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Interactive Realism

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Abstract

I investigate a new understanding of realism in science, referred to as 'interactive realism', and I suggest the 'evolutionary progressiveness' of a theory as novel criterion for this kind of realism. My basic claim is that we cannot be realists about anything except the progress affected by myriad science-reality interactions that are constantly moving on a continuum of increased 'fitness' determined according to empirical constraints. Moreover to reflect this movement accurately, there is a corresponding continuum of verdicts about the status of the knowledge conveyed by theories - ranging from stark instrumentalism to full-blown realism. This view may sound like a pessimistic inductivist's dream, but actually this is so only if one evaluates it from within a traditional context where the 'truth' of a *single* theory is the exclusive criterion for realism. I, on the other hand, want to redefine the terms of realist debate in such a way that the units of assessment of realism are *sequences of theories* evaluated according to their 'evolutionary progressiveness'. I unpack 'interactive realism' by defining my notion of 'evolutionary progressiveness', the notion of 'truth-as-historied reference' underpinning it, and the continuum of interaction between theories and aspects of reality it affects. I conclude that, although interactive realism is a radically non-standard kind of realism, it is at least more realistic about science as a fractured complex multi-faceted enterprise than most other kinds of realism on the block, because it shows coherence amidst fragmentation.

1. Introduction

In this article I argue for a complete reconsideration of the notion of scientific realism. Rather than focus on the truth of single theories, my basic claim is that we cannot be realists about anything except the progress affected by myriad science-reality interactions that are constantly moving on a continuum of increased 'fitness' determined according to empirical constraints. Moreover to reflect this movement accurately, there is a corresponding continuum, ranging from stark instrumentalism to full-blown realism, on which verdicts about the status of the knowledge conveyed by theories move.

Specifically I speak of the 'evolutionary progressiveness' of theories, where 'evolutionary' means no more than gradual adjustment according to changing empirical constraints, and 'progressiveness' is interpreted not exclusively in terms of novel facts, but rather in terms of gaining more and more nuanced and complex knowledge of an aspect of reality. Most importantly, measurement of 'evolutionary progressiveness' reflects the different degrees of continuity manifested by theory change, the heuristic value of 'misguided' theories, and the heuristic coherence of the layers of information expressed by incompatible theories. My claim is that the more of the theories effecting interactions with a given aspect of reality turn out to be 'evolutionary progressive', the more sure realists can be that there has been scientific interaction with postulated unobservable entities such as electrons or genes, which may allow them to claim that the knowledge at issue here is knowledge of 'actual 'entities.

I propose that this view, however foreign it may sound, and however non-standard it is, is still a realist one, because 1) it accepts the metaphysical assumption of a reality existing independently of science, 2) the existence of unobservables can be established albeit in a historied manner, 3) 'truth' plays a role in establishing realism about scientific interactions, but is unpacked in terms of historied causal reference.

In the next section I position interactive realism as neither an entity nor a 'theory' realism. I then discuss the various degrees of continuity displayed by the functioning of science. In order to do justice to these degrees of continuity, I then unpack my plea that the unit of 'appraisement' of realist content is an 'evolutionary progressive' sequence of

theories augmented by other, possibly incompatible, such sequences of theories about the same aspect of reality, and supported by the series of relations of reference displayed by each such sequence. I then discuss my notion of 'evolutionary progressiveness', the notion of reference underpinning it, and the continuum of interaction between theories and aspects of reality it affects. I conclude that, although interactive realism is a radically non-standard kind of realism, it is more realistic about science as a fractured complex multi-faceted enterprise than most other kinds of realism on the block, because it shows coherence amidst fragmentation.

2. Realism about Entities, Theories, or Interactions?

Ian Hacking and Nancy Cartwright made the distinction between realism about theories and realism about entities famous. The understanding is that realism about theories is about truth and realism about entities is about existence. I add another option, namely realism about scientific interactions at various levels (as expressed in 'evolutionary progressive' sequences of theories).

