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Are There No Things That Are Scientific Theories? ^{*1}

Steven French and Peter Vickers

ABSTRACT

The ontological status of theories themselves has recently re-emerged as a live topic in the philosophy of science. We consider whether a recent approach within the philosophy of art can shed some light on this issue. For many years philosophers of aesthetics have debated a paradox in the (meta)ontology of musical works (eg. Levinson 1980). Taken individually, there are good reasons to accept each of the following three propositions: (i) musical works are created; (ii) musical works are abstract objects; (iii) abstract objects cannot be created. However it seems clear that, if one wants to avoid inconsistency, one cannot commit to all three. Following up recent developments courtesy of Cameron (2008a), we consider how one might respond to the corresponding set of propositions in the (meta)ontology of scientific theories.

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1 Introduction

What are scientific theories? Or, to phrase our question more explicitly, what is the ontological status of a scientific theory? Note, we are interested not in the ontological *implications* of theories, but in the ontological status of theories themselves, as objects.

Now it might seem that we can obtain a ready answer to our question if we turn to well-known accounts of theory structure.² However, as we shall see below, in §3 matters are not quite so straightforward. Nevertheless, many have taken one such account (namely the so-called model-theoretic approach) to involve an ontological commitment to theories as abstract structures, of some form or other. We shall consider this view in more detail below but here we wish to emphasise that our aim in this paper is to offer an alternative for those who wish to adopt a less inflationary view. The challenge, then, is to account for the truth of various statements that can be made about theories, while keeping our ontology as deflationary as possible.

In addressing this challenge, we shall suggest that fruitful comparisons may be drawn with works of art and similar objects. Thus in the discussions of the representational capacity of theories we have seen significant and wide-ranging (and not always apposite) comparisons with certain kinds of paintings (see for example French 2003; Suarez 2004; Contessa 2007; van Fraassen 2008). But their apparent similarity with musical works also crops up in what literature there is on the ontological status of theories, despite some obvious and important differences between musical works and paintings.

In this paper we shall bring various different perspectives to bear on a variation of a well-known paradox in the (meta)ontology of musical works (eg. Levinson 1980). This will help to tease out the similarities and differences between different accounts of theories, and will highlight some strengths and weaknesses in these accounts. We shall apply an approach recently put forward by Cameron (2008a) as

² Although the answer to our question might be found in such accounts, we take the question itself to be distinct from ‘what is the structure of scientific theories?’, on which there is of course a considerable literature.

an analysis of musical works, which has the consequence that scientific theories should not be taken to exist as ‘things’, in a sense (contrary to some popular accounts championed by Popper, Giere, and others).

The paradox of musical works is introduced in the next section, and an analogous form is shown to hold for scientific theories. In §3 the most obvious ways of avoiding the paradox are considered, and each is shown to face considerable difficulties. In §4 we introduce Cameron’s approach, and suggest that it dissolves the paradox for theories just as it does for musical works, although some difficult questions remain to be answered. In §5 we introduce some possible objections, and provide replies. §6 is the conclusion.

2 Setting up the problem

Consider the following paradox in the ontology of musical works. Taken individually, the following three statements all seem to be plausible, and yet they are inconsistent:

M1: Musical works are created.

M2: Musical works are abstract objects.

M3: Abstract objects cannot be created.

The question arises which of these three propositions we are willing to reject. For many years now this question has generated considerable debate, with Cameron (2008a) recently putting forward an original proposal to be considered in detail in §4. Here we wish to consider whether a similar paradox can be generated with regard to *scientific theories* and *scientific models*. In other words, we want to consider the following three statements:

S1: Scientific theories (and models) are created.

S2: Scientific theories (and models) are abstract objects.

S3: Abstract objects cannot be created.

Clearly scientific theories differ from musical works in many important respects. But crucially, they share many similarities. For example, they are ‘multiply realizable’ in a certain sense: just as there can be many performances of Beethoven’s Fifth, so there can be many presentations of Einstein’s Special Theory of Relativity. And just as the performances can be subtly, or perhaps not so subtly, different, as the conductor and the performers bring out different aspects of Beethoven’s work, so different presentations of Einstein’s theory can emphasise different features or aspects of it. And very similar questions of identity can arise too: how different can a performance or presentation be before it is no longer the Fifth or the Special Theory?

For present purposes the similarities we shall focus upon are as follows. It can plausibly be claimed (or so it would appear) that both musical works and scientific theories can be created, in some sense (where we shall consider in what sense below). And in both cases there doesn’t appear to be anything ‘concrete’ that we can identify a given musical work or scientific theory with. Indeed, it turns out that each of S1, S2 and S3 has been accepted by philosophers both past and present. But, if we are going to retain a consistent belief set, at least one of the claims must be rejected. Is there really good reason to believe S1, S2 and S3? In the next section the possibility of rejecting each statement will be considered.

3 What to reject?

In the literature on musical works each one of M1, M2 and M3 has been rejected by someone or another (see Cameron 2008a, p.295-297 for discussion and references). In this section we consider whether there is any good motivation to reject S1, S2 or S3.

Before we do, let us consider the claim, mentioned in the Introduction, that certain well-known accounts of theory structure already offer answers to our original question – What are scientific theories? – on the basis of which a response to the above paradox can be constructed.

On the so-called Received View, theories are characterised in terms of the deductive closure of sets of propositions, whereas according to the ‘semantic’ or model-theoretic approach – perhaps now the most widely held view of theory structure – they are characterised in set-theoretic terms. We use the word ‘characterise’ here because although, again, these approaches might be taken to supply an easy answer to our question (so, on the model-theoretic view, theories just *are* set-theoretic entities), the implications have led some adherents of this approach to hold back from making such an identification. Van Fraassen, for example, associates the essence of the model-theoretic approach with the claim that ‘... to *present* a theory, we define the class of its models directly ...’ (van Fraassen 1989, p. 222; our emphasis), and goes on to assert the following conditional:

‘... if the theory as such, is to be identified with anything at all - if theories are to be reified - then a theory should be identified with its class of models.’ (*ibid.*)

The point is sometimes missed that for a constructive empiricist, like van Fraassen, this is a big ‘if’. However, one needn’t be such a strong anti-realist to have concerns about inflating our ontology in this way. Da Costa and French, for example, have resisted the inflated ontology associated with the above easy answer by defending Suppes’ dual characterisation of theories: from the extrinsic perspective, theories - whatever they *are*, ontologically - are *represented* in terms of models, or classes of models; whereas from the intrinsic perspective, they can be taken to be the objects of epistemic attitudes, and in particular that of belief, and be regarded as true, empirically adequate, quasi-true, or whatever, where these attitudes are expressed by belief reports which are sentential or propositional in nature (da Costa and French 2003, Ch. 2). This dualist view then overcomes concerns as to how one can talk of theories being true within the semantic approach (Chakravartty 2001). But of course it leaves open the question what theories *are*, ontologically speaking.³

Now, even if one were to adopt, say, the model-theoretic approach it would offer little help with regard to resolving the paradox. On what is perhaps the most common understanding of this view, as we have just noted, theories *are* set-theoretic structures, related to data structures etc. via partial isomorphism or some such formal

³ One option is to adopt a ‘quietist’ attitude towards this question (French 2010).

relation. Even if this is palatable in itself in terms of the ontological *identification* of theories (and as we have just emphasised, for some adherents of this approach it most definitely is not), it fails to address the main problem presented here, namely, the paradox. We remain in the dark as to which statement S1, S2 or S3 to reject. Given this, and the afore-mentioned reluctance of some adherents of this approach to understand it as implying certain ontological identifications, we shall focus on less specific ways in which the paradox might be resolved.

3.1 Scientific theories are *not* created?

To some, S1 might seem to be a prime candidate for rejection. We don't normally say that scientific theories are created; in fact, in the literature it is much more common to talk in terms of the *discovery* of theories. As is well known, for much of the 20th century it was assumed that a distinction could be drawn between 'discovery' and 'justification' in science, and that philosophy of science should be focused purely on the latter, leaving questions of 'discovery' to sociologists and psychologists.⁴ Today the distinction is regarded as having become blurred or as broken down completely, but this in itself doesn't mean that talk of 'discovering scientific theories' must be abandoned. And if it is really appropriate to say that we *discover* scientific theories, then it seems clear that we don't create them. On this view theories are 'already there', in some sense, waiting to be discovered.

