|D_T| = |D_T|$, so $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is T-cardinality correct (by Definition 2).

> [2] Right-to-left: Suppose A has a model, $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$, that is empirically correct and T-cardinality correct. As $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is empirically correct, $\langle D_1, R_{1.1}, R_{1.2}, \ldots\rangle$ is isomorphic to $\langle D_O, O_1, O_2, \ldots\rangle$, i.e. there is a bijection, $f: D_1 \to D_O$, such that, for every $R_{1.i}$ and every *n*-tuple, $\langle x_1, x_2, \ldots, x_n\rangle$, of elements of D_1:
>
> $$\langle x_1, x_2, \ldots, x_n\rangle \in R_{1.i} \text{ if and only if } \langle f(x_1), f(x_2), \ldots, f(x_n)\rangle \in O_i.$$
>
> As $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is T-cardinality correct, $|D_2| = |D_T|$, i.e. there is a bijection, $g: D_2 \to D_T$. We can use f and g to define a new function, $f^*g: \langle D_1, D_2\rangle \to \langle D_O, D_T\rangle$, such that $f^*g(x) = f(x)$

if $x \in D_1$ and $f^*g(x) = g(x)$ if $x \in D_2$ and we can use f^*g to define new relations such that, for every $R_{2.i}$ and every $R_{3.i}$:

(i) $R'_{2.i} =_{df} \{\langle f^*g(x_1), f^*g(x_2), \ldots, f^*g(x_n)\rangle : \langle x_1, x_2, \ldots, x_n\rangle \in R_{2.i}\}$.

(ii) $R'_{3.i} =_{df} \{\langle f^*g(x_1), f^*g(x_2), \ldots, f^*g(x_n)\rangle : \langle x_1, x_2, \ldots, x_n\rangle \in R_{3.i}\}$.

By the construction of the $R'_{2.i}$s and $R'_{3.i}$s, f^*g is an isomorphism between $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ and $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R'_{2.1}, R'_{2.2}, \ldots, R'_{3.1}, R'_{3.2}, \ldots\rangle$. We know that $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle \models A$, so $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R'_{2.1}, R'_{2.2}, \ldots, R'_{3.1}, R'_{3.2}, \ldots\rangle \models A$. So by theorem 1, the Ramsey-sentence of A is true.[8] ■

How does Ketland's result compare to Demopoulos and Friedman's claim that if 'our theory is consistent, and if all its purely observational consequences are true, then the truth of the Ramsey-sentence *follows* as a theorem of set theory or second-order logic, provided our initial domain has the right cardinality' (Demopoulos and Friedman [1985], p. 635, original emphasis)? Ketland notes that his result is, strictly speaking, weaker, because it is in principle possible that all a theory's purely observational consequences could be true whilst it might not have an empirically correct model but not vice versa. (An observational consequence here is assumed to be any statement formed using only observational predicates and logical terms, excluding predicate variables. Observational consequences in this sense are thus assumed to include empirical generalizations. Zahar's reply to the modern version of the objection is based on the claim that this is inappropriate; this is discussed in Section 5.1).

It is not easy to give an example that demonstrates how all a theory's purely observational consequences could be true whilst it might not have an empirically correct model, but Ketland gives an example that demonstrates how something analogous can occur in number theory. Say that a model is 'arithmetically correct' if and only if it has a reduct isomorphic to the standard natural number structure. Say that a theory has true 'arithmetical consequences' if and only if all the consequences of the theory that are stated in the language of arithmetic are satisfied in the standard natural number structure. Let L be the language of arithmetic, and let L_T be the language of arithmetic extended by a monadic predicate symbol, T (which is intended to behave like a truth predicate). Now consider the theory FS*: this contains the axioms of Peano arithmetic and certain axioms concerning the predicate T (these are axioms that, intuitively

[8] As a referee pointed out, this proof assumes that we are dealing with a full (standard) second-order model (i.e. a model in which the second-order quantifiers range over all the relations on the domain[s]). If we were dealing with a non-full (Henkin) model then there would be no guarantee that the relations that are defined in the proof would be in the scope of the second-order quantifiers, so the proof would not go through.

speaking, a truth predicate should satisfy) (see Halbach [1999], pp. 368–9). It can be shown that, (i) if M is a model of FS* then M does not have a reduct isomorphic to the standard natural number structure, so FS* does not have a model that is arithmetically correct, but nonetheless, (ii) every consequence of FS* that does not involve T is true in the standard natural number structure, so FS* has only true arithmetical consequences. (For more on this see Ketland [2004], pp. 295–8).

However, despite the fact that Ketland's result is strictly speaking weaker than the one Demopoulos and Friedman claim, the difference appears to be immaterial: Ketland's result still suggests that ESR is not significantly distinct from antirealism. As noted, Ketland's notion of empirical correctness formalizes van Fraassen's notion of empirical adequacy. Since van Fraassen argues that it is rational to believe that our mature theories are empirically adequate (but not necessarily true) Ketland's result shows that what the knowledge that a theory's Ramsey-sentence is (approximately) true would amount to, beyond what van Fraassen's antirealism allows, would be (at most) only knowledge of the cardinality of the unobservable world. Thus ESR (in its Ramsey-sentence form) is just van Fraassen's antirealism, augmented by the peculiar claim that we can (perhaps) know the cardinality of the unobservable world.[9]

4 Replies that Abandon the Ramsey-Sentence Approach to ESR

In this section, two arguments that claim that Newman's objection can be evaded if one abandons the Ramsey-sentence approach to ESR are discussed. On the face of it, this appears to be a strange line to take, because although Demopoulos and Friedman's and Ketland's versions of the objection are directed at the Ramsey-sentence approach to ESR, Newman's original version of the objection is not. This first impression remains on closer inspection of these arguments.

4.1 Redhead's reply

Redhead ([2001]) argues that the Ramsey-sentence approach to ESR is indeed undermined by Newman's objection, commenting that 'the Ramsey sentence $\exists R(S[R])$, asserting the existence of a relation R which has structure S, is in fact a logical truth, modulo the specification of the cardinality of the domain over which the relation is defined' (Redhead [2001], pp. 345–6). This is false: the Ramsey-sentence of a theory is not satisfied by every model of the right

[9] The qualifications 'at most' and 'perhaps' appear here because knowing that a theory's Ramsey-sentence is true doesn't guarantee that we know the cardinality of the unobservable world, it only guarantees that we know that the theory has *some* model with the right cardinality (and the theory might have models of different cardinalities).

cardinality, so the Ramsey-sentence is not, 'a logical truth, modulo the specification of the cardinality of the domain' (on the most obvious reading of this expression). For example, consider the 'theory' expressed by the sentence $\exists w \exists x ([w \neq x] \& \forall y [(y = w) \vee (y = x)]) \& \forall z(Pz)$ (which says that there are two things, and that everything is P). Its Ramsey-sentence is $\exists X[\exists w \exists x ([w \neq x] \& \forall y [(y = w) \vee (y = x)]) \& \forall z(Xz)]$ (assuming P needs to be Ramseyfied). This is satisfied by the structure $\langle\{1, 2\}, \{1, 2\}\rangle$ but not by every structure with two elements in its domain. For example, it is not satisfied by the structure $\langle\{1, 2\}, \{1\}\rangle$. Hence it is not 'a logical truth, modulo the specification of the cardinality of the domain'. What (Ketland's version of) Newman's objection actually shows is that *if the theory has an empirically correct model* then the theory's Ramsey-sentence is bound to be satisfied by *some* structure (instantiated by the world) as long as the world contains an appropriate number of (unobservable) things.