I agree with entity realists that traditional realism about theories is untenable. I agree because of the fact that theories 'lie' in the main derogatory sense of Cartwright's (1983) word – i.e. because of the idealised nature of theories, the fact that they are mostly applied by mutually incompatible models, and the fact that such models are only in very rare cases deducible from theories. I do think science is trustworthy though, because it is self-revising and because it is adaptive, and it is because of this that I think we can say that it is 'about' reality. But, I am getting ahead of myself.

Although entity realism is a fantastic thought, especially if one has to be an anti-realist about theories, I cannot accept it. Leaving other critiques (e.g. Clarke, Dilworth, de Regt, and many others) aside, specifically I cannot accept, despite all his arguments for the various kinds of interaction between theory and experiment (see e.g. Hacking 1983, 155-162), Hacking's somewhat idealistic separation of theory and experiment in his defense of entity realism. The artificiality of the a-historical context – or "snapshot view of history" (Vicedo 2000, 238) - in which such a separation is affected, is simply not

acceptable. I agree with Vicedo (2000, 237) who stresses that to "assess the 'trustworthiness' of an experiment and any associated claims about the existence of unobservable entities, we need to analyse it within the tradition in which it is embedded, as part of an ongoing process of inquiry about a given aspect of the world" (see also specifically Morrison 1990 for similar arguments). Moreover the kind of symbiosis between empirical work and theorizing necessary to effect 'evolutionary progressiveness' (to be explained soon) is in full agreement with both Morrison (1990) and Vicedo's (2000) pleas for acknowledging the interwovenness of theories and experiment.[1]

Consequently, the realism that I defend here is not a theory realism, but neither is it an entity realism in the full sense of the word. Rather it is a realism about scientific interaction which stresses, more than the experimental side of science only, also the gradual adaptation of science according to current empirical constraints. The core ideas behind this 'interactive' realism, which will be unpacked in the following sections, are: (1) Scientific knowledge is tentative in the positive sense that it is continuously in a state of 'evolutionary' self-revision, renewal and refinement. (2) Science reaches out to systems in reality in myriad ways and via myriad theories – some, or most, of them mutually incompatible. (3) In making their claims about the status of scientific knowledge about a certain entity or aspect of reality, realists consider 'evolutionary progressive' sequences of all available (compatible and incompatible) theories studying this entity, superimposed over the relations of reference displayed by each theory in each sequence. (4) To do justice to the functioning of the continuously evolving self-corrective enterprise which is science, I suggest realist verdicts about the status of scientific knowledge must be as tentative as science is.

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[1] Vicedo (2000, 222-232) uses Castle's experiment to test if selection could modify the hooded pattern in hooded rats to show the importance of interlaced empirical and theoretical assumptions in deciding if it were indeed genes that were manipulated in the experiment, while Morrison (1990, 12-13) uses, *inter alia*, the investigation into the aspect of reality of 'charmed quarks' in the seventies to show that given that there was no consensus at the time on whether or not quarks existed, it was not so much their manipulation, but rather "… the interaction between theory and experiment that occurred at various stages throughout the investigation that finally produced commitment and belief" (Morrison 1990, 18).

3. The Functioning of Science: Degrees of Continuity, Sequences and Realism

Scientific knowledge is tentative because science is a self-revising enterprise and reaches out to reality in myriad ways. In order to do justice to these features of scientific knowledge, realism must be able to deal with the different degrees of continuity manifest through theory change and with incompatible theories about the same aspect of reality.

In this context, consider first what may happen in the case of differently slanted, but compatible investigations of the same aspect of reality. Here there is a kind of 'collaborative continuity', for instance, a wide selection of people worked on different aspects of cathode rays - the Curies, Röntgen, Villard, Thomson, Rutherford, Einstein - and these different investigations led to different 'discoveries', i.e. X-rays, the existence of radium, the aspect of reality of radio-activity, Rutherford's discovery of neutrons and his description of the structure of an atom, Bohr's atomic model, and many others.