However, even within Popperian philosophy of science, with its rigid adherence to the above distinction, it is clear that talk of the discovery of theories should not be taken *literally*. Thus in his classic statement that relegates discovery to the realm of psychology, Popper himself talks of 'the act of conceiving or inventing a theory' and of ideas 'occurring' to a scientist (Popper 2002 [1959], pp.7-8). Here Popper clearly doesn't mean 'discover' in the sense of 'already there waiting to be found'. Indeed, his language is suggestive of 'creation' more than 'discovery', and the fact that he directly compares how we come up with new musical themes and new scientific theories further supports the thesis that Popper was not using the word 'discover' in a literal sense.

⁴ For a recent assessment of the distinction, see Schickore and Steinle (2006).

It may appear particularly difficult to hold on to the idea that scientific theories subsequently revealed to be *false* are discovered. The suggestion that *true* theories can be discovered has some initial plausibility at least. After all, didn't we discover that the earth orbits the sun, and not the other way around? In fact even this doesn't support the claim that we discover theories: we discover *that* the earth orbits the sun, we don't discover the *theory* that the earth orbits the sun. But when we move to false theories we don't even have this initial plausibility. Of course, a realist who cleaves to some form of the General Correspondence Principle and insists that appropriate commonalities can be found across even quite radical instances of theory change may suggest that these common features that support claims of approximate or partial truth are discovered, but this would be to again confuse the discovery of that to which these features refer (on a realist view) with the discovery of these features as referential or, more broadly, representational devices. Where there are few if any such commonalities, such suggestions appear even less plausible. Consider the rather wild theory once put forward that electrons in an atom orbit the nucleus in hexagon-shaped trajectories. How could this feasibly be 'discovered' rather than created, in some sense?

The 'discovery' of scientific models presents similar problems. If they are not considered candidates for the truth, then the same considerations as above seem to apply. If, on the other hand, they are regarded as partially or 'pragmatically' true (da Costa and French[2003]), then again, from a realist stance, the above confusion between theory and world must be avoided. And from the stance of the (philosophical) pragmatist, discovery, in any genuine sense, again seems inappropriate here. In either case, models, too, are not 'out there', waiting to be discovered.

Of course, it might be argued that if one were to follow the syntactic approach and identify theories with sets of propositions, as indicated above, then the claim that *false* theories can be discovered may appear more plausible.⁵ On this view, false theories are just sets of propositions that contain a false proposition, which should be no more ontologically troubling than sets of true propositions. And if propositions

⁵ We'd like to thank Ross Cameron for raising this concern (although he should not be taken to hold this argument!).

are taken to be effectively ‘out there’, in some sense, then *if* (a big ‘if’) true theories can be discovered, then so can false ones.

Now, the *identification* of theories with either sets of propositions or set-theoretic structures faces well-known problems, as we have said. But even setting this aside, pushing the above argument would appear to take the proponent away from the view that theories themselves have ontological status as things. Of course, one could then take propositions themselves to be things, such as eternally existing abstracta. Hence via a two-fold identification (first of theories with propositions and then of the latter with abstracta) one could maintain that false theories are just as discoverable as true ones, since both would now be identified with sets of propositions, in turn understood as abstracta. However, such moves face problems – in particular, the so-called ‘Benacerraf problem’ of how we can have knowledge of such entities, given the lack of causal interaction – and these appear to be exacerbated in the case of theories.⁶

So, if S1 were to be replaced with,

S1’: Scientific theories (and models) are discovered

we appear to land in another paradox, since there would remain an obvious tension with S2. By what means would scientific theories, qua abstract objects, be discovered? Presumably a proponent of such a view would have to appeal to some kind of ‘platonic’ sense, similar to that by which mathematicians supposedly discover their theorems on the Platonist’s account, but even if that is plausible for mathematical objects, it seems much less so for scientific theories, whose heuristic development can be much more straightforwardly traced.

One way of dissipating this tension would be as follows: just as those who regard art-works as abstract objects could argue that what we call ‘discovery’ involves a form of selection, or mediated access to the relevant type that allows it to be tokened, so access to scientific theories as abstract objects could be understood as mediated

⁶ Interestingly, given the account to be defended here, Schiffer (2003) offers a deflationary account of propositions which regards them as ‘pleonastic’ entities in the sense that they are involved in moves that allow us to deduce statements about certain kinds of entity from statements that make no reference to those entities.

via the very heuristic moves by which they are ‘discovered’. However, these ‘moves’ differ considerably in nature and kind. Consider Post’s famous taxonomy for example, which includes very general criteria such as the General Correspondence Principle mentioned above, as well as more specific suggestions to do with the role of symmetry principles in physics etc (Post 1971). It is difficult to see what these have in common both between themselves and with the sensory modalities in terms of which we gain access to observable objects. Of course one might argue that the relevant comparison should be with our indirect access to unobservable entities, but again it isn’t clear that there are any similarities with the inferential moves that are made there. So, until this mode of access to theories is spelled out in terms of the specific heuristics, this proposal remains just a suggestion.

Thus rejecting proposition S1 raises tricky issues, both because S1 seems much more intrinsically plausible than its negation, and because the negation of S1 does not sit comfortably with S2. If the paradox cannot be easily dissolved in this way, what are the other options?

3.2 Scientific theories are *not* abstract objects?

A more likely candidate for rejection might be S2, the statement that scientific theories and models are abstract objects. One might think that there are some relevant disanalogies between scientific theories and musical works here, such that the argument for *musical works* being abstract objects does not cross over to scientific theories. Our first job is to see if this is the case.

The argument that musical works are abstract objects can be summed up as follows: What else could musical works be? (cf. Cameron 2008a, p.296). There is a consensus amongst metaphysicians that things are either abstract or concrete, so that if musical works are *not* abstract, then there must be something concrete we can identify them with.⁷ But they cannot be identified with the score of the music: ultimately this is just markings on paper (or on a computer screen, say). And they cannot be identified with the thoughts in some person’s head, or indeed the thoughts in a number of persons’ heads, because musical works are sometimes *heard*, but

⁷ In fact, despite the consensus, there are some serious difficulties with drawing a straightforward abstract/concrete distinction. See §5.3, below.

thoughts are not. And they cannot be identified with a performance (by an orchestra, say): musical works are performed, but they are not the performance itself. So, the argument goes, since they can be identified with no concrete thing, they must be abstract.

Does this argument cross over to scientific theories? Certainly some have been persuaded. On Giere's view, for example, models are taken to be abstract entities that satisfy a certain theoretical definition and are related to systems of physical objects via a theoretical hypothesis (Giere 1988, p.80ff).⁸ The central idea is the following: the fundamental laws of science, such as Newton's laws, Maxwell's laws of electrodynamics, the laws of thermodynamics and so on, should all be regarded as 'principles' that define 'highly abstract entities' included in the category of models (see for example Giere 2008). These principles are true of the models, in the way that definitions are true. And the models themselves are abstract in two ways:

First, they are abstract objects like numerical relationships or geometrical figures, square roots, perfect squares and circles, or never constructed buildings described in architect's drawings. They are not physically realized. Second, they are abstract in that they are not fully specified. Newton's Laws refer to forces, masses, accelerations, velocities, positions, and times, but not to any specific such objects or quantities. (Giere 2008, p.5)

The issue now is whether alternative accounts of the ontological status of such models can be ruled out. Just as a musical work cannot be identified with the score, a scientific theory or model cannot be identified with markings on paper or some other medium (cf. French 2003). Can a theory be identified with some person's thoughts, or with the thoughts of a number of people? Here there is a disanalogy with musical works: one of the main reasons that musical works cannot be identified with thoughts is that musical works are sometimes *heard*, but what would be the corresponding argument for scientific theories? Can't these be identified with certain thoughts?

The obvious question is 'Which thoughts?' We wouldn't want to identify a theory with the thoughts in any particular person's mind. The 'Great Men' view of

⁸ This doesn't mean one can't be a realist on this view – cf. Psillos forthcoming.

science which attributes theories to individual discoverers has been widely and justifiably criticised. Theories cannot be associated with any one mind, but develop within a community: they are in a certain sense public rather than private objects. If we were to identify a theory with the thoughts in an individual mind, we would have to say that it existed many times over, one theory for each mind. But we do not want to say this: there is (or appears to be) one ‘theory of quantum mechanics’, not a multitude.

A better option might be to identify a theory with those thoughts held in common (about a given domain) by the members of a particular community. However, it would then seem that the theory becomes an abstract object once again. It is no longer identified with the thoughts in any individual mind, nor some collection of thoughts in multiple minds, but with the abstract entities referred to as ‘thoughts common to individuals in the relevant scientific community’.⁹ And this is *prima facie* an uncomfortable conclusion at any rate. Can two minds really share a thought, or will they always merely be “similar”? Which shared thoughts in particular should we focus on? And which individuals should we include in the ‘relevant scientific community’? It seems to push the limits of conceivability too far to call such a strange, disjoint collection of things an object.