Redhead puts forward an alternative approach to ESR, which, he claims, avoids Newman's objection. He describes this alternative approach as follows:

> We need not deny that there are real physical relations posited by physical theories [. . .] Thus S(R), where R refers to a specific relation having the structure S, is of course logically stronger than the Ramsey sentence, and is by no means a logical truth. But this means [. . .] that the reference of R must be picked out in non-structural terms. But this is not denied in the above account. Our claim is merely that R is hypothesised in some explanatory theoretical context so it exists as an ontological posit, but all that we have epistemic warrant for is the second-order structure S. (Redhead [2001], p. 346).

Redhead appears to suggest that the Ramsey-sentence approach to ESR denies that there are real physical relations posited by physical theories. This is also false. The Ramsey-sentence approach does claim (roughly speaking) that all we know about (some of) these relations is structural, and this is (roughly speaking) why Newman's objection operates against it. But this is a claim that Redhead apparently endorses. The point of Newman's objection is (roughly speaking) that if all we know is that there is *some* (real) relation R (of which we have only structural knowledge) then we know nothing more than a cardinality constraint on the domain over which the relation is defined.

On the other hand, in parts of the above quote Redhead seems to suggest that we can specify the relation R intensionally. If he does think this then he appears to have abandoned ESR, and it is hard to see how he can maintain the claim that we have only structural knowledge of R.

Perhaps the most charitable reading of Redhead's position would be to substitute the word 'important' or 'natural' for the words 'real' and 'specific' in the above quote. This would lead us back to Newman's own 'absurd' response to his objection (variants of which are discussed in Section 6). However, it is doubtful that this is really what Redhead intended. Neither 'natural' nor 'important' means the same as 'real', much less is either synonymous with 'specific'. Moreover, there seems to be no reason why taking this line forces one to abandon the Ramsey-sentence approach (as will be seen when this approach is discussed in Section 6).

4.2 French and Ladyman's reply

French and Ladyman ([2003]) appear to suggest that Newman's objection does not arise if one adopts the semantic view of theories (whereby a theory is taken to be a collection of structures) as opposed to the syntactic view (whereby a theory is taken to be a collection of sentences):

> Worrall's approach is thoroughly embedded in the so-called syntactic view of theories that adopts first-order quantificational logic as the appropriate form for the representation of physical theories. [Footnote omitted] We will not rehearse our reasons here, but we consider this approach to be deeply flawed, not only because of its inadequacy in reflecting scientific practice, but also because of the pseudo-problems that arise once one has adopted it. So for example, the Newman problem is obviated if one does not think of structures and relations in first-order extensional terms. One of us (Ladyman [1998]) has suggested an alternative descriptive framework for SR [structural realism], namely the 'semantic' or model theoretic approach to theories. (French and Ladyman [2003], p. 33)

On the face of it, it seems highly unlikely that moving to the semantic view would really allow the ESRist to evade Newman's objection. In fact, Newman's original version of the objection is posed against the view that scientific theories directly specify a structure that represents the world. It is true that Demopoulos and Friedman ([1985]) and Ketland ([2004]) aim their objections at the Ramsey-sentence approach, which does assume that science presents us with a linguistic representation of the world. However, it is easy to show that an analogue of their objections applies to a version of ESR framed using the semantic view.

Framed in terms of the semantic view, ESR would imply something like the following limitation on our knowledge:

> The most that we can know about the world is that some structure (provided by our scientific theories) is empirically correct and isomorphic to a structure instantiated by the world.

Let $\langle D_O, O_1, O_2, \ldots \rangle$ be the structure instantiated by the observable world (relative to some chosen observational predicates): i.e. let D_O be the set of observable objects in the world and let O_1, O_2 etc. be the intended extensions of observational predicates. Let a theory present us with a structure, $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$, where D_1 is a domain that is to represent the set of observable objects, D_2 is a domain that is to represent the set of unobservable objects, each $R_{1.i}$ is to represent an observable relation (where an observable relation is taken to be a set of [tuples of] observable objects), each $R_{2.i}$ is to represent a mixed relation (where a mixed relation is taken to be a set of tuples that each contain at least one observable object and at least one unobservable object) and each $R_{3.i}$ is to represent an unobservable relation (where an unobservable relation is taken to be a set of (tuples of) unobservable objects). Define such a structure to be empirically correct as before:

> Definition 1: $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is *empirically correct* if and only if its reduct $\langle D_1, R_{1.1}, R_{1.2}, \ldots\rangle$ is isomorphic to $\langle D_O, O_1, O_2, \ldots\rangle$. (cf. Ketland's 'Definition E' [2004], p. 296)

Let D_T be the set of unobservable objects in the world. Define $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ to be T-cardinality correct as before:

> Definition 2: $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is *T-cardinality correct* if and only if $|D_2| = |D_T|$. (cf. Ketland's 'Definition G' [2004], p. 298)

We can now prove that:

> Theorem 3: $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is empirically correct and isomorphic to a structure instantiated by the world if and only if it is empirically correct and T-cardinality correct.

The proof comes in two stages:

> [1] Left to right: Suppose $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is empirically correct and isomorphic to a structure instantiated by the world. That is, $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is isomorphic to a structure of the form, $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R'_{2.1}, R'_{2.2}, \ldots, R'_{3.1}, R'_{3.2}, \ldots\rangle$, where O_1, O_2 etc. are the intended extensions of observational predicates. By stipulation it is empirically correct. And clearly, $|D_2| = |D_T|$, i.e. $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is T-cardinality correct.
>
> [2] Right to left: Suppose $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is empirically correct and T-cardinality correct. By stipulation it is empirically correct. As $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is empirically correct there is some isomorphism between $\langle D_1, R_{1.1}, R_{1.2}, \ldots\rangle$ and $\langle D_O, O_1, O_2, \ldots\rangle$. That is, there is a bijection $f: D_1 \to D_O$, such that, for every $R_{1.i}$ and every *n*-tuple, $\langle x_1, x_2, \ldots, x_n\rangle$, of elements of D_1:
>
> $$\langle x_1, x_2, \ldots, x_n\rangle \in R_{1.i} \text{ if and only if } \langle f(x_1), f(x_2), \ldots, f(x_n)\rangle \in O_i.$$

As $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ is T-cardinality correct there is some bijection, $g: D_2 \rightarrow D_T$. We can use these functions to define a new function, $f^*g: \langle D_1, D_2\rangle \rightarrow \langle D_O, D_T\rangle$ such that $f^*g(x) = f(x)$ if $x \in D_1$ and $f^*g(x) = g(x)$ if $x \in D_2$ and we can use f^*g to define new relations such that, for every $R_{2.i}$ and every $R_{3.i}$:

(i) $R'_{2.i} =_{df} \{\langle f^*g(x_1), f^*g(x_2), \ldots, f^*g(x_n)\rangle : \langle x_1, x_2, \ldots, x_n\rangle \in R_{2.i}\}$.

(ii) $R'_{3.i} =_{df} \{\langle f^*g(x_1), f^*g(x_2), \ldots, f^*g(x_n)\rangle : \langle x_1, x_2, \ldots, x_n\rangle \in R_{3.i}\}$.

By the construction of the $R'_{2.i}$s and $R'_{3.i}$s, f^*g is an isomorphism between $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ and $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R'_{2.1}, R'_{2.2}, \ldots, R'_{3.1}, R'_{3.2}, \ldots\rangle$. $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R'_{2.1}, R'_{2.2}, \ldots, R'_{3.1}, R'_{3.2}, \ldots\rangle$ is a structure instantiated by the world: we know that O_1, O_2 etc. are the intended extensions of observational predicates and each $R'_{2.i}$ is an arbitrary mixed relation that is obviously instantiated by the world (all its tuples are built from objects in the set $D_O \cup D_T$, i.e. the set of objects in the world) and similarly, each $R'_{3.i}$ is an arbitrary unobservable relation that is obviously instantiated by the world (all its tuples are built from objects in the set D_T, i.e. the set of unobservable objects in the world).[10] ■

Theorem 3 states that the semantic view formulation of ESR (i.e. the claim that the most that we can know about the world is that some structure—provided by our scientific theories—is empirically adequate and isomorphic to a structure instantiated by the world) is equivalent to the claim that the most that we can know about the world is that some structure (provided by our scientific theories), $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$, is empirically correct and T-cardinality correct, so Theorem 3 provides a Newman-esque reductio of the semantic view formulation of ESR. It is true that there is a slight difference between the ESRist who works with the semantic view and the ESRist who works with the syntactic view/Ramsey-sentence approach (because the latter's claim is equivalent to the even less optimistic view that the most we can know about the world is that one of the—possibly many—structures that satisfy a given theory is empirically correct and T-cardinality correct) but this difference does not appear to be very significant. (The difference arises because the proponent of the semantic view—at least as he has been characterized here—thinks that the theory specifies a unique structure, whereas the proponent of the syntactic view thinks that a theory is a sentence that picks out only a family of structures, all of which satisfy the sentence).