On the other hand, there can also be 'continuity' as a kind of heuristic 'cross-informativeness' in cases of incompatible investigations of the same aspect of reality, for instance the separate work done by Thomson, Lorentz, Bohr, Millikan and others, all contributed valuable information about the charge, mass, and behaviour of electrons, although these physicists did not hold compatible views of the electron. In the latter case, there is a kind of heuristic value in considering incompatible views, in the sense that surely we know more about the electron by knowing that it can be portrayed as a wave or as a particle, than if we would have had only one portrayal?

There is also a third kind of 'disjointed' continuity, or 'benign discontinuity' at issue in cases of 'mismatched representation' and 'misguided' theories, for instance, in the end, Priestley put Lavoisier on the track of oxygen as it were, although he himself never let go of his belief in the notion of phlogiston, and physicists such as Lamor and FitzGerald did valuable work to further quantum research, although they never let go of the relation they saw between atoms (matter) and ether – in other words, here is another variant of cross-informative (dis)continuity. Note that in this sense deletions are meaningful for scientific

work, as are instances of 'mismatched reference', because there is still a kind of heuristic continuity of process at issue.

In the last instance, there is a kind of 'preservative' continuity in the sense that through what can sometimes be centuries, the same aspect of reality is studied although our depictions of it are constantly adjusted. Think for instance of the various guises of 'luminiferous aether' – from Maxwell's model, to FitzGerald's in which wheels played the role that rolling particles played in Maxwell's model (Whittaker 1951, 292), to Thomson and FitzGerald's model of the ether as a vortex sponge; to Lamor's portrayal of the ether as "an immaterial medium, … not composed of identifiable elements having definite locations in absolute space" (Whittaker 1951, 303); and Lorentz's ether which was "… simply space endowed with certain dynamical properties" (Whittaker 1951, 393), etc. Another example is depictions of 'gene' – "The gene has been considered to be an undefined unit, a unit-character, a unit factor, a factor, an abstract point on a recombination map, a three-dimensional segment of an anaphase chromosome, a linear segment of an interphase chromosome, a sac of genomeres, a series of linear subgenes, a spherical unit defined by target theory, a dynamic functional quantity of one specific unit, a pseudo-allele, a specific chromosome segment subject to position effect, a rearrangement within a continuous chromosome molecule, a cistron within which fine structure can be demonstrated, and a linear segment of nucleic acid specifying a structural or regulatory product" (Carlson 1966, 259).[2] Here is a kind of (spiraling) selective accumulation of information.

[2] See also Falk (2010): "The dialectic discourse of the 'gene' as the unit of heredity deduced from the phenotype, whether an intervening variable or a hypothetical construct, appeared to be settled with the presentation of the molecular model of DNA: the gene was reduced to a sequence of DNA that is transcribed into RNA that is translated into a polypeptide; the polypeptides may fold into proteins that are involved in cellular metabolism and structure, and hence function. This path turned out to be more bewildering the more the regulation of products and functions were uncovered in the contexts of integrated cellular systems. Philosophers struggling to define a unified concept of the gene as the basic entity of (molecular) genetics confronted those who suggested several different 'genes' according to the conceptual frameworks of the experimentalists. Researchers increasingly regarded genes de facto as generic terms for describing their empiric data, and with improved DNA-sequencing capacities these entities were as a rule bottom-up nucleotide sequences that determine functions. Only recently did empiricists return to discuss conceptual considerations, including top-down

Of course there could be – and is - debate about these kinds of continuity. Consider views on whether for instance the cases of phlogiston and oxygen are disjointed or preservative (e.g. Kitcher (1993); Ladyman (2009); and Psillos (1997)), whether the cases of luminiferous ether and electromagnetic field are preservative or disjointed (e.g. Psillos (1999), Doppelt (2007)), and how much accumulation there really is in the different depictions of genes through the development of the concept (e.g. Kitcher (1982), Vicedo (2000)). Rather than refuting my plea for recognizing the different ways in which science may be said to be continuous, to my mind this emphasizes the fact that continuity is a many-faceted issue. *But* the myriad ways in which science extends itself towards reality are informative and significant however revisable or inconclusive they turn out to be. This characteristic of the course of science implies that any linear depiction of the course of science and its processes is inappropriate. I therefore plead for describing the course of science as a spiral movement, rather than a linear one.