A final option would be to identify a theory with certain (concrete) scientific *practices*. In other words, we might say that a theory *just is* the writing of articles, the carrying out of experiments, and so on. This may seem quite a peculiar conception of a theory for many people, but comparisons can be drawn with nominalistic moves in other fields. However, if a theory were to be identified with *individual* practices, an obvious worry would be which practices, or which collection of practices, should we pick? One option would be to adopt a relaxed stance on this issue and, for example, suggest that it is a matter of convention where one draws the line, as it were. Alternatively one could identify theories with certain *types* of practice, but then, of course, we are back with identifying theories as abstract objects

⁹ Cameron discusses a similar move for musical works. He writes, ‘Perhaps you object to the identification of the score with the piece of paper on which it is written. Fair enough—but then you are probably thinking of the score as an abstract type of which that piece of paper is an instance; in which case identifying this abstract object with the musical work is not going to solve the problem currently under discussion.’ (2008, p.296).

(cf. footnote 4). But whatever the case, there is a strong intuition that just as musical works can be performed but should not be identified with the performance itself, so theories can in a sense be acted upon in various ways, but should not be identified with those actions themselves.

Thus the argument against theories as concrete objects mirrors that against musical works. There doesn't seem to be any concrete object with which we could conceivably identify scientific theories. The alternative is to regard scientific theories as *non-concrete* things, and if we accept some form of the concrete/abstract dichotomy as most metaphysicians do, we are thus forced to accept S2, and label scientific theories 'abstract objects'.

3.3 Abstract objects *can* be created?

S3 is identical to M3, of course, and there has already been considerable discussion of it in the literature on musical works. Simply put, most metaphysicians insist that abstract objects *cannot* be created, on the grounds that creation requires causation (in the form of a causal chain from creator to created) and abstract objects are causally inert.¹⁰ In this section we will argue that the obvious ways around this difficulty are not particularly promising.

First, one might deny that creation requires causation. Thus it might be claimed that at the same instant that a scientist 'discovers' or creates a theory, the corresponding abstract object comes into being. One might then speculate whether it comes into being at the moment the scientist conceives of the theory in her mind, or when she writes down the relevant statements, equations etc., or whether it 'emerges' during such a process. This broadly meshes with the 'lightbulb' or 'Eureka!' view of scientific discovery, typically rejected as too naïve in not accommodating the role of heuristic factors (such as discussed by Post and others, as mentioned above). One could then allow for such factors by modifying this line so that in conceiving of a hypothesis, say, or writing down an equation, etc., on the basis of making the relevant heuristic moves, one thereby creates the corresponding abstract element. And just as some combination of such elements in practice would be taken to

¹⁰ On the issue of creation and/or discovery of musical works, see for example Walhout (1986).

compose the theory, so, paralleling this, at the abstract level, we would have abstract objects corresponding to such elements composing the abstract object corresponding to the theory.

One might already feel a little squeamish at the ontological inflation involved with such a view, but the more pressing problem concerns the relationship between the thought (the conceiving of the hypothesis) or the practice (the writing of the equation) and the corresponding abstract objects. If this is not causation, what is it? It remains a mystery.

One possible way of dissolving the mystery is indicated by Thomasson in her proposal that art-works should be regarded as ‘abstract artifacts’. These lack a spatio-temporal location and may be created, come into existence, change, and cease to exist (see Thomasson 1999, pp.132-134).¹¹ Thus painting, sculpture, musical works, literature etc. are created by and depend for their continued existence on certain human intentional states but are not to be identified with either the imaginary creations of individual minds or physical objects. Applying such a view to scientific theories, we might then say that insofar as the creation of such a theory involves the intention of the scientist, it is this intention alone that brings the theory into existence.

Again, however, one might wonder how this meshes with the heuristics of scientific discovery. At the very least anyone adopting Thomasson’s view would have to acknowledge that these intentions would have to be constrained in some way. Perhaps one could argue that any intention to produce a theory, no matter how bizarre, unjustified, or out of step with current science, creates the corresponding abstract artefact but that only the sub-set of the resultant plethora of such artefacts that meet the relevant heuristic criteria would count as ‘theories’. And again one would have to accept certain relations between the various artefacts corresponding to the different stages of the development of the theory, paralleling the relations we discern between their material counterparts in practice.

The ontological inflation involved in this proposal is again considerable. In addition, as Thomasson openly acknowledges, it also requires us to accept a new hybrid category of entity that lies between those of concrete individuals and platonic abstracta.

¹¹ As we shall see, this bears certain similarities to Popper’s view of theories that we shall consider below.

As far as Thomasson is concerned, this is a price we have to pay in order to resolve various ontological problems faced by works of art. However, when it comes to theories, at least, we believe we can resolve such problems without having to pay such a price, and that represents an advantage of the view we shall shortly present.¹²

A closely related option would be to argue that although creation *does* require causation (in some sense), and we can't causally interact with abstract objects, this in itself doesn't mean that we can't create abstract objects. After all, during the process of creation the abstract object doesn't yet exist, so one is free to tell a story where we manipulate things we *can* causally interact with, and the abstract object comes about as a result of our manipulating these things.¹³ But the obvious concern is similar to that discussed above: quite how the abstract object comes into existence remains a mystery, a mystery which renders this option most unappealing, in our view.

Thus we find that there is no immediately satisfactory way out of the paradox, as applied to scientific theories. And it looks like, in trying to reject S1, S2 and S3, we've covered all the possible ways out. However, Cameron's (2008a) approach to the paradox of musical works provides us with a fourth way in which this 'paradox of scientific theories' might be dissolved.

4 A fourth way: truthmaker theory

Cameron (2008a) has put forward a novel solution to the paradox of musical works in the general context of a metaphysical framework that urges a reduction in one's ontological commitments. We are sympathetic to such urges but we do not need to accept all aspects of Cameron's approach here. His solution allows one to retain M1,

¹² One might also have concerns about the implication that, just as for art-works on Thomasson's view, scientific theories not only come into existence at a certain point in time but would also cease to exist if all records of them, such as journal papers, books etc., and memories, were destroyed or otherwise ceased to be. Since the view we propose raises similar concerns, we shall put off our response until we have presented our alternative below.

¹³ This option has been suggested by a commentator on a presentation of the ideas in this paper.

M2 and M3 (in a sense) and we shall adapt it to our S1-3.

There are two crucial features of Cameron's approach. The first is that he adheres to a version of 'truthmaker' theory, which has as its central focus the issue of what it is for a proposition to be true. On the standard understanding of this account, the truthmaker for the claim ' x exists' is always x (see, for example, Armstrong 2004). However, Cameron offers a new twist, by allowing for the truthmaker of the sentence to be something other than ' x ':

'I think one of the benefits of truthmaker theory is to allow that ' x exists' might be made true by something other than x , and hence that ' a exists' might be true according to some theory without a being an ontological commitment of that theory.'
(Cameron 2008b, p. 4)

This then leads on to the second feature of the account which is a commitment to a form of fundamentality: our ontology should characterise how the world is at its most fundamental level. Elements of this ontology will be the truthmakers for sentences involving both these elements and other, non-fundamental, features of the world. We should pause at this point and note that this commitment to fundamental elements – standardly known as metaphysical 'simples' – has attracted considerable debate in the relevant literature. In adopting Cameron's general approach we shall not be making the same commitment when it comes to the consideration of the ontological status of theories. Returning to Cameron's account, in order to keep it clear which kinds of elements one is referring to, a distinction is drawn between two different types of statement: those of English, and those of 'Ontologese', where it is the latter that describes the world at its fundamental level (2008a p.300f.). Statements of Ontologese look like statements of English, so to distinguish them we shall follow Cameron in using bold type.

Consider the example, '**there are statues**'. This is false, because at a fundamental ontological level, Cameron argues, there are no statues. However, 'there are statues' is true, and it is true not in virtue of the fact that **there are statues**, but in virtue of the fact that there are elements of our fundamental ontology that are

arranged ‘statue shaped’ (p.301).¹⁴ Such a distinction might be found elsewhere, including in the philosophy of science. Thus the (ontic) structural realist might insist that ‘**there are particles**’ is false, because at the most fundamental level there are no particles qua objects, only structures, whereas ‘there are particles’ is true, in virtue of the fact that there are structures ‘arranged particle shaped’ (that is, ‘shaped’ via the relevant symmetry groups for example; see French and Ladyman 2003).