[10] It may be objected that the $R'_{2.i}$s and the $R'_{3.i}$s, presumably unlike the O_is, may not correspond to any natural relations; this again leads to essentially Newman's own 'absurd' response to his objection (variants of which are discussed in Section 6).

5 Replies Designed to Rescue the Ramsey-Sentence Approach

In this section, three replies that are designed to save the Ramsey-sentence approach to ESR from the modern versions of Newman's objection are considered.

5.1 Zahar's reply

Zahar ([2001], Appendix 4, co-written with John Worrall; [2004]) takes issue with Demopoulos and Friedman's version of Newman's objection, which he characterizes as the claim that it is 'only what the Ramsey-sentence asserts *over and above its observational content* [that] is reducible to [...] a cardinality constraint' (Zahar [2004], p. 10, original emphasis). Zahar goes on to say that:

> This 'over and above' however proves to be essentially indefinable; for on the one hand, the Ramsey-sentence does not normally follow from its empirical basis, i.e. from the set of true and empirically decidable, hence *singular* sentences. If, on the other hand, all the—generally undecidable—'empirical generalisations' were included in the observational content of a theory, then the Ramsey-sentence might well turn out to be one of them; in which case Demopoulos's and Friedman's thesis collapses into the trivial claim that the Ramsey-sentence follows from itself (Zahar [2004], p. 10, original emphasis).

Zahar's first 'hand' holds the proposition that only singular sentences form the observational content of a theory. He then demonstrates that Ramsey-sentences can go beyond such observational content. He asks us (Zahar [2004], p. 11) to consider a theory expressed by the sentence

$$A : \forall x(Fx \rightarrow Tx) \,\&\, \forall y(Ty \rightarrow Ky),$$

where F and K are observational predicates and T is a theoretical predicate. The Ramsey-sentence of this theory is

$$A^* : \exists X(\forall x[Fx \rightarrow Xx] \,\&\, \forall y[Xy \rightarrow Ky]),$$

which is equivalent to

$$\forall x(Fx \rightarrow Kx)$$

and this last sentence (and hence the equivalent A*) goes beyond any number of singular statements of the form

$$Fa_i \rightarrow Ka_i$$

in the sense that no matter how many statements of this form we have, there is always a model in which they are all true but in which the generalization

$\forall x(Fx \rightarrow Kx)$ (and hence the equivalent A*) is false. So there is a clear sense in which the Ramsey-sentence of the theory goes beyond (Zahar's understanding of) the observational content of the theory.

However, given Zahar's understanding of the observational content of a theory as consisting of the singular sentences (containing only observational terms) entailed by the theory, then not only do Ramsey-sentences typically go beyond observational content but, as Zahar's example clearly illustrates, universal generalizations that involve only observational predicates (i.e. 'empirical generalisations') also go beyond observational content. Even the antirealist would typically agree that we can know such generalizations to be true, so even the antirealist would agree that we can know more than the observational content of a theory, in Zahar's sense of observational content.[11] Unless the ESRist can demonstrate that Ramsey-sentences also go beyond empirical generalizations, he has failed to distinguish his position from antirealism. In fact, Zahar clearly states (in the above quote) that the Ramsey-sentence of a theory might often be (equivalent to) an empirical generalization. At this point he seems to concede to Demopoulos and Friedman even more than they ask for: they claim that ESR is antirealism plus a cardinality constraint, while Zahar seems to concede that ESR is (often) plain antirealism (because he claims that Ramsey-sentences are [often] equivalent to empirical generalizations, so the ESRists' claim that we can have knowledge of at most Ramsey-sentences is [often] equivalent to the antirealists' claim that we can have knowledge of at most empirical generalizations).

Nonetheless, Zahar denies that ESR is just antirealism. This denial seems to rest on an equivocation over the meaning of 'observational content'. Zahar claims that the difference between realists and antirealists is that the latter deny that we can have knowledge that goes beyond the observational content of a theory, which is true, but only if the observational content of a theory is taken to *include* empirical generalizations. He then demonstrates that the Ramsey-sentence of a theory goes beyond the observational content of a theory, where this is now taken to *exclude* empirical generalizations. Thus his conclusion that to know the Ramsey-sentence of a theory is to know more than the antirealist would allow does not follow.

[11] Typically, the antirealist would say that we can have knowledge of singular empirical statements and empirical generalizations (i.e. generalizations that do not involve theoretical terms or second-order variables) but would deny that we generally have knowledge of a theory's Ramsey-sentence (since, notwithstanding Zahar's example, a theory's Ramsey-sentence is not typically equivalent to an empirical generalization). (Although what Newman's objection purports to show is—roughly speaking—that knowing a theory's Ramsey-sentence to be true is knowing *very little* beyond knowing that the singular empirical statements and empirical generalizations that follow from the theory are true, so ESR collapses into a position not significantly distinct from antirealism.)

5.2 Cruse's reply

Cruse's ([2005]) reply is directed at Ketland's version of the objection. In particular, Cruse objects that not all ESRists need draw the observational term/theoretical term distinction in the way that Ketland suggests (and given a suitably different construal of the distinction, Ketland's proof of Theorem 2 would not go through). Recall that Ketland takes observational predicates to refer exclusively to sets of (tuples of) observable objects, theoretical predicates to refer exclusively to sets of (tuples of) unobservables objects and mixed predicates to refer to sets of tuples that each contain at least one observable and one unobservable object. As noted, Ketland acknowledges that this has some rather counter-intuitive consequences. Cruse emphasizes this point:

> consider the relation denoted by the predicate 'larger than'. On Ketland's taxonomy, there is no such single relation; there are three. First, there is the relation we might call *observably larger than*, which ranges entirely over observable objects. Second[,] there is the relation we might call *unobservably larger than*, which ranges entirely over unobservable objects. Third, there is the relation we might call *miscellaneously larger than*, which applies to all and only pairs of objects such that the first is observable, the second unobservable, and the first larger than the second.[12] On Ketland's terminology, only the first class of relations—those which range entirely over observable objects—count as observable [...] I will call this the *strong* version of the observational-theoretical (O/T) distinction. (Cruse [2005], p. 561, original emphasis, footnote added)

Cruse's reply is based on rejecting the strong observational term/theoretical term distinction.

Cruse notes that *some* ESRists do appear to be committed to this form of the observational term/theoretical term distinction or rather (as he puts it) 'something isomorphic to it' (Cruse [2005], p. 563). Translated into the terminology of this paper, he suggests that the internal term/external term distinction employed by SESRists (such as Russell) must take this form because 'the mental and physical domains are entirely disjoint, so no (non-mathematical) property which applies to a mental event applies to a physical event or vice versa. Similarly, no (non-mathematical) predicate which applies to a mental event will apply to a physical event' (Cruse [2005], p. 563).