Describing the course of science in terms of a spiral movement seems apt for my purposes in the sense of 'spiraling' meaning 'winding in a continuous and gradually widening or tightening curve around a central point or axis' – in other words sometimes theories make 'close' contact with the entities or aspects of reality or events they describe (think of theories concerning blood circulation for instance), and sometimes not (think of quantum physics), depending on factors such as quality of available background theories; state of the art of experimental apparatus, methodology, and focus; the nature of the aspect of reality under investigation; etc. Depicting the functioning or course of science as *spiral-like* instead of as linear emphasises the following features of science: its non-stop movement (adaptation) according to empirical (and theoretical) circumstances, the fact that the direction of this movement can change, and different degrees of continuity through theory change. Thus the patterns of the course of science or of scientific theory change are a matter of continuity of various degrees – for instance in the case of the discovery of oxygen, there is a tightening movement at issue when the focus is narrowed

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definitions of units of function that through cellular mechanisms select the DNA sequences which comprise 'genomic-footprints' of functional entities".

down (Conant (1950)), while in the case of plate tectonics for instance, there is a widening movement at issue where more aspects of reality are brought into the focus of the relevant theory (see e.g. Wilson (1968), Hallum (1973)).

Now, part of understanding the functioning of science (and specifically 'evolutionary progressiveness') is accepting the possibility of multiple descriptions of one aspect of reality through the history of its scientific investigation. I mean to investigate the possibility of a form of realism that can include, or at least take note of or consider, *all* such descriptions or explanations, rather than just acting from the viewpoint of one of these. Here I thus plead for considering every twist and turn, every nook and cranny, of the course of scientific investigation of a certain aspect of reality, in order to be able to make the most informed verdict on the status of our knowledge about said aspect of reality.

As I see it – and taken very broadly - science basically consists of a process in which an aspect of reality is studied according to a particular theory – via empirical or causal generalizations - that (indirectly) 'describes' or 'explains' the relevant aspect of reality 'adequately' or 'successfully' at the time. Then, in time, the theory evolves according to changes at the empirical level of science[3], which causes it to offer some more refined descriptions or explanations of the particular aspect of reality, and so on and so on. Note that this kind of self-correcting adjustment itself is a very complex matter of to-and-fro movements between theory and experiment, which absolutely cannot be addressed adequately here.[4] Suffice it to say that such adaptation can be presented as an interlacing of shifting empirical-theoretical maneuverings[5]. On a meta-level – where we find

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[3] Note that changes on the theoretical level can also effect more refined descriptions in this sense. This is however not the focus now, and in the end, such changes are anyhow also in the last instance somehow dependent on empirical change of some kind.

[4] See Hacking (1983, 155-162), Suppes (1967), and also Galison (1987), for discussions of the complexity and different guises of the interplay between theories, experiments, and instruments.

[5] Science and reality interacts in many ways – e.g. through experiments, observations, technology such as telescopes and microscopes, measuring instruments of various kinds, testing of chemical substances and rocks, theories that focus observation or interpret data, etc., etc.

ourselves as philosophers – though, series of such maneuverings may be studied in terms of *sequences* of theories (interactions between science and reality) in a specific field of investigation. Usually there are more than one such sequence, which could all be mutually incompatible or not, but which all study the same aspect of reality – in other words, for instance, and very simplistically put, there could be a sequence of theories depicting an electron as a wave, and a sequence of theories depicting an electron as a particle, and there could be important instances of heuristic cross-informativeness here.

I suggest then that in formulating their verdicts on the status of scientific knowledge about a certain entity or aspect of reality, realists should consider all such available sequences and evaluate them in terms of their 'evolutionary progressiveness'. My claim is that the more 'evolutionary progressive' a sequence is, the more sure realists can be that there has been scientific interaction with postulated unobservable entities such as electrons or genes, which may allow them to claim that the knowledge at issue here is knowledge of 'actual 'entities.