The distinction between English and Ontologese then applies to the paradox of musical works as follows. M1 and M2 are true, but M3 is false.¹⁵ The latter is false, because ‘the way the world is fundamentally results in there being truths of English that proclaim the coming to be of certain abstract objects’ (ibid.).¹⁶ To put it another way, it is completely entrenched in our linguistic community to say that certain abstract objects (such as musical works) come into existence, and on those grounds we have to say that M3 is false. What is true is **M3: abstract objects cannot be created**, because *fundamentally* speaking abstract objects cannot be created (regardless of how native speakers of English are inclined to talk). And there is no paradox in ontologese here either, because we needn’t be motivated to believe the truth of the bold counterparts to M1 and M2. **M1 and M2** are false because **there are no things that are musical works**. It is only M1 and M2 that are true. M1 is true by virtue of the fact that there are ‘eternally existing abstract sound structures’ which ‘get indicated by composers, who lay down instructions for their performance’ (p.306; we shall address worries about the introduction of such structures in §5.1, below). And M2 is true by virtue of the fact that ‘the objects that perform the role of musical works are abstract objects: they are sound structures’ (p.309).¹⁷

¹⁴ Obviously such a metaphysical claim will have to be backed up by the relevant physics, involving, for example, Pauli’s Exclusion Principle to underpin such features as the statue’s solidity. And of course, spelling out the relevant physics may not be straightforward.

¹⁵ If one were tempted to adopt a reificationist form of the model-theoretic approach and identify theories with mathematical structures, it is worth noting that Cameron applies his approach to mathematical ontology as well (2008b).

¹⁶ Actually, there isn’t such a motivation to resolve paradoxes in English, according to Cameron. In his 2008b he argues that there can be true contradictions in English, even though fundamental reality is consistent. The logic of English should be paraconsistent, even if the logic of Ontologese is classical. Azzouni (2007) takes a similar view. What really matters is that we don’t have conflicts in our beliefs about how the world is, fundamentally.

¹⁷ It is important to appreciate that this is part of a much broader programme defending a form of metaphysical nihilism; see Cameron forthcoming.

Now, let us again be clear: we do not adopt all aspects of Cameron's account. All we need is the distinction that allows us to say that '*a* exists' is true, in (colloquial) English, without having to be ontologically committed to *a*. What *makes* '*a* exists' true is the existence of other things that we do want to be ontologically committed to, *in some sense*. Now, for Cameron these 'other things'—the truthmakers— must necessarily be at the fundamental level: they must be metaphysical 'simples' such as 'abstract sound structures', electrons, quantum fields, etc. Although we have some sympathy for this line, we acknowledge that it has possibly controversial features: tables, for example, could not be said to exist at the fundamental ontological level. So what makes the statement 'tables exist' true is *not* that '**tables exist**'. '**Tables exist**' is false because tables aren't part of the fundamental ontology on this view.¹⁸

However, we do not need to go this far for our purposes: we will simply draw on truthmaker theory to dissolve the inconsistency of S1-S3 and reduce our ontological commitments with regard to theories, models etc. We shall not address the question whether one should reduce one's ontological commitments even further, as Cameron does, and extend his approach to physical objects. So, we maintain the English/Ontologese distinction, but statements in bold type will be about what exists when we come to consider the status of theories, models and so forth.¹⁹

These options will become clearer as we proceed to apply truthmaker theory to the case of scientific theories. First, S3 is the same as M3, so we can draw directly on Cameron's argument that M3 is false. Only **M3** is true, because abstract objects, as standardly conceived, are causally inert and creation requires causation (recall section 3.3, above). What about the bold counterparts of S1, S2 and S3? If **S3** is true, then we need to be sure that **S1** and **S2** are not also true—this would just put us straight back into paradox, but in Ontologese instead of English.

We can follow Cameron again here, saying that **S1** and **S2** are false because **there are no things that are scientific theories**. In other words, **S1** and **S2** are false because they fail to refer. Since we are not ontologically committed to the existence

¹⁸ For Cameron's defence of this particular consequence of his view see his 2008b, p.6.

¹⁹ One option would be to apply the notion of a 'hierarchy of ontological categories' in this context and take our considerations to be restricted to the category that encompasses theories models and the like (see eg. Rosenkrantz 1991). This in itself invites further discussion of the nature of such a hierarchy, whether more than one such hierarchy can be established and so forth, although we shall not pursue these issues here.

of theories, it is false to say that theories are created or are abstract objects.²⁰ What *does* exist—what does the truthmaker work for theories—will be discussed in the next section.

It is worth emphasising the point that we *can* talk about theories, their existence, their various qualities and so forth, in English. We can maintain all our usual talk about theories *but* what makes this talk true (or false) are not the entities directly referred to in it (namely the theories) but rather certain elements (still to be presented) to which we *are* ontologically committed. Thus we retain all the advantages of being able to talk about theories in English, but we avoid having to inflate our ontology unnecessarily.²¹

At this stage the paradox is resolved. When stated in English it dissolves because S3 is false, and when stated in Ontologese (the language of ontological commitment appropriate for our considerations here) it dissolves because **S1** and **S2** are false. Of course, it comes with its own cost, namely accepting a distinction between statements in English and statements in Ontologese, or whatever language one takes to refer directly to the elements to which one is ontologically committed. We think this is a lower cost than those associated with the alternatives, which involve either inflating our ontology or accepting hybrid categories of objects. Furthermore, the above distinction should not be entirely unfamiliar: many would maintain that what fundamentally exist are quantum fields, say, but that we can still utter true (and false) statements about tables, people, and so on. Nevertheless, this approach to the ontology of scientific theories throws up some further questions that must now be addressed.

²⁰ If the reader is unhappy with the distinction between English and Ontologese, note that Cameron himself suggests that it can be dispensed with (Cameron forthcoming). All that we need is the distinction between statements about those entities we are ontologically committed to and those we are not. Thus it is a simple matter to translate our analysis so that the English/Ontologese distinction disappears, and is replaced by a distinction between truths and truthmakers, if the reader prefers.

²¹ Of course, one could still insist that we want to understand why claims about theories are true or false in English, in the sense that the truthmakers are describable in English, without having to introduce Ontologese, but this would be to beg the question against us. We are grateful to one of the referee's for pushing us on this issue.

5 Objections and replies

The first thought might be that this is really a pyrrhic victory. Certainly the paradox is resolved, but we still need to tell a story about what exists in our ontology that ‘makes true’ our everyday talk about theories (eg. statements such as ‘quantum mechanics is an extremely successful theory’). This will be addressed in §5.1. Thereafter, in §5.2, we consider some possible objections that might be raised against our account, including concerns over the nature of the concrete/abstract distinction. In §5.3 we then consider the fictionalist approach, which again rejects the straightforward concrete/abstract distinction. Finally in §5.4 we consider in more detail the role this distinction is playing in the debate.

5.1 What are the truth-makers?

The question which must be answered here is: What corresponds to ‘the eternally existing abstract sound structures’, which ‘perform the role of musical works’ on Cameron’s account? In Cameron (2008a) it is suggested that musical works are abstract objects (speaking in English, for the moment) *because the things that perform the role of musical works are abstract objects*. As Cameron puts it,

[T]here is a perfectly good sense in which we can say that musical works are abstract, just as there is a perfectly good sense in which we can say that statues are concrete: while there are no things that are musical works or statues, the things that do the truthmaking work for the English sentences ‘there is a musical work’ and ‘there is a statue’ are abstract and concrete respectively. (p.309)

So it would seem that if we want to say that ‘scientific theories are abstract objects’, then we need to find some really (fundamentally) existing abstract objects which

‘perform the role of theories’. As abstract objects, the latter need to be ‘eternally existing’, like the sound structures in Cameron’s account.²²

One option would be to again follow (certain forms of) the model-theoretic approach and take mathematical structures as analogous to Cameron’s sound structures: they are abstract and eternally existing and it would seem that they can perform the role of theories when selected by scientists to represent certain sets of phenomena. And just as, on Cameron’s view, some of the abstract sound structures get indicated by composers, who lay down instructions for their performance, so we might say that some of the abstract mathematical structures get indicated by scientists who lay down instructions for how they should be brought into the appropriate relationship with both other theories and experimental structures.²³

However, although this is not to *identify* musical works or theories with the respective abstract structures it would amount to a reinflation of our ontology. We have eliminated theories, as such, from our ontology, only to introduce abstract mathematical structures. Given that there is a less inflationary alternative, we think this option should be rejected.

What, then, would make S1 and S2 true without reintroducing abstract entities? Interestingly, Cameron himself doesn’t claim that what does the truthmaking work *must* be abstract in such a case. Consider his example of the Supreme Court. It looks like this is an abstract object (speaking in English), simply because there don’t seem to be any good concrete candidates to identify it with. But Cameron writes,

What makes it true that there is a Supreme Court is ... simply that there are various people performing a certain role. (p.311)

However people and their performances are *concrete* things: in particular, they are *not* ‘eternally existing’, as abstract objects are. So here we have a clear case of something that might be regarded as abstract²⁴ (*speaking in English*), but where the

²² Although see Popper’s take on ‘abstract’ objects, below.