In fact, in the face of Newman's objection, Russell decided that he was not committed to this form of the distinction. In a letter to Newman (reprinted in his autobiography [1968] and by Demopoulos and Friedman [1985]) he wrote:

[12] This is splitting hairs, but it seems that we could also have an unobservable object that was larger than an observable object if, for example, 'the universe' or 'the nearest black hole' qualifies as unobservable object.

> 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 spacio-temporal continuity with the world of percepts, that is to say, I had assumed that there might be co-punctuality between percepts and non-percepts [. . .] And co-punctuality I regarded as a relation which might exist among percepts and is itself perceptible. (Russell [1968], p. 176)

Russell is here putting forward the view that there is at least one non-logical predicate ('co-punctuality') that refers to a relation that can hold between (i) pairs of external objects, (ii) pairs consisting of one external object and one internal object (in either order), and (iii) pairs of internal objects. Russell's own reply to Newman is actually essentially the same as Cruse's reply to Ketland, which is perhaps surprising, as Cruse cites Russell as the sort of ESRist for whom this reply is not available.

There are good reasons to think that this sort of reply isn't available to Russell. As Demopoulos and Friedman ([1985]) point out, Russell's move is completely *ad hoc*:

> in the earlier theory [i.e. Russell's [1927] theory] we could not assume acquaintance with a cross category notion such as spacio-temporal contiguity or causality; but in the light of the difficulties of that theory we now find that we *can* assume this! [Footnote omitted] We are not saying that one *cannot* resolve the issue in this way. But it seems quite clear that without a considerable advance in the theoretical articulation of this rather elusive Russellian concept [i.e. acquaintance], no such resolution of the difficulty can be very compelling. (Demopoulos and Friedman [1985], p. 632, original emphasis)

I would go further: it seems that, given the supposedly radical difference between external and internal objects, it is very unlikely that the issue could be satisfactorily resolved this way. Moreover, if Russell makes this concession then he seems to be left at the top of a slippery slope: if we can assume that external objects can be 'co-punctual' with one another in the same way that internal objects sometimes are, why can't we assume that they can be 'bigger than' one another in the same way? It thus does seem (as Cruse suggests) that SESRists (such as Russell) are committed to an internal term/external term distinction of the form Ketland suggests (so they cannot evade the Newman/Ketland objection this way).

However, Cruse's main point (translated into the current idiom) is that the WESRist is not committed to anything like Ketland's form of the observational term/theoretical term distinction. He proposes an alternative form of the distinction according to which:

> observational predicates refer to, broadly speaking, perceptible, or observable properties such as redness or squareness. A natural understanding of this would be that these observable properties are unproblematic not because they are *always* observable, but simply because we can in *at least some* cases observe them (Cruse [2005], p. 565, original emphasis)

This is supposed to capture the intuition that 'we can meaningfully (and for a realist, truly) assert the existence of red blood cells, or microscopic square grids, for example' (Cruse [2005], p. 564); i.e. that observational predicates can be applied to unobservable objects. A natural interpretation of this suggestion (natural in the light of the foregoing discussion, at any rate) is that rather than taking an observational predicate to be one whose intended extension is a set consisting *only* of (tuples of) observable objects (as Ketland suggests), we are to take an observational predicate to be one whose intended extension is a set consisting of *at least some* (tuples of) observable objects. Theoretical predicates would then be those whose intended extension is a set consisting entirely of (tuples of) unobservable objects. However, interpreted this way, Cruse's suggestion is also deeply counter-intuitive, because it classes as observational a number of predicates that are, intuitively speaking, theoretical. It is true that 'being a superstring' is on this account a theoretical predicate, because no superstring is observable, but 'being a collection of superstrings' is observational, because it applies to some (in fact, if the theory is correct, all) observable objects. And it is (to say the least) counter-intuitive to classify 'being a collection of superstrings' as observational.

However, this is not the only possible interpretation of Cruse's suggestion. Like Ketland's original proposal, this interpretation of Cruse's proposal makes the assumption that either a predicate is observational if and only if its extension contains only (tuples of) observable objects or that a predicate is theoretical if and only if its extension contains only (tuples of) unobservable objects. But why make this assumption?

The assumption seems to rest on the idea that we can determine whether an object is observable or unobservable, but that we cannot (directly) determine whether a property or relation is observable or unobservable, so whether or not a property or relation is unobservable must be defined in terms of whether or not the objects to which it applies are. But this idea is surely wrong. Surely we know that *red* is an observable property as surely and directly as we know that *Jeff Ketland* is an observable object. And surely we know that *being a collection of superstrings* is an unobservable property as surely and directly as we know that *the nearest black hole* is an unobservable object. It is true that there are some properties and relations that we might hesitate to class either way. But it is equally true that there are some objects that we might hesitate to class either way (small particles of dust, for example). So the idea that we must define the observability or unobservability of properties and relations in terms of the observability or unobservability of the objects to which they apply is at least questionable.

This suggests that the extensions of observational predicates can contain both observable and unobservable objects, *and* that the extensions of theoretical predicates can contain both observable and unobservable objects, depending on what the criteria of observability are. If the WESRist adopts an observational term/theoretical term distinction along these lines then it is true that Ketland's proof of Theorem 2 does not go through (Ketland's proof crucially assumes that observational predicates apply only to sets of [tuples of] observables, which is not the case with this characterization of the observational term/theoretical term distinction). The WESRist can thereby evade the conclusion that:

> Theorem 2: The Ramsey-sentence of a theory A is true if and only if A has a model which is empirically correct and T-cardinality correct. (cf. Ketland's 'Theorem 6' [2004], p. 298)

However, the WESRist would be well advised to leave the champagne on ice, if not in the cellar. Even using this more liberal characterization of the observational term/theoretical term distinction, we can still prove a theorem that casts doubt on the view that knowledge of a theory's Ramsey-sentence is the sort of knowledge that the WESRist wants to claim that we have.

We assume that we have a language containing a number of observational predicates (construed as above, so that they may apply to observable and unobservable objects) and a number of theoretical predicates (construed as above, so that they too may apply to observable and unobservable objects). The structure associated with the intended interpretation of the observational predicates is:

$$\langle D_A, O_1, O_2, \ldots \rangle,$$

where D_A is the domain of (observable and unobservable) objects in the world that instantiate some observable property or relation that is referred to by one of the observational predicates of the language and each O_i is the intended extension of an observational predicate of the language. Now, given a theory, A, the Ramsey-sentence of A is obtained by Ramseyfying away the theoretical predicates. As before, it is obvious that:

> Theorem 4: The Ramsey-sentence of a theory A is true if and only if there is some sequence of relations, $R_{2.1}, R_{2.2}, \ldots$ such that $\langle\langle D_A, D_B\rangle, O_1, O_2, \ldots, R_{2.1}, R_{2.2}, \ldots\rangle \vDash A$

where D_B is the domain of objects in the world that do not instantiate any observable property or relation that is referred to by one of the observational predicates of the language (depending on the choice of these predicates, D_B

may well be the empty set, e.g. if one of the observational predicates is 'larger than', D_B will presumably be empty as every object is surely on at least one side of this relation to at least one other object). We will say of an arbitrary structure for the language, $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots\rangle$, (where $\langle D_1, D_2\rangle$ is an arbitrary two-sorted domain, each $R_{1.i}$ is an arbitrary interpretation of an observational predicate over D_1, and each $R_{2.i}$ is an arbitrary interpretation of a theoretical predicate over $D_1 \cup D_2$) that:

> Definition 3: $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots\rangle$ *gets the extensions of the observational predicates right* if and only if its reduct $\langle D_1, R_{1.1}, R_{1.2}, \ldots\rangle$ is isomorphic to $\langle D_A, O_1, O_2, \ldots\rangle$

We will also say that:

> Definition 4: $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots\rangle$ is *B-cardinality correct* if and only if $|D_2| = |D_B|$.

It is easy to prove:

> Theorem 5: The Ramsey-sentence of a theory A is true if and only if A has a model which gets the extensions of the observational predicates right and which is B-cardinality correct.