4. 'Evolutionary progressiveness', Truth, and Reference

It should be clear that I claim that science is a continuously unfolding enterprise – always self-revising, having the ability to turn back unto itself, and carefully making clear the limits of its accuracy while simultaneously striving for the highest degree of precision attainable at the time. In such a context 'evolutionary progressiveness' offers a tool to investigate and fully appreciate the constantly adjusting interactions with reality which science and its processes effect. Briefly, I mean 'evolutionary' here in analogy to Darwin's sense of 'evolution', thus not goal-directed evolution such as can be found in Lamarck for instance, but evolution according to the current environment. More to the point, the analogy with 'evolution' which my use of the term 'evolutionary progressiveness' is intended to capture is that I view the functioning and course of science to happen as an infinite series of gradual, self-corrective, adaptation according to current empirical constraints[6]. As in Darwinism, trial and error is the central metaphor

here (see e.g. Gould 2002, 94)[7]. Thus, in my terms, the functioning of science is portrayed as a spiral movement *according to* current empirical constraints (such as state of the art of technology, apparatus, and experimental methodology; methods of data interpretation; standard of background theories; etc.), rather than a linear movement *towards* some fixed goal.

Broadly 'evolutionary progressiveness' can be defined as follows: A theory T is 'evolutionary progressive' at time t_n iff 1) it *satisfies empirical criteria* determined by t_n-state of the art experiments, empirical instruments and apparatus, data interpretation methods, and background theories (i.e. it is empirically adequate according to empirical practices in the area of investigation at time t_n) *in such a way* that previous versions of theory T, in order to affect this satisfaction, have been adapted in significant ways, AND 2) theory T *causally refers* to relevant aspects of reality by virtue of the empirical situation at t_n (i.e. T's theoretical terms have been adapted such that they refer to unobservable entities that are taken to be the causes of aspects of reality that are observable according to empirical practices in place at t_n).

We must realise though that the story of realism plays itself out on an ever-changing continuum of verdicts about the status of the knowledge conveyed by theories - ranging from stark instrumentalism to full-blown realism.[8] If only the first part of the above definition is satisfied, instrumentalism seems indicated, while by the time that it can also satisfy the second part of the definition, it has moved in the direction of allowing realist attitudes towards its interactions with reality. And, the more 'evolutionary progressive' a sequence of theories is, the more we move in the direction of realism. This comes back to the comments concerning degrees of continuity in section 2 of this article, and to the need to consider all sequences of theories available at the time in formulating realist verdicts

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[6] Consider Gould's (2002) description of evolution as a "relentless accumulation of tiny changes through … time".

[7] See also Kuhn's (1996) interpretation and use of the metaphor of evolution to describe the course of science.

[8] This continuum can be compared to Grover Maxwell's (1962) continuum of 'observable-ness' in interesting ways, but I have no space to do that here.

about science. Viewed from the present, current theories thus may be no more than tools in the instrumentalist sense of the word, but considered or evaluated over periods of time, evolutionary progressive sequences of theories may come to tell entire stories of series of interlaced interactions with aspects of reality (think for instance of the development of a science such as virology which has run the full gamut from instrumentalism to realism).

I suspect that the only kind of 'truth' that fits into a context such as this is a functional one. For this reason the notion of truth I advocate is defined simply as the flipside of reference. Truth should simply be understood in the sense of the Greek word *aletheia*.[9] Mainly, the meaning of the word *aletheia* can be described as 'unhidden, no longer concealing that which is evident'. In ancient Greek writings, *aletheia* is often described in combination with *anagnorisis* which refers to an insight, the unveiling of a truth that would otherwise remain hidden. Reading these two notions together implies temporality (in the sense of self-corrective-ness and revision), and even, particularity – as if the nature of the truth being unveiled depends on the nature of the insight (provided by reference at a given time, see below) causing the unveiling to take place, which, to my mind, fits nicely with what happens in science. More to the point, in this sense saying something is true, means it has been 'disclosed' in some way (via some relation of reference).