²³ We are grateful to one of the referees for suggesting this option and for encouraging us to be clear in our response to it.

²⁴ Cameron himself regards the Supreme Court as concrete (personal communication) since, for example, one could assassinate all its members and state ‘I just killed the Supreme Court’.

truthmakers for it are *not* abstract. And there doesn't seem to be anything to stop us applying this approach to scientific theories: scientific theories can be abstract (speaking in English) and whatever is it that 'performs the role of theories' does *not* have to be abstract.

So we can ask our question again—'What makes S1 and S2 true?'—and now we don't have to feel that we are confined in our answer to *abstract* objects. Two candidates for the truthmakers have already been mentioned above: scientific practices and the thoughts in the minds of individuals in the relevant scientific community.

Let us consider each of these options in turn. We might say that all that *really* exists is the complex set of practices of the scientific community: the writing and dissemination of articles, the performance of experiments, the kinds of heuristic moves already mentioned, and so on.²⁵ These are all either concrete entities or reducible to such and within this particular context, ontological commitment to such practices can be taken at face value. These practices will then collectively act as the truth-makers for our theory talk. This is not to *identify* a theory, qua concrete object, with the set of actions that are taken with regard to it, a move we dismissed in section 3.2 above.²⁶ There are no theories in our view—just theory-talk whose truthmakers are concrete things. Recalling the statue example, we might sloganise this view as follows: there are no theories, just 'theory-shaped bits of practice'.

However, it is unclear whether by eliminating all the members of the Supreme Court, one has eliminated *it*, qua an entity.

²⁵ Recalling Schiffer's pleonastic account of propositions, he argues that we know about propositions by participating in the relevant linguistic and conceptual practices and it is these that make true our proposition talk. Thus if one were keen to maintain the identification of theories with sets of propositions, one could still adopt the kind of deflationary view on offer here.

²⁶ There appear to be similarities between the view advocated here and that of Cartwright and Suarez, for example, who write that '...theorising is constituted by a heterogeneous mixture of journal articles, textbooks, lectures, PhD seminars, practices, techniques, explicit explanations, implicit half-formed understandings and the like". (Suárez and Cartwright, 2008, p. 79). Here it is 'theorising' that is taken to be constituted by practice and if that is understood as distinct from the creation of theories, qua objects then it clearly meshes with what we say here. Cartwright and Suarez's arguments for such a position, however, are entirely different from ours. Furthermore, this is associated with an instrumentalist view of theories which sees them as 'tools', whereas we do not view them 'as' anything. Finally, our view is still consistent with an appropriate understanding of the model-theoretic approach that Cartwright and her collaborators reject.

So, consider the claims ‘QM is a very elegant theory’ or ‘QM is empirically adequate’. The first can be characterised, within the model-theoretic approach, in terms of certain relations holding between different parts of the theory, for example. But it is made true by certain practices, involving, for example, the ease of deduction of certain (written, typed, scrawled ...) statements from the axioms or fundamental claims of the theory, the way in which a wide variety of claims (both theoretical and empirical) can be obtained from these axioms and so on (the details of which aspects of practice will act as truthmakers will depend on how one understands ‘elegant’). Likewise, the second can be characterised via the embedding of empirical sub-structures into theoretical structures, again on the model-theoretic account. But it is made true by a complex nexus of practices involving the obtaining of predictions or the identification of experimental consequences more generally and the testing of such consequences through experiments. Finally, consider the statement ‘According to standard QM, undisturbed systems obey a linear dynamic.’ Consider how we would determine whether such a claim is true: if we were smart enough we would take the appropriate definitions of ‘undisturbed system’ and ‘linear dynamics’ and work through the mathematics ourselves, such ‘working through’ constituting a form of practice. More likely, we would pick up a textbook and look for the relevant statements supporting such a claim, these statements being the product of, and thus encoding, in a sense, the relevant practice. Note that in all cases, we are not talking about the truth or falsity of claims the theory makes about the *world*, but rather the truth or falsity of claims made about the *theory*.

Now some obvious concerns arise. The first is that this approach doesn’t seem to accord with how we, or more pertinently, scientists, use, refer to, describe and so on, theories. When Einstein’s General Theory is referred to in the latest volume on quantum gravity, that referral does not appear to bring in train a whole complex set of practices but rather appears to denote a single entity. But of course the equally obvious response is that appearances can be deceptive! The name ‘General Theory of Relativity’ denotes, on this view, not some abstract entity but rather the whole set of practices, just as ‘The Supreme Court’ denotes the set of five individuals and their practices (say), or ‘Islam’ denotes a whole set of religious practices. On this view, although it remains sensible to talk of theories as abstract *in English*, all that really

exists are concrete practices, and it is the failure to appropriately distinguish our talk between colloquial English and the more restricted language that expresses our ontological commitments to such practices (that is, a form of ‘Ontologese’ appropriate in this context), that generates the appearance of paradox.²⁷

The second concern is that even if we were to stop writing articles and carrying out experiments we might still want to say that a given scientific theory ‘existed’. Now the insertion of scare quotes here indicates that we need to be a little careful with how we understand the term. We certainly want to avoid any question begging, since on the view being defended, theories don’t exist, qua abstract objects, have never existed as such and hence will not continue to exist (or stop existing) were science to come to an end. But it does seem right to say that it would be appropriate to *refer* to theories as ‘existing’, in English, even if all of the relevant practices were to be halted. But how can it be appropriate, if the truthmakers for theory talk *are* the practices?

One response might be to say that we could still refer to Einstein’s theory, say, but the name would really denote a set of past and no longer evolving practices. We could still write about and describe that theory and in that sense the theory would still continue to exist—namely in the sense that the past practices and associated discussions etc. existed and can still be referred to if necessary. It may seem strange to say that the theory exists *now* because of what happened in the *past*, but this can hardly be an objection given the distinction between English and Ontologese. Alternatively one could insist that as long as the relevant books, papers, etc. continue to exist, then the reading of such books, the working through of examples and so on, constitute a set of practices sufficient to constitute truth-makers for the relevant claims.

Of course, if not only the human race but all sentience across the universe were to cease to exist, and all traces of our existence, our practices etc., wiped out, so that there was no longer even the possibility of ever referring to these sets of practices, and indeed, no traces of past practices to mediate that reference, then in that sense

²⁷ Alternatively one could maintain that the term ‘General Relativity’ refers to the theory of General Relativity but insist that having a singular term of English occur in a true sentence of English doesn’t suffice to bring ontological commitment to the denotation of that singular term. Thanks to Ross Cameron for pointing this out.

theories might be said to no longer exist, even nominalistically understood, but that seems to us to be a not particularly problematic consequence of this line. Indeed, one might worry that there is some question-begging going on here in that the sense of appropriateness above depends on blurring the English/Ontologese distinction and taking ‘General Relativity’ to be referring to something over and above the relevant set of practices.

Nevertheless, the main thrust of this objection could be pushed a little further. Suppose Sherlock Holmes, faced with various clues at a crime scene, were to suddenly think up a theory of what happened in his own mind. At that precise moment it might seem perfectly natural to say that the theory exists, but there haven’t *been* any relevant practices which could make this true. Taking *future* practices as the relevant truth-makers seems to be pushing the relationship between our language and the world a bit too far. Furthermore, suppose that Sherlock Holmes dies before he manages to pass on his theory. To say ‘the theory existed’ is true in virtue of the practices that *would* have happened if Holmes had lived seems unpalatable, as does the alternative claim, to say that the theory never in fact *did* exist.

Of course, one straightforward response is simply to deny that scientists or even Sherlock Holmes ‘suddenly’ think up theories and insist that there is always a heuristic context in which certain moves are made, that in turn ‘bleeds over’ into what has been called theory ‘pursuit’. In that case, the claim would be, there are always sufficient bits of practice to function as the truth-makers of the relevant claims, particularly as the latter will be of the form ‘this theory is worth pursuing’ or ‘this theory shows promise’, as they will be, since, by assumption, the theory has not yet been thrown to the justificatory wolves. And if it were to be insisted that Sherlock, or our putative scientist, was never involved in any such heuristic moves and that the theory really did just ‘spring’ into his/her mind (as has indeed been claimed about certain scientific theories), one might be tempted to insist back that in that case what we are dealing with is not actually a ‘theory’ but just a speculative thought.