The proof is in two steps:

> [1] Left-to-right: Suppose the Ramsey-sentence of A is true. Then, by Theorem 3, there is some sequence of relations $R_{2.1}, R_{2.2}, \ldots$ such that $\langle\langle D_A, D_B\rangle, O_1, O_2, \ldots, R_{2.1}, R_{2.2}, \ldots\rangle \models A$, i.e. $\langle\langle D_A, D_B\rangle, O_1, O_2, \ldots, R_{2.1}, R_{2.2}, \ldots\rangle$ is a model of A. Clearly, $\langle D_A, O_1, O_2, \ldots\rangle$ is isomorphic to $\langle D_A, O_1, O_2, \ldots\rangle$, so $\langle\langle D_A, D_B\rangle, O_1, O_2, \ldots, R_{2.1}, R_{2.2}, \ldots\rangle$ gets the extensions of the observational predicates right (by Definition 3). Equally clearly, $|D_B| = |D_B|$, i.e. $\langle\langle D_A, D_B\rangle, O_1, O_2, \ldots, R_{2.1}, R_{2.2}, \ldots\rangle$ is B-cardinality correct (by Definition 4).
>
> [2] Right-to-left: Suppose A has a model, $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots\rangle$, which gets the extensions of the observational predicates right and which is B-cardinality correct. As $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots\rangle$ gets the extensions of the observational predicates right, $\langle D_1, R_{1.1}, R_{1.2}, \ldots\rangle$ is isomorphic to $\langle D_A, O_1, O_2, \ldots\rangle$, i.e. there is a bijection $f: D_1 \rightarrow D_A$, such that, for every $R_{1.i}$ and every n-tuple, $\langle x_1, x_2, \ldots x_n\rangle$, of elements of D_1:
>
> $$\langle x_1, x_2, \ldots, x_n\rangle \in R_{1.i} \text{ if and only if } \langle f(x_1), f(x_2), \ldots, f(x_n)\rangle \in O_i.$$
>
> As $\langle\langle D_1, D_2\rangle, R_{1.i}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots\rangle$ is B-cardinality correct, there is a bijection $g: D_2 \rightarrow D_B$. We can use f and g to define a new function, $f^*g: \langle D_1, D_2\rangle \rightarrow \langle D_A, D_B\rangle$ such that $f^*g(x) = f(x)$ if $x \in D_1$ and $f^*g(x) = g(x)$

if $x \in D_2$ and we can use f^*g to define new relations such that, for every $R_{2.i}$:

$$R'_{2.i} =_{df} \{\langle f^*g(x_1), f^*g(x_2), \ldots, f^*g(x_n)\rangle : \langle x_1, x_2, \ldots, x_n\rangle \in R_{2.i}\}.$$

By the construction of the $R_{2.i}$'s, f^*g is an isomorphism between $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots\rangle$ and $\langle\langle D_A, D_B\rangle, O_1, O_2, \ldots, R'_{2.1}, R'_{2.2}, \ldots\rangle$. We know that $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots\rangle \models A$, so $\langle\langle D_A, D_B\rangle, O_1, O_2, \ldots, R'_{2.1}, R'_{2.2}, \ldots\rangle \models A$. So by Theorem 3, the Ramsey-sentence of A is true. ■

Theorem 5 implies that the Ramsey-sentence of a theory can tell us *something* substantial about the world, beyond what the antirealist typically allows: it tells us about the 'observable' properties and relations of the unobservable world. So ESR, construed on these lines, does represent a halfway house between realism and antirealism. However, it doesn't look like the house the ESRist claims to inhabit: the position implies that we have no non-trivial knowledge of unobservable properties and relations (and, in particular, no interesting 'structural' knowledge of such properties and relations). This implies that predicates such as 'strangeness' or 'being a collection of superstrings' serve only an instrumentalist function in our theories, which seems to be at odds with the traditional ESRist's claims.[13]

5.3 Melia and Saatsi's reply

Melia and Saatsi's ([2006]) response to Newman's objection is based on the observation that:

> The properties postulated in scientific theories are typically taken to stand in certain intensional relations to various other properties. Some properties *counterfactually depend* on others, some are *correlated in a law-like manner* with others, some are *independent* of others, and some are *explanatory* of others. (Melia and Saatsi [2006], pp. 579–80, original emphasis)

Melia and Saatsi point out that such relations between properties (i.e. second-order relations) cannot be expressed in standard second-order logic.[14] Moreover, they claim that if we formulate scientific theories and their Ramsey-sentences in a language that is capable of expressing such relations then Newman's objection will be blocked.

[13] Discussing whether or not this position was actually plausible would be tangential to the aims of this paper. It would also be a highly scholastic exercise, because it is not a position that anyone holds.

[14] The terminology could become confusing here. I call properties and relations *of* properties and relations second-order properties and relations. It is important to note that second-order logic is so called because it allows for quantification over sets of (tuples of) objects as well as objects and not because it accommodates second-order properties and relations in this sense.

As Melia and Saatsi note ([2006], p. 580) the obvious way to formulate such relations would be to introduce higher-order predicates into one's language. This is not the approach they ultimately favour, but let's consider this approach first. Consider a 'theory' that states that there is a click on a Geiger counter if and only if there is an atom in the vicinity of the Geiger counter that radioactively decays. We might attempt to formalize this theory as follows:

$$\exists x Cx \leftrightarrow \exists y(Ay \,\&\, Dy),$$

where 'A' and 'D' are 'theoretical' predicates such that 'Ax' means 'x is an atom in the vicinity of a Geiger counter' and 'Dx' means 'x radioactively decays' and 'C' is an 'observational' predicate such that 'Cx' means 'x is a click in a Geiger counter'. Melia and Saatsi would say that implicit in the theory is the claim that the correlation between Geiger counter clicks and radioactive decay is a lawful (as opposed to accidental) correlation. Consequently, they would argue that a more faithful formalization of the theory would be as follows:

$$(\exists x Cx \leftrightarrow \exists y[Ay \,\&\, Dy]) \,\&\, \mathbf{L}DC,$$

where **L** is a second-order predicate such that **L**XY means 'X is lawfully correlated with Y'. Consequently the Ramsey-sentence of the theory is not

$$\exists X \exists Y(\exists x Cx \leftrightarrow \exists y[Xy \,\&\, Yy]),$$

wnich would be contentless[15] but is rather:

$$\exists X \exists Y[(\exists x Cx \leftrightarrow \exists y[Xy \,\&\, Yy]) \,\&\, \mathbf{L}XC],$$

which is not so trivial: it states that *some* property has a lawful correlation with clicks on Geiger counters.

However, this assumes that the second-order predicate **L** does not need to be 'Ramseyfied'. If it does then we would obtain the following 'Ramsey-sentence':

$$\exists \mathbf{X} \exists X \exists Y[(\exists x Cx \leftrightarrow \exists y[Xy \,\&\, Yy]) \,\&\, \mathbf{X}XC],$$

which is, again, effectively contentless: it states that there is a click on a Geiger counter if and only if there is something that has two (not necessarily distinct) properties and that there is some (second-order) relation between one of these properties and clicks on Geiger counters. This is contentless because there is always *some* second-order relation between *any* two properties: given any two properties P and Q we can construct the second-order relation $\{\langle P, Q\rangle\}$ between them.

So this response is only viable if it is reasonable to suppose that second-order relations between properties like 'is lawfully correlated with' do not themselves

15 The Ramsey-sentence of this 'theory' (formalized this way) is completely contentless: it states that there is a click on a Geiger counter if and only if there is something that has two (not necessarily distinct) properties. This is utterly trivial since a click on a Geiger counter is something that has at least one and hence two (not necessarily distinct) properties.

need to be Ramseyfied. But this is surely not something the ESRist could consistently accept: 'lawful correlations' and their ilk are surely not observable, much less internal, relations.