Thus 'truth' isn't a property that whatever is being investigated already possesses, nor is it a property of scientific theories; rather it is an *understanding one comes to while establishing a specific kind of relation – one of ('historied') reference – between whatever is being investigated, and the (empirical and theoretical) terms in a scientific theory*. In terms of my definition of evolutionary progressiveness above, this notion of 'truth' is nothing but van Fraasen-ian empirical adequacy[10] plus (or embedded in) causal reference. In these terms truth is *unfolding reference* in the sense that aspects of reality

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[9] I realize that Heidegger also uses *aletheia* to depict his notion of truth. I do not here specifically mean to interact with his view.

[10] If a theory is 'empirically adequate', it means that "… what the theory says about what is observable is true" (Van Fraassen 1980, 18).

are 'disclosed' or 'revealed' in different ways as investigation of a given aspect or system of reality evolves or progresses and referential relations are refined.

The kind of reference I have in mind here is a causal relation. Although there is no space here to talk about causal reference *per* se, let us very briefly consider why a causal theory of reference is so apt here. It is apt for reasons pointed out by Putnam (e.g. 1975), i.e. if reference of a certain term is given during a dubbing ceremony accompanied by a 'causal story' including 'groundings' of the reference (compare Devitt (1981, 1990) and Evans (1973, 1982)) which will explain why it is claimed that a term 't' refers to a postulated unobservable entity iff the phenomena caused by the entity are indeed observed, and, if there is a causal chain of communication stretching back to the original dubbing, then continuity of reference at least becomes a possibility. This all may sound wonderful, but there are well-known problems (e.g. Devitt & Sterelny 1987) into which I cannot go here. Suffice it to say that one good solution to these problems at present is that offered by Psillos' (1999) theory of reference. He mixes into the Putnam-kind of causal link idea, the descriptivist intuition (see Devitt (1981), and also Lewis (1970, 1984)) that "if an act of reference-fixing is to be successful, the reference-fixer must think of the referent-to-be under a certain description" (Reimer 2010).[11]

Psillos' (1999, 295) claim is that "…some parts of the full description associated with a term may be abandoned – or replaced by others – without change of reference, insofar as the core causal description remains intact" (Psillos 1999, 295).[12] Here I am not entirely in

[11] See also Kroon (1985, 1987).

[12] He (Psillos 1999, 295-296) gives the following definition for his causal descriptive reference: "a theoretical term *t* typically refers by means of a core causal description of a set of kind-constitutive properties, by virtue of which its referent *x* is supposed to play a given causal role in respect of a certain set of phenomena". This leads to the following conditions: "1. A term *t* refers to an entity *x* if and only if *x* satisfies the core causal description associated with *t*. 2. Two terms *t* and *t'* denote the same entity if and only if (a) their putative referents play the same causal role with respect to a network of phenomena; and (b) the core causal description *t'* takes up the kind-constitutive properties of the core causal description associated with *t*" (Ibid.), which implies that the referents share the same explanatory structure (Psillos 1999, 297). In this sense Psillos (1999, 296 ff.) claims that the terms 'luminiferous ether' and 'electromagnetic field' refer to the same entity given that 'ether' and 'field' share some fundamental properties by virtue of which they play(ed) a specific causal role, and not simply by virtue of playing the same causal role as Hardin and Rosenberg (1982) suggested. However, the term 'phlogiston' refers to nothing (Psillos

agreement – and not only because of the difficulties of identifying such core constitutive properties. [13] I think that the 'core causal descriptions' may also change in time, although I heed Psillos' warning that "…referential continuity requires not a mere overlap in properties, but a substantive continuity in those properties which explain/ground the causal role attributed the posited entities. That there are such common explanatory properties is far from trivial" (Psillos 1999, 294).