The strength one attributes to the above objection may depend on what one takes to count as a ‘theory’.²⁸ Perhaps some would want to insist that, in the previous example, Sherlock really *did* have a ‘theory’, and not merely a ‘speculative thought’, and that grounding the truth of claims about theories in practices comes at too high a cost. Consider the statements about quantum mechanics referred to above: to make these true it can be argued that we need something that goes beyond all possible practices, namely, meaning, human understanding, thoughts, or, generally speaking, the mental representations of various kinds we all experience and make use of when we think, reason, understand, and so on. Could such things stand as the necessary truthmakers?

Here we could resort to some of the considerations mentioned above, in §3.2. We could begin by saying that what matters vis-à-vis theory-talk are the mental representations (about a certain domain of phenomena) common to individuals in the relevant scientific community. The difficulties encountered in §3.2 do not arise here, since we are no longer *identifying* theories with these thoughts: fundamentally speaking theories do not exist. But theory-*talk* can be assessed by looking to what is going on in the minds of those in the relevant scientific community.²⁹ One can then understand the truth of, for example, ‘Quantum mechanics is an elegant theory’ as given in terms of some aesthetic element associated with the relevant mental phenomena. Likewise the statement ‘According to standard QM, undisturbed systems obey a linear dynamic’ is made true by an understanding of the statement and its component elements that is shared by relevant scientists.³⁰ And the Sherlock

²⁸ There is more to say about evaluating the counterfactual claims here and the truth of the assertion ‘had there been no human practices and thoughts, there would have been no scientific theories’ may depend on our views of such evaluation. Thus, if it is accepted that judgments about such possible worlds are made from this, the actual, world, then perhaps we can maintain that we have actual truthmakers for the counterfactual claim that there would still have been theories, even if thinking about that possible world *as actual* yields the conclusion that there are no theories there. Again, we’d like to thank Ross Cameron for suggesting this.

²⁹ It has been pointed out that at least since Frege, there have been arguments against the identification of abstract objects with collections of psychological objects. However, it is important to appreciate that we are not *identifying* theories with such objects or collections thereof; rather we are invoking the latter as truthmakers for sentences about such theories. We are grateful to one of the referees for encouraging us to be clear about this.

³⁰ Of course it may be that this is *not* accepted by everybody in the relevant scientific community, or even that its contrary is accepted. Such cognitive facts may then in turn

Holmes case is straightforwardly resolved: what makes it the case that a theory existed, just before Sherlock died, are the mental representations that existed in Sherlock's mind just before he died.

Of course, this is still a difficult line to take in some respects: there are difficult questions to ask in the philosophy of mind. How exactly should we understand these 'mental representations' that do the truth-making work? What is the relationship between a mental representation in one mind and that in another? Can these ever truly be exactly the same? If not, how should we think about the *similarity* of one mental representation to another?

Many of these questions do not have to be answered right away. If we grant that a single individual can conjure up in their own mind a theory about something, as in the case of Sherlock Holmes, then it seems clear that the theory can be 'transported', with minimal distortion, from that first mind to a second mind by way of language (written or spoken). There will then be significant overlap between the theories in these two minds, even if they are not 'exactly the same'.³¹ If this is accepted, then it seems plausible to say that a scientific theory can be conceived as a large scale version of this: a complicated network of overlapping mental representations in the minds of individuals in the relevant scientific community. Finer details can be left to philosophers of mind.

However, there may be a further important disanalogy between the kinds of theories conjured up by Sherlock Holmes and scientific theories. The latter are more complicated, involve more abstract ideas, and often involve complicated mathematics. Arguably, this means that nobody can hold such a scientific theory in their own head. Giere (2002) argues that even multiplying together 456 and 789

support claims to the effect that 'QM is not committed to a linear dynamics'. The issue as to whether QM should be considered broad enough to encompass linear and non-linear dynamics or whether the introduction of forms of the latter (for undisturbed systems) contribute toward the introduction of an entirely new theory eventually takes us to the further issue of the identity conditions for QM, or theories in general. Our approach allows us to sidestep this issue since we do not think there are theories, qua objects, that have identity conditions.

³¹ It is a truism of cognitive science that every mind differs from every other, because every brain differs from every other. Churchland (1989, Ch.9) describes scientific theories 'naturalistically', in terms of 'configurations of synaptic weights' in the brain. Given the neurophysical composition of the human brain, Churchland calculates that it can hold $10^{100,000,000,000,000}$ different theories!

usually means ‘creating and manipulating *external representations*’ (p.288, original emphasis). In other words, we have to start writing things down to work through the problem. Similarly, it might be claimed, theories cannot be conceived unless we start writing things down to assist our minds. Giere goes on to recommend that we think in terms of *distributed cognitive systems*, essentially a combination of the internal (whether in a single individual or in many) and the external. He argues that only fragments of a theory exist within any one mind at any one time.

Whether one should take this route depends on how one answers the following question: Do we want to say that a given theory (quantum mechanics, say) would disappear if all external representations (books, articles, physical models, etc.) were destroyed? Or would it still exist, in a sense, simply in virtue of the *internal* representations which would still exist in people’s minds? If one thinks of the truthmaker as a network of overlapping mental representations we might be inclined to say that the theory *would* still exist, simply in virtue of the fact that each part of the theory would at least exist in *some* mind, which could then, in principle, be communicated to all the others. However, clearly we hold very little consciously in our minds at any one time, so that it is reasonable to suppose that there would be times when certain parts of certain theories would not exist in *any* mind (consciously, at least). On the ‘mental representations as truthmakers’ view, would this then mean that the theory didn’t exist at that moment?

Given the difficulties with focusing on only practices or only thoughts, an obvious third option would be to combine the two. Certainly, there is no *metaphysical* advantage in having truthmakers which are only one type of thing (apart from classificatory simplicity), and if one accepts a combination of types of truthmaker for theory-talk, the above objections dissipate. Of course, one might then worry that inhomogenous truth-makers imply a fundamental inhomogeneity in theories (think of the analogous situation for ‘statues’). But remember, these don’t actually exist so what we would really be dealing with is a kind of inhomogeneity in theory-talk, which is much less worrisome. Furthermore, this option might assuage the concerns of those who feel neither practices alone nor thoughts/mental representations alone can provide the appropriate truth-makers for statements such as

‘Quantum mechanics is an elegant theory’ or ‘According to standard QM, undisturbed systems obey a linear dynamic’

Whatever option one chooses, our central point is that the relevant truth-makers do not have to be, and should not be taken to be, abstract objects. ‘Theories are abstract objects’ is a true statement of English, but what makes it true are concrete practices and/or internal and external representations. In this way no inflation in ontology is required.

5.2 Objections from World 3

A Popperian, of course, will have serious objections to the above analysis. Popper famously argued that things exist either in a ‘World 1’, as physical things (including energy), in a ‘World 2’ as mental processes (including thoughts and desires), or in a ‘World 3’, occupied by scientific theories as well as works of art (including musical works) and social institutions (Popper 1978). He writes,

Examples of world 3 objects are: the American Constitution; or Shakespeare’s *The Tempest*; or his *Hamlet*; or Beethoven’s Fifth Symphony; or Newton’s theory of gravitation. (Popper *ibid.*, p. 145)

The relationship between objects in worlds 3 and 1 appears akin to that between types and tokens: there are many different copies of *The Tempest*, scattered about ‘World 1’ but insofar as they contain the same text, they are all the embodiment or physical realization of ‘one and the same book’ that ‘lives’ in ‘World 3’. Significantly, Popper draws this distinction as follows:

One can, if one wishes, say that the world 3 objects themselves are *abstract* objects, and that their physical embodiments or realizations are *concrete* objects. (*ibid.*)

However, the relationship between these two kinds of objects is not to be conceived of in Platonistic terms. First of all, the objects of ‘World 3’ are not timeless (as Cameron’s ‘abstract objects’ are); indeed, Popper takes it as crucial for his overall epistemology that theories, qua ‘World 3’ objects, be seen as tentative and hence as

subject to change. He writes,

In opposition to Plato and Hegel I consider *tentative theories* about the world—that is, hypotheses together with their logical consequences—as the most important citizens of the world of ideas; and I do not think (as Plato did) that their strangely non-temporal character makes them eternal and thereby *more real* than things that are generated and are subject to change, and to decay. On the contrary, a thing that can change and perish should for this very reason be accepted as *prima facie* real; and even an illusion is, *qua* illusion, a real illusion. (Popper 1972, p.300)

Secondly, these objects interact causally with those of the other worlds:

[T]hey [the objects of ‘World 3’] may be real in that they may *have a causal effect* upon us, upon our world 2 experiences, and further upon our world 1 brains, and thus upon material bodies. (Tanner lectures p. 150)³²

Already it is clear how Popper would respond to the paradox introduced above. For him scientific theories are *not* either abstract objects (in the modern sense) or concrete objects, but they can instead be ‘World 3’ objects, which *can* be created, and which are *not* causally inert. In other words, his alternative metaphysics allows him to reject S2 or, if one wants to use the word ‘abstract’ to refer to World 3 objects (as Popper does sometimes), to reject S3. In this way Popper agrees with the arguments in §3.1, and also with those in §3.2 that scientific theories cannot be identified with any *concrete* thing. In short, the paradox is undermined because he rejects the underlying metaphysical picture.