As noted, Melia and Saatsi do not advocate the use of higher-order predicates to formalize the relations between properties. They suggest that we should instead augment the language with a number of modal operators that express the pertinent relations: 'So, for instance, let L_P express "it is physically necessary that...". Then $\exists X L_P \forall x(Xx \leftrightarrow Gx)$ says that there is a property that is *lawfully* coextensive with G.' (Melia and Saatsi [2006], p. 581). The claim is that scientific theories, and their Ramsey-sentences, would typically (perhaps invariably) include such modal operators. This sidesteps the problem that undermines the previous approach, because there can be no question of 'Ramseyfying' modal operators. This approach is, however, open to the objection that it requires us to take these modal operators as logical primitives and we surely cannot accept that modal operators expressing things like 'it is *physically* necessary that...' can be taken as *logical* primitives, since whether or not something happens as a matter of *physical* necessity is an issue that must be decided empirically, not as a matter of logic.

6 Replies that Argue that Some Structures/Relations are Privileged

In this section, three variants of Newman's own 'absurd' response to his objection are considered. This response is founded on the claim that some relations are more important than others. Newman took this response to be absurd because, as the ESRist believes, we have only structural knowledge of the relations in question, we lack a criterion to distinguish the important relations from the unimportant relations, so 'importance' must be left as an unanalyzed primitive, a mysterious quality that attaches to some relations but not to others. However, the idea of a primitive important/unimportant distinction (or something similar) has not appeared absurd to everyone. The proposal most similar to Newman's own was put forward by Carnap ([1967]) to resolve an analogue of Newman's problem that faces the theory he puts forward in the *Aufbau*. The adaptation of this proposal to resolve Newman's objection to ESR is discussed in Section 6.1. The other two variants of this approach discussed here both in some sense deny that 'importance' needs to be taken as primitive. Votsis' ([2003]; [2004], Chapter 4) proposal (discussed in Section 6.2) grounds the importance of a relation on the means by which it is discovered. Psillos' ([1999], Chapter 3) proposal (discussed in Section 6.3) takes the importance of a relation to be a contingent physical property of the relation. Psillos himself argues that taking the approach ultimately amounts to abandoning ESR. (Both Merrill [1980] and Lewis [1983] make suggestions similar to Psillos' in response to

Putnam's [1977] 'model-theoretic' argument against realism: an argument that is very closely related to Newman's objection to ESR).

6.1 A Carnapian reply

This reply has some similarities to Melia and Saatsi's ([2006]) reply (discussed in Section 5.3). The essence of the proposal is the suggestion that we should take importance (or as Carnap [1967] calls it, 'foundedness') as a primitive (second-order) logical property that attaches to some relations (in the way that identity is sometimes taken as a primitive logical relation that holds between some pairs). With a little adaptation of the Ramsey-sentence approach, this enables the proponent of ESR to evade Ketland's variant of the Newman objection. Let the symbol for the foundedness property be '**Found**'. Instead of advocating belief in a theory's Ramsey-sentence, the ESRist who takes this approach should advocate belief in the theory's Ramsey-sentence*, where the latter is just like a normal Ramsey sentence, except that, for each predicate variable, X, we add (in the scope of the quantifier $\exists X$) the phrase '&**Found**(X)'. For example, consider the toy theory:

$$\forall x(O_1x \rightarrow T_1x) \ \& \ \forall y(T_2y \rightarrow O_2y),$$

where O_1 and O_2 are observational predicates and T_1 and T_2 are theoretical predicates. This theory yields the Ramsey-sentence

$$\exists X \exists Y(\forall x[O_1x \rightarrow Xx] \ \& \ \forall y[Yy \rightarrow O_2y])$$

and the Ramsey-sentence*

$$\exists X \exists Y(\forall x[O_1x \rightarrow Xx] \ \& \ \forall y[Yy \rightarrow O_2y] \ \& \ \mathbf{Found}[X] \ \& \ \mathbf{Found}[Y]).$$

As '**Found**' is taken as a logical primitive the Ramsey-sentence* contains only logical and observational terms. It is thus hygienic, by the WESRist's standards (in that the WESRist's claim does not imply that it is impossible to know the Ramsey-sentence*). However, if Ramsey-sentences are swapped for Ramsey-sentence*s then Ketland's argument no longer goes through. In particular, the relevant analogue of:

> Theorem 1: The Ramsey-sentence of a theory A is true if and only if there is some sequence of relations, $R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots$ such that $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle \models A$

is:

> Theorem 1′: The Ramsey-sentence* of a theory A is true if and only if there is some sequence of relations, $R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots$ such that $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle \models A$ *and such that each member of the sequence is a founded relation.*

This blocks Ketland's proof of Theorem 2 at the last step: although, given that a theory has some model $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ that is empirically correct and T-cardinality correct, we can construct a model of the theory of the form $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R'_{2.1}, R'_{2.2}, \ldots, R'_{3.1}, R'_{3.2}, \ldots\rangle$, this does not guarantee that the theory's Ramsey-sentence* is true, as there is no guarantee that the relations $R'_{2.1}, R'_{2.2}, \ldots$ we have constructed will be founded.

However, even Carnap does not have licence to invent logical predicates at whim; if we are to accept '**Found**' as a new logical term we surely must be given reasons to do so. Here is what Carnap says:

> [**Found**] does not belong to any definite extralogical domain, as all other nonlogical objects do. Our considerations concerning the characterisation of the basic relations of a constructional system as founded relation extensions of a certain kind hold for every constructional system of any domain whatever. It is perhaps permissible, because of this generality, to envisage the concept of foundedness as a concept of logic and to introduce it, since it is undefinable, as a *basic concept of logic*. (Carnap [1967], p. 237, original emphasis)

We *might*, just possibly, think that the following was plausible:

> If a property or relation is instantiated in every possible system then it is a logical property or relation.

However, if I understand him correctly, Carnap seems to assume something like the following:

> If a property or relation is instantiated in every possible constructional system then it is a logical property or relation.

The notion of a constructional system is central to Carnap's theory in the *Aufbau*, but it is not the case that every possible system is a possible constructional system, so it is hard to see why we should accept this assumption. Compare Carnap's assumption with the following assumption:

> If a property or relation is instantiated in every possible system whose domain contains human beings then it is a logical property or relation.

No one would accept this: it would lead to the conclusion that properties like 'being a human being' and 'being a mammal' are logical properties. So it seems we at least need an argument that shows that constructional systems are more important (founded, as it were) than systems whose domain contains human beings.

It is instructive to contrast foundedness with identity, a relation we might sensibly take to be logical. In the first place we can see that the identity relation will be instantiated by some pairs of objects from any possible non-empty domain; by contrast the foundedness property need not be instantiated by any relations from a given set of relations. In the second place, given a domain, we can determine the extension of the identity relation over that domain a priori; by contrast we cannot determine the extension of the foundedness relation over a set of (extensionally specified) relations a priori.

It seems that it is fair to say that taking the notion of the importance of a relation as a primitive logical notion *is* absurd and cannot form the basis of a reasonable response to Newman's objection.

6.2 Votsis' reply

Votsis claims that Newman's objection purports to show that 'the knowledge claims of SR [structural realism] [are] of little worth or importance' (Votsis [2003], p. 886) by showing that 'the information they offer can also be derived a priori from set theory modulo a cardinality constraint, hence the only important information contained in the structural realist claims concerns the cardinality of the domain' (Votsis [2003], p. 886).[16] He also claims that the inference from the latter to the former rests on the assumption that 'any information contained in a statement that is also derivable a priori lacks importance' (Votsis [2003], p. 886). Votsis takes issue with this assumption. There is a sense in which everyone will surely agree that this assumption is false. The statement that there is no largest prime is surely of some importance, at least in some contexts, but the claim is derivable a priori.