Certainly referential continuity is not a trivial thing to establish, but I suggest we look for it in more than one way. What I mean is that it may sometimes be the case that indeed, as Psillos claims, the core constitutive properties are the ones that overlap through theory change, say for argument sake, in the case of his example of the luminiferous ether and electromagnetic fields. On the other hand, it may also, in the context of considering different evolutionary progressive sequences of theories investigating the same aspect of reality discussed above, sometimes be the case that there are overlap of causal descriptions of properties, not necessarily core ones, think of the case of caloric, in the history of which surely there was at least heuristic (spiraling) continuity. Also what is core to the description of an aspect of reality can surely be adapted while (a core of) the empirical evidence remains the same – e.g. continental drift and tectonic plates. Thus it is not necessarily the case that the *core* descriptions will remain intact, but rather merely that some descriptions may do so for different reasons. This is good enough for me though, because I suggest that realist claims consider a collage of relations of reference underpinning evolutionary progressive sequences of theories.

1999, 291) because "nothing answers to the kind-constitutive properties attributed to phlogiston, [and so] 'phlogiston' is an empty term".

[13] See Stanford (2006), Doppelt (2002), Chang (2003), Lyons (2006), Ladyman & Ross (2007) and many others for discussions of this aspect of Psilllos' account.

And this is where the ‘historied’ (in the sense of meaning ‘adorned with historical incidents’) part of the theory of reference I suggest comes in. I use ‘historied’ rather than ‘historicised’ because the latter implies a level of relativism that is impossible in my view of considering every nuance, every turn of knowledge of an aspect of reality since investigation started. Thus, by ‘historied’ I mean to emphasise, in step with my discussion of evolutionary progressive sequences of theories determining the status of scientific knowledge, that relations of reference ‘unfold’ as theories adjust to empirical constraints. In other words, evolutionary progressive sequences of theories are underpinned by series of reference relations between the theoretical terms of the theories in the sequence and the particular entity or aspect of reality at issue.

Thus the more such relations realists consider in their judgments, the better. It is ‘better’ because such an approach is linked to a dynamic and flexible realism rather than to promises of science solving metaphysical puzzles once and for all. Note again that ‘better’ is not ‘better’ because of a notion of approximating some one conception of ‘the truth’, rather it is ‘better’ because each additional reference relation reflects a different or new or adapted description of an aspect of reality and the more there are of these at a given time, the more nuanced is our knowledge of the aspect of reality covered in this way. To make sense of this unfolding, evolutionary, progression, I thus argue for considering the full functioning of science by considering sequences of theories as scientific knowledge about a given aspect of reality develops, which is more true to how actual science works, than declaring discontinuity among either ‘corrections’ of theories, or among incompatible theories, based on considerations of the knowledge conveyed by single theories. Far from implying that anything goes, this means acknowledging that the course of science is much more nuanced and multi-faceted than perhaps generally assumed.

5. Conclusion

Theories thus give us neither unique nor exactly correct descriptions of aspects of reality, but rather their development affects a collection of imperfect ‘interactions’ with reality in the history of science. This is not necessarily news to philosophers of science. What I

tried to show here though is that, given the above, perhaps, if sequences of theories are considered for their evolutionary progressiveness, rather than single theories for their 'truth', the kind of realism at issue is more truly interactive than otherwise. This is so because in this sense the full functioning of science is taken account of in a historied manner, rather than 'snapshot' interactions with reality affected by single theories. And, I suggest that if realists consider science in the way I have proposed here, they are considering the most nuanced, deep knowledge possible at a given time of a given aspect of reality, which surely is what realism should be about.

However, paradoxically, the price may be too high, in the sense that the implication of my suggestions above that verdicts about the status of scientific knowledge are also not permanent, may be indicating that the realist debate has played itself out. Perhaps 'interactive realism' is so non-standard that it suggests a novel genre of evaluation of scientific knowledge. This is the topic of another article however. For now enough has been said perhaps to show that a Lakatosian slant – at least in the sense of assessing scientific knowledge in a historied manner - to our interpretations of science remains infinitely meaningful.

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