Now, the most obvious objection is that we should not introduce a new ontological category without good reason. However, the only sensible alternative to ‘World 3’, Popper thinks, is that theories are mental representations, whether conceived of physically in terms of memory engrams, or ‘mentalistically’ in terms of mental experiences. His rejection of the mental representation account when it comes to musical works such as Beethoven’s Fifth is based on the claim that unless such

³² This is similar to Thomasson’s account of artworks, which we encountered in §3.3. For more see Thomasson 1999.

objects were taken to exist, we would have no way of objectively judging what is a good or bad performance of them.

One response to this would be to simply accept that, in fact, we *don't* have a way of objectively judging what is a good or bad performance of Beethoven's Fifth, but have to rely on our own past experiences, our own aesthetic judgement, and what other people tell us. But in fact it isn't even clear that this argument crosses over to scientific theories very well. Arguably, we don't have good or bad 'versions' of Einstein's theory of relativity, for example, and at any rate we *can* judge whether we have Einstein's theory of relativity 'right' (in some sense), by working out whether it provides the predictions and explanations Einstein's theory is supposed to achieve.³³

Perhaps it is better, then, to look to Popper's positive arguments for the existence of theories as 'World 3' objects. The first follows from his non-Platonist conception of this world, as indicated above, and invokes a causal criterion of reality:

[W]hat is real or what exists is whatever may, directly or indirectly, have *a causal effect* upon physical things, and especially upon those primitive physical things that can be easily handled. (p. 153)

Thus, what he calls his 'fundamental argument' invokes the way in which science has changed the (physical) world, or more particularly, the way in which 'conjectures and theories' are used as 'instruments of change'. Hence,

[S]cientific conjectures or theories can exert a causal or an instrumental effect upon physical things; far more so than, say, screwdrivers or scissors. (p. 154)

Now in defending this claim against the opposing view that it's the mental representations—whether conceived of physically or mentalistically—that exert causal effects, Popper argues as follows. He distinguishes between the subjective thought processes that led to, for example, the Special Theory of Relativity, and the objective *content* of that theory by noting that,

³³ There might be questions of better or worse *interpretations* of the theory, of course.

There are many important logical consequences of the Special Theory of Relativity which Einstein did not think of in 1905; and there may be important logical consequences of this theory which nobody has thought of so far, and which perhaps nobody will ever think out. (p. 158)

In particular, mental experiences, however conceived, can stand in causal relationships with one another, but not in logical relationships. Thus he insists,

These purely objective logical relationships are characteristic of the entities which I have called theories, or knowledge, in the objective sense. (1972)

That these logical relationships are objective can be inferred from the point that, with regard to Einstein's theory for example, there are many such relationships that are not conceived of when the theory is first proposed, or that are never conceived of. However, one can agree to this whilst disagreeing with the claim that theories cannot be mental entities for *this* reason. If one accepts that two beliefs can be inconsistent one must accept that at least some mental entities can stand in logical relations.

However, Popper continues his argument as follows,

[A] full understanding of a theory would mean understanding all its logical consequences. But these are infinite in a non-trivial sense: there are infinitely many situations of infinite variety to which the theory might be applicable; that is to say, upon which some of its logical consequences may bear; and many of these situations have never been thought of; their possibility may not yet have been discovered. But this means that nobody, neither its creator nor anybody who has tried to grasp it, can have a full understanding of all the possibilities inherent in a theory; which shows again that the theory, in its logical sense, is something objective and something objectively existing – an object that we can study, something that we try to grasp. (1972, p.299)

The key element of this passage, we believe, is that theories *cannot* be mental objects, because theories include their consequences, but some of these consequences do not exist in any mind. One can reconstruct the argument as follows:

- 1) a theory consists of a number of (explicit) hypotheses together with their consequences (as Popper insists in the quote above);
- 2) many of these consequences are not known when the theory is proposed, at time t ; hence,
- 3) such consequences cannot be simply mental representations or otherwise said to exist in the mind; and,
- 4) it is implausible to regard them as concrete entities; hence
- 5) these unconceived consequences, as constitutive parts of theories, are not in minds or concrete at time t ; hence,
- 6) the only alternative is that they exist in World 3 at time t ; but,
- 7) if parts of theories exist in World 3 at time t , then theories as a whole must exist in World 3 at time t , and,
- 8) even if we do work out these consequences at some later time, that should not mean that they now exist in our minds, such that World 3 is redundant, but rather than they still exist in World 3 and the only difference is that now we know about them.³⁴

Even if one rejects the syntactic view of theories as sets of hypotheses and their logical consequences, the argument still goes through as long as theories are thought to have as constitutive elements explicit parts and unknown consequences of these explicit parts. But if these unknown consequences do not exist in concrete form or in any mind (at time t at least), then where do they exist? In World 3, says Popper.

Of course, one might question premise 5, arguing that insofar as deducible consequences are obtained from their premises, if the latter are ‘in the mind’ then so must be the former. Or, relatedly, one might question the lack of logical omniscience on which this argument appears to depend; or, more radically perhaps, one might simply insist that the logical consequences in question are not proper parts of the

³⁴ Perhaps Popper’s emphasis on an *infinite* number of consequences can be introduced at this final stage, to show that however many consequences we discover, there will always remain further unconceived consequences in World 3. However, we don’t feel there is any need to demand such an infinite number of consequences: the main point is to show that World 3 is a necessary ontological category, and this can be achieved by contemplating time t , before many important consequences have been identified.

theory per se (that is, one would deny that a theory is constituted by its deductive closure). However, as it stands the argument carries little force from our point of view, since it assumes that which we deny, namely that theories exist. We can incorporate and render more plausible Popper's problematic claim that theories have causal powers, for example, by saying that the mental representations and/or scientific practices which stand as truthmakers for theories have causal powers.

However, what about the idea that theories are 'something we can study, something we can try to grasp'? In this context Popper argues that theories, as described above, have a property that *only* existing things could have: the element of *surprise*. He writes,

Such a theory, or such a system, is infinite, and may be full of surprises. Thus it must have been a surprise for Einstein when he found, shortly after writing his first paper on Special Relativity, that the now-famous formula $E = mc^2$ could be deduced from it as a theorem. (Tanner lectures, p.162)

Popper intends this aspect of 'surprise' as a mark of the reality of something: just as physical objects surprise us as we discover more about them, so too do scientific theories.

One might respond by rejecting this element of surprise as such a mark of reality. Wittgenstein, famously, gave such an idea short shrift and as Simons has noted, his objection is straightforward:

'... the reasons why people are surprised lie in their limitations: a proof is too long to keep all its steps in mind, so something is lost from purview.' (Simons, unpublished)

Leaving such objections aside, this element of surprise can also be incorporated into our account. What makes it true to say 'the consequences of this theory surprised everyone'? How can the truthmakers, our own thoughts and/or practices, surprise us? Insofar as the relevant practices will involve physical objects – and on Popper's own view, these may surprise us – so practices in general may incorporate elements of surprise. And certainly our own *thoughts* can surprise us if we accept that those thoughts (or their propositional representations) can have consequences we

haven't deduced yet. We might reject the claim that consequences are somehow contained within the relevant premises and argue that the element of surprise comes because we have certain beliefs plus certain rules for generating new beliefs therefrom, not because the new beliefs actually already exist and we *discover* them as we make our inferences. We talk as if the latter is true, but that doesn't have to mean that it *is* true, ontologically speaking. As we have seen above, the distinction between English and Ontologese allows us to speak in one way but to have quite different ontological commitments.³⁵

Thus, even if we accept all of Popper's concerns and intuitions (and as we have indicated some of these are problematic) our account can accommodate them but without having to invoke any 'World 3'.

5.3 Fictionalism

Another view that would have no difficulty with the paradox is fictionalism. This view holds that theories (and on some accounts musical works also: see Bueno 2008) are fictional objects. As with Popper, the paradox dissolves because the underlying metaphysics is rejected.

Suggestions along these lines can be found in earlier works, such as (Cartwright 1983, p.153) and Giere identifies (but rejects) three reasons for adopting such a view (Giere 2008b): 1) that scientists themselves sometimes invoke fictional entities when discussing theories and models; 2) that many such models are not actually realizable; and 3) that this view meshes with a fictionalist (and anti-realist) account of science in general.