However, Votsis does not dispute the assumption that 'any information contained in a statement that is also derivable a priori lacks importance' by pointing out that there is a sense in which some results that are obtained a priori are important. Rather, he seems to make the extraordinary suggestion that *how* a claim is arrived at affects its importance. In particular, he seems to suggest that a claim is more important if it is arrived at empirically than if it is arrived at a priori. He claims that 'The *method* of arriving at the abstract structures is at least partly empirical [...] The fact that set theory also allows me to derive the same structure a priori does not mean that the information I have reached is

[16] This isn't strictly true, at least if we take the modern version of Newman's objection that is directed at the Ramsey-sentence approach to ESR. In this form, what Newman's objection shows is that knowing that a theory's Ramsey-sentence is true is only knowing that the theory has a model that is T-cardinality correct *and empirically correct*. Moreover, it seems that the essence of Newman's objection is not so much that ESR implies that scientific theories are of little worth but rather that it implies that all they tell us about the unobservable world is its cardinality, so ESR is not significantly distinct from antirealism. So it seems that Votsis fails to address the right issue in his reply to Newman's objection. However, this is not too important: it will be argued that he does not satisfactorily address the wrong issue.

devoid of importance' (Votsis [2003], p. 887, original emphasis). But if some fact is of no importance when it is acquired by set-theoretical reasoning, that surely *does* mean that it is of no importance when it is acquired empirically. A fact that is unimportant, insofar as it can be easily discovered, does not become more important because it can also be discovered by an unnecessarily difficult route. For example, suppose someone claims to have made the important discovery that 'eggs is eggs'. We might well reply that their discovery is not in fact important, insofar as it is easy to show (a priori) that 'eggs is eggs': the claim follows directly from the a priori principle that everything is self-identical. It would be ridiculous if they were to reply that the discovery *was* important because they arrived at it by an empirical study of eggs. Indeed, it seems that Votsis' contention comes down to the claim that 'two' results can be the same but of different importance, a claim that violates the law of the indiscernibility of identicals.

Votsis attempts to support his contention with a thought experiment:

> Take the numbers 133 and 123. I can, restricting myself solely to arithmetic, perform various operations on these numbers. One such operation is addition. Similarly, if I had two collections of 133 and 123 physical objects respectively, I could count them one by one, and would reach the same result. Despite the similarities, there is an important difference between the two cases. The latter case is one in which the result is a property that is then ascribed to the physical world, in particular to the physical objects under consideration, and not merely an exercise of arithmetic. This claim is warranted by the employment of an *empirical method* to arrive at the given number. The main point is quite simple: The fact that arithmetic allows me to do this a priori does not mean that the information I have reached counting objects is of little or no importance. One need only consider the consequences if I had made an error in counting. (Votsis [2003], p. 886, original emphasis)

This case does not at all support Votsis' contention. In this case the two procedures, the a priori arithmetical procedure of adding 133 and 123 and the empirical procedure of counting the objects in two collections, do not achieve the same results. The former enables us to determine that $133 + 123 = 256$, whereas, as Votsis notes, the latter enables us to determine that there are 256 objects in a particular collection. These results may well be of different importance but we cannot infer from this, as Votsis does, that two procedures yielding the same result can yield results of different importance, as the results in this case are not the same: the former is a theorem of arithmetic, the latter is a contingent fact about the world.

Votsis goes on to note that 'Using the [. . .] *a priori method*, set theory allows us to set up any structure we like [. . .] No structure is privileged in this sense. The structural realist's *a posteriori method* guarantees that some structures are privileged over others.' (Votsis [2003], p. 887, original emphasis). There is a trivial sense in which the structures that have been arrived at a posteriori are privileged compared with those that have not been arrived at a posteriori, but it is not clear that there is an important sense: it is not obvious why the fact that some structures have been arrived at a posteriori guarantees that these structures are *more important* than those structures that have been arrived at 'merely' a priori. Simply being arrived at via an a posteriori method does not seem to be sufficient to make a result important, especially if that result could have been arrived at a priori. After all, if the claim 'eggs is eggs' *had* been discovered to be true a posteriori, it would not thereby be more important than those identity claims that had been arrived at 'merely' a priori.

Newman argued (in effect) that the ESRist (unlike the conventional realist) does not have the resources to distinguish the important structures instantiated by a system from the unimportant structures, or even to say in what sense one structure could be more important than another. Votsis seems to be suggesting that the ESRist can make the distinction, because a structure is made important simply in virtue of the fact that it has been arrived at via an a posteriori method. This is surely untenable.

6.3 The Merrill/Lewis/Psillos reply

This proposal was first suggested as a possible response to Putnam's model theoretic argument against realism by Merrill ([1980]). It was adopted by Lewis ([1983]) and has been discussed in connection with Newman's objection by Psillos ([1999]). The key to the proposal is the suggestion that it is a contingent fact that some relations instantiated by the world are more important than others. The importance, or as proponents of this approach usually put it, 'naturalness', of a relation is not a logical property of the relation, nor a property the relation somehow acquires via the method by which it is discovered, but a physical property. Proponents of this view would not, presumably, deny that there is a perfectly good sense in which objects in the domain of the world, D_W, instantiate every relation compatible with the cardinality of D_W. However, they would add that only some of these relations are natural relations. The idea is that the world isn't *just* a collection of objects that can be grouped howsoever we please; rather, it is a collection of objects that also have preferred *natural* groupings. The world itself determines that some relations are more important than others and in this way comes pre-structured.

This is just the 'natural kinds' doctrine (or something very similar) and so this response is only open to those ESRists who are prepared to buy into this doctrine (or something very similar).[17] However, if one does accept it then

[17] Worrall (personal communication) says that he takes natural kinds to be, by definition, the properties and relations that we refer to with the predicates of our best theories. This response to Newman's objection is also not open to the ESRist who accepts only this form of the natural kinds doctrine: saying that the predicates of our best theories refer to natural kinds does not limit

Newman's objection misses the point. Let's call a structure a structure of the world if its domain is D_W (the set of objects in the world). Let's call a structure a natural structure of the world if in addition the relations in it are (the sets corresponding to) natural relations. It is true that any structure whose domain has the same cardinality as D_W is isomorphic to some structure of the world, but it is certainly not true that any such structure is isomorphic to some natural structure of the world (and presumably science aims to discover not just any old structures of the world but only the natural structures).

In terms of the Ramsey-sentence approach to ESR, the claim would be that the relations over which the quantifiers in the Ramsey-sentence range are restricted to the natural relations. It follows that Theorem 1

> Theorem 1: The Ramsey-sentence of a theory A is true if and only if there is some sequence of relations, $R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots$ such that $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle \models A$

must be replaced by

> Theorem 1″: The Ramsey-sentence of a theory A is true if and only if there is some sequence of *natural* relations, $R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots$, such that $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle \models A$

because the relations $R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots$ are now only in the scope of the existential quantifiers if they are natural. This blocks Ketland's proof of Theorem 2 at the last step: although given a theory has some model $\langle\langle D_1, D_2\rangle, R_{1.1}, R_{1.2}, \ldots, R_{2.1}, R_{2.2}, \ldots, R_{3.1}, R_{3.2}, \ldots\rangle$ that is empirically correct and T-cardinality correct we can construct a model of the theory of the form $\langle\langle D_O, D_T\rangle, O_1, O_2, \ldots, R'_{2.1}, R'_{2.2}, \ldots, R'_{3.1}, R'_{3.2}, \ldots\rangle$, it does not guarantee that the theory's Ramsey-sentence is true, as there is no guarantee that the relations $R'_{2.1}, R'_{2.2}, \ldots$ we have constructed are natural. As Merrill puts it:

> So long as we ignore any *intrinsic* structuring of the world, there is nothing to forbid us *imposing* a structure along any lines we chose. But if, as the realist surely must hold, the real world is a *structured* domain, then we are not free to ignore its intrinsic structuring in playing our model-theoretic tricks. (Merrill [1980], p. 74, original emphasis)

It might be objected that the ESRist could have no warrant for the claim that the second-order variables in the Ramsey-sentence range over only natural properties and relations, because we can have no idea what the natural kinds are independently of our theories. However, the ESRist needn't claim that we do know what natural kinds are *independently* of our theories. He will claim that whatever reason we have to believe that our theories are true is also a

the properties and relations to which these predicates can refer if any property or relation that is referred to by these predicates is, by definition, a natural kind.

good reason to think that the terms in our theories refer to natural kinds and that the second-order variables in the Ramsey-sentence range over only natural properties and relations.[18]

As noted, Psillos ([1999]) considers this response to Newman's objection but argues that it is not available to the ESRist:

> in order for them [i.e. ESRists] to distinguish between natural and non-natural classes they have to admit that some non-structural knowledge is possible, viz. that some classes are natural, while others are not. (Psillos [1999], p. 66)

As long as we do not go down Carnap's route and take naturalness to be a logical property of properties and relations then it is true that the knowledge that some property or relation is natural is not purely structural. However, neither the WESRist nor the SESRist claims that we have only purely structural knowledge (WESRists claim that our knowledge is restricted to claims constructed using logical and observational terms, SESRists claim that our knowledge is restricted to claims constructed using logical and internal terms). However, Psillos' point is essentially unaffected by this consideration, because the 'naturalness' of a property or relation is surely not an observable (or internal) property, so neither the WESRist nor the SESRist can consistently treat 'naturalness' as a primitive second-order non-logical predicate, and if the predicate 'naturalness' must itself be 'Ramseyfied', this response will not work; cf. Section 5.3.

7 Summary

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

[18] He might also suggest, as Lewis does, that, 'It takes two to make a reference, and we will not find the constraint [on what properties and relations we refer to] if we look for it always on the wrong side of the relationship. Reference consists in part of what we do in language or thought when we refer, but in part it consists in eligibility of the referent.' (Lewis [1983], p. 371). Lewis' suggestion is that there is some *feature of the world* that restricts the range of our variables for us. So it doesn't matter whether we *know* that our terms refer to natural kinds or not. It is just a fact that only certain properties and relations are eligible referents of terms, so, like it or not, our (second-order) variables can only range over certain properties and relations. However, this response is incoherent. It amounts to the claim that 'there are some properties and relations (the unnatural ones) that lie outside the scope of our quantifiers' and this claim is obviously self-defeating. Suppose (for reductio) that it is true. Then there is something in the scope of the 'some properties and relations' that lies outside the scope of the 'some properties and relations'. So the claim is false. Or, to put it in another way, we clearly can refer to unnatural relations, even if we don't typically do so.

Acknowledgements

I'm grateful to Roman Frigg and John Worrall for their comments on this paper.

Department of Philosophy, Logic and Scientific Method
London School of Economics and Political Science
Houghton Street, London, WC2A 2AE, UK
P.M.Ainsworth@lse.ac.uk

References

Carnap, R. [1967]: *The Logical Structure of the World: Pseudoproblems in Philosophy*, translated by R. A. George, London: Routledge & Kegan Paul.

Cruse, P. [2005]: 'Ramsey Sentences, Structural Realism and Trivial Realization', *Studies in the History and Philosophy of Science*, **36**, pp. 557–76.

Demopoulos, W. and Friedman, M. [1985]: 'Bertrand Russell's *The Analysis of Matter*: Its Historical Context and Contemporary Interest', *Philosophy of Science*, **52**, pp. 621–39.

Duhem, P. [1906]: *The Aim and Structure of Physical Theory*, translated by P. P. Wiener, reprinted 1991, Princeton, NJ: Princeton University Press.

Enderton, H. B. [2001]: *A Mathematical Introduction to Logic*, 2nd edition, San Diego, CA: Harcourt.

French, S. and Ladyman, J. [2003]: 'Remodelling Structural Realism: Quantum Physics and the Metaphysics of Structure', *Synthese*, **136**, pp. 31–56.

Halbach, V. [1999]: 'Conservative Theories of Classical Truth', *Studia Logica*, **62**, pp. 353–70.

Ketland, J. [2004]: 'Empirical Adequacy and Ramsification', *British Journal for the Philosophy of Science*, **55**, pp. 287–300.

Ladyman, J. [1998]: 'What Is Structural Realism?', *Studies in the History and Philosophy of Science*, **29**, pp. 409–24.

Lewis, D. [1983]: 'New Work for a Theory of Universals', *Australasian Journal of Philosophy*, **61**, pp. 343–77.

Maxwell, G. [1968]: 'Scientific Methodology and the Causal Theory of Perception', in I. Lakatos and A. Musgrave (*eds*), *Problems in the Philosophy of Science: Proceedings of the International Colloquium in the Philosophy of Science, London, 1965*, Vol. **3**, Amsterdam: North-Holland Publishing, pp. 148–60.

Maxwell, G. [1970a]: 'Structural Realism and the Meaning of Theoretical Terms', in S. Winokur and M. Radner (*eds*), *Analyses of Theories and Methods of Physics and Psychology*, Minneapolis, MN: University of Minnesota Press, pp. 181–92.

Maxwell, G. [1970b]: 'Theories, Perception, and Structural Realism', in R. Colodny (*ed.*), *Nature and Function of Scientific Theories*, Pittsburgh, PA: University of Pittsburgh Press, pp. 3–34.

Melia, J. and Saatsi, J. [2006]: 'Ramseyfication and Theoretical Content', *British Journal for the Philosophy of Science*, **57**, pp. 561–85.

Merrill, G. H. [1980]: 'The Model-Theoretic Argument Against Realism', *Philosophy of Science*, **47**, pp. 69–81.

Newman, M. H. A. [1928]: 'Mr. Russell's "Causal Theory of Perception"' *Mind*, **37**, pp. 137–48.

Poincaré, H. [1903]: *Science and Hypothesis*, reprinted in S. J. Gould (*ed.*), *The Value of Science: Essential Writings of Henri Poincaré*, New York: Random House.

Psillos, S. [1999]: *Scientific Realism. How Science Tracks Truth*, London: Routledge.

Putnam, H. [1977]: 'Realism and Reason', *Proceedings and Addresses of the American Philosophical Association*, **50**, pp. 483–98.

Redhead, M. [2001]: 'Quests of a Realist', *Metascience*, **10**, pp. 341–7.

Russell, B. [1912]: *The Problems of Philosophy*, Oxford: Oxford University Press.

Russell, B. [1927]: *The Analysis of Matter*, London: Kegan Paul, Trench, Trubner.

Russell, B. [1968]: *The Autobiography of Bertrand Russell, II*, London: Allen & Unwin.

van Fraassen, B. C. [1980]: *The Scientific Image*, Oxford: Clarendon Press.

Votsis, I. [2003]: 'Is Structure Not Enough?', *Philosophy of Science*, **70**, pp. 879–90.

Votsis, I. [2004]: *The Epistemological Statue of Scientific Theories: An Investigation of the Structural Realist Account*, PhD thesis, London School of Economics and Political Science.

Worrall, J. [1989]: 'Structural Realism: The Best of Both Worlds?', *Dialectica*, **43**, pp. 99–124.

Worrall, J. [1994]: 'How to Remain (Reasonably) Optimistic: Scientific Realism and the "Luminiferous Ether"', *PSA 1994*, **1**, pp. 334–42.

Zahar, E. G. [2001]: *Poincaré's Philosophy: From Conventionalism to Phenomenology*, Chicago: Open Court.

Zahar, E. G. [2004]: 'Ramseyfication and Structural Realism', *Theoria: Revista de Teoria, Historia y Fundamentos de la Ciencia*, **19**, pp. 5–30.