Each of these motivations can be rejected. Thus, when scientists talk of certain entities postulated in the context of a given model as 'fictional', what they typically mean here is that there is no counterpart of such entities in the real world, and Giere (rightly) sees no reason to regard the model itself as fictional, on that basis. Furthermore, such discourse, whether applied to elements of a model, or the model itself (as in the case of Maxwell's model of the ether) provides no reason for

³⁵ Authors of fiction often say that the actions of their fictional characters surprise them, as if they have 'a mind of their own' (see eg. Spacks 2006, p.76). But it would be too much to suggest that we should admit the character really *does* exist on these grounds!

supposing that the models concerned *function* as works of fiction in the way that novels do. It is this functional aspect that Giere identifies as crucial. As for the second motivation, claims of an imperfect fit between models and the world at best motivate the view of models as involving significant approximations and idealisations, rather than as being fictional. And finally, leaving aside the well-known criticisms of fictionalism (or the ‘as if’ view) as a form of anti-realism, a fictional account of models is also compatible with forms of moderate realism, weakening the motivation here as well.

Giere concedes that theoretical models and works of fiction are ontologically on a par in that they are both imaginary constructs but insists that they have dramatically different functions in practice. Novels and other works of fiction can plausibly be said to have many functions, with entertainment perhaps top of the list, but with scientific models, one such function stands out, namely that of representation. It is this, primarily, that makes it inappropriate to regard scientific models as works of fiction (*ibid.*)

Contessa has also taken up this idea that models are imaginary entities but articulates it in a more sophisticated manner that offers a useful comparison with our view (Contessa forthcoming).

Thus he focuses on a particular kind of model, exemplified by that of the simple pendulum (so, explicitly not ‘physical’ models, such as Crick and Watson’s model of DNA, nor ‘mathematical’ models, such as the logistic growth model in population biology). As he notes, these models have some of the characteristics of physical objects, but are not taken to exist, just like fictional characters in literature. Both ‘fictional models’ and fictional characters are to be characterized as two analogous species of ‘imaginary objects’. This still leaves considerable scope as to their ontological status and Contessa rejects the suggestions that fictional models should be conceived of either as possible concrete objects, or as actual abstract objects. With regard to the latter, in particular, he argues that it is difficult to make sense of the claim that certain propositions regarding such models are true ‘in some sense’ on such a view.

Instead he adopts a ‘dualist’ account according to which a fictional model is an abstract object that ‘stands for’ one or other of a set of possible concrete systems.

What he calls ‘external’ sentences about such models (such as sentences describing their creation, for example) talk of them as models, whereas ‘internal’ sentences (such as those that refer to the internal composition of the model, for example) talk of them as if they were concrete physical systems.³⁶ The former can be literally true, while the latter are literally false, but insofar as the model can be considered to ‘stand in’ for a particular concrete system, they can be regarded as true ‘by proxy’. On this account, the creation of a model involves the public description of a possible system in a given context and its proposal as a model of a certain kind of actual system. This ‘generative’ description of the model can then be further specified or altered in various ways as it is both itself investigated and applied to a range of situations.

Unlike Giere, who regards such a description as complete, Contessa takes it to have an open-ended character, in the sense of features that are neither explicitly nor implicitly attributed to it but that are unforeseen at the time of creation and can be subsequently discovered, as in the case of the stability of the Rutherford/Bohr model of the atom. And whereas the implicit characteristics can be excavated through logical investigation, these other features that give models their truly open-ended character³⁷ typically arise when further laws are applied to the objects of the model, as in the case of the Rutherford/Bohr model and the laws of electrodynamics.

Here we have a dual ontology involving both abstract and possible objects that also avoids the paradox by deploying a linguistic division and allowing for a robust sense of creation. However, as Contessa acknowledges, it is metaphysically inflationary. Nevertheless, he insists, in the absence of any viable alternative, the package should be accepted. We hope to have provided just such a viable alternative here. Furthermore, we can straightforwardly accommodate Contessa’s distinction above: external statements about models are made true by the relevant practices and/or thoughts without needing to suppose the existence of any ‘stand in’.

5.4 Concrete/abstract

³⁶ Cf. the Suppesian distinction between ‘external’ or extrinsic and ‘internal’ or intrinsic characterisations of theories as deployed by da Costa and French ([2003]).

³⁷ Cf. the partial structures approach to models (da Costa and French [2003]), proposed in large part to capture the open-ended nature of theories and models.

We have now seen several alternative accounts of types of existence, including Popper's trichotomy of Worlds 1, 2 and 3, and Contessa's trichotomy of concrete, abstract, and possible. In the above analysis we have indicated problems with each of these accounts, chiefly owing to unnecessary metaphysical inflationism. Our own deflationary view may appear to depend on a standard distinction between concrete and abstract and concerns may be raised with regard to this. In particular, there appear to be good reasons to doubt that this distinction can tolerate the weight put upon it. And if it does not hold up it might be objected that we don't have a paradox in the first place, because S2 and S3 refer to a concept, *abstract*, which isn't sufficiently well understood.

As Rosen has pointed out (2001), the drawing of this distinction between the concrete and the abstract as one that holds between objects is not only peculiar to the last hundred years or so, but is also notoriously difficult to characterise. Appealing to causal efficacy, or the lack thereof, is problematic insofar as the involvement of physical objects in causal relations—standardly taken to hold between events—remains unsatisfactorily explicated. Likewise, appeals to spatio-temporality may not be decisive either: Rosen gives the counter-example of physical objects such as photons that may be said not to have spatio-temporal location (this is itself problematic of course) and of supposedly abstract objects, such as chess, which arguably did come into existence at a certain time in a certain place, and has changed over the years. Indeed, there is a clear analogy between the latter example and theories: it seems odd to say that Einstein's Special Theory of Relativity existed before 1905 (although that sense of oddness could be dissipated by someone keen to maintain such an existence claim by, for example, explicating how eternally existing abstract objects such as chess and relativity theory are effectively accessed and hence appear to come into existence at a certain time and place) and as we saw Popper regarded theories as both abstract and subject to change.

However, we can avoid these thorny issues by reformulating the paradox without referring to the word 'abstract'. Instead, one simply specifies precisely which properties of theories we intended the word 'abstract' to convey, as follows:

1. Theories are created.

2. Theories are non-concrete, public objects.
3. Non-concrete, public objects cannot be created.

The first statement is just as before. The second statement does the work S2 was intended to do. We still won't be able to find any good candidate for theories that is concrete, and mental entities still won't do because they are non-public. And finally, the third statement does its work because the only public objects that can be created are concrete, and the only non-concrete objects that can be created are subjective, non-public mental entities such as ideas. In this way, the paradox retains the force it always had, but one avoids the difficulties associated with the many subtly different ways the word 'abstract' is used in the literature.

6 Conclusion

The paradox of musical works *does* retain its force when it is applied to scientific theories: *prima facie* it isn't at all obvious what statement to reject. However, Cameron's 'fourth way' provides a natural solution. The paradox splits into two: one paradox expressed in colloquial English and one in the language that expresses our ontological commitments in this context whether that be 'Ontologese' or whatever. In English it is resolved because it is natural to say that abstract objects *can* be created. In the language of ontological commitments it is resolved because, fundamentally speaking, scientific theories do not exist. Instead what exists—what makes talk of theories and their properties true or false—are either (i) scientific practices, (ii) thoughts in the minds of those in the relevant scientific community (possibly supported by external representations), or (iii) some combination of the two.

It might be claimed that our approach is at best only as convincing as Cameron's original argument, which is itself contentious (for, among other things, presupposing that abstract objects cannot be created). However, our conclusions do not depend on how good Cameron's account is *in the first place*. Rather, what we are doing here is adapting Cameron's account and then *showing* that it is a good approach in the

current context because it is able to solve a new and genuine paradox without necessitating ontological inflationism (and we definitely *don't* agree with everything Cameron says!). We accept that there are alternative ways out of the paradox by, for example, claiming that abstract objects *can* be created, but as noted above we don't think this approach holds much appeal when it comes to scientific theories. More importantly, we think we can escape the paradox without the ontological costs of these alternatives.

Of course, more needs to be said about what we *are* ontologically committed to. Whichever of the three options above is preferred, philosophers' discussions of scientific theories will have to be reassessed. Theories are not the simple, logical entities assumed (still) in the vast majority of discussions within the history and philosophy of science. Since scientific theories play such a fundamental role in such discussions, their nature deserves more attention than it has thus-far enjoyed. Until we are clear on how to talk about theories, we are not clear on how to talk about science.

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