

Incommensurability and Theory Change

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1. Relativism and incommensurability

Relativism emerged as a significant issue in the philosophy of science as a result of the historical turn that took place in the field in the 1960s. Influenced by historical studies of science, philosophers came to see the process of scientific theory change as crucial to the understanding of science itself. Rather than focus on static relations between theory and evidence, proponents of the historical turn emphasized the profound transformations which accompany theory change. The transformations are not restricted to mere change in what theories say about the world. They extend to the method and practice of science, alter the conceptual and semantic apparatus of theories, and affect the content of scientists' perceptual experience. But in the absence of fixed elements capable of playing a neutral role in the context of theory change, it is unclear how choice between competing theories may be made on an objective basis. Because of this a relativistic account of scientific theory choice may seem to be the inevitable consequence of the historical turn in the philosophy of science.

Among the most influential advocates of the historical approach to the philosophy of science were Paul Feyerabend and Thomas Kuhn, both of whom emphasized the far-reaching implications of scientific theory change. In separate publications originally published in 1962, Feyerabend and Kuhn independently proposed the thesis that successive or competing theories may be

incommensurable with each other. But while they used the same word to describe the relationship between theories, they did not mean precisely the same thing by it. In 'Explanation, Reduction and Empiricism', Feyerabend characterized the absence of logical relations which he took to follow from meaning variance between theories as a relation of incommensurability (Feyerabend 1981, ch. 4). In *The Structure of Scientific Revolutions*, Kuhn argued that revolutionary transition between the theoretical structures that he called 'paradigms' leads to variation of method, conceptual apparatus and perceptual experience which renders such paradigms incommensurable. In later work, Kuhn restricted the claim of incommensurability to a semantic relation of untranslatability between the specialized vocabularies used by theories. The thesis that alternative scientific theories or paradigms may be incommensurable with each other provides a basis for a number of different forms of relativism in the philosophy of science.

There are at least three distinct ways in which relativism may derive support from the thesis of incommensurability. The first relates to the choice between theories. If incommensurable theories are expressed by means of semantically variant vocabulary, then it may not be possible for the claims of one theory to enter into conflict with the claims of a theory with which it is incommensurable. In such a situation, it may be impossible to conduct a crucial test to empirically decide between conflicting predictions made by the alternative theories. If, in addition to this, the standards of theory appraisal are not fixed and neutral, but instead vary with theory, the proponents of alternative theories may appeal to different sets of standards to justify their acceptance of opposing theories. But if each side appeals to their own standards, and there are no shared standards, the result is a stand-off. Under such circumstances, there would appear to be no objective basis for the choice between theories. Such an outcome lends support to the position of epistemic

relativism which denies the existence of universal or objective standards which may serve as neutral arbiter in the choice between alternative theories or belief-systems.

The second route to relativism turns on the relation between semantic variance and truth. Semantic variance gives rise to a form of relativism about truth. Semantic variance may result in failure to translate from the vocabulary of one theory into the vocabulary of another. But if translation fails between theories, then a true claim that is asserted by one theory may be unable to be expressed in the context of another theory. Such inability to express true claims of one theory in the vocabulary of another provides a sense in which truth is relative to theory. It makes truth relative in the sense that a truth that may be formulated in the vocabulary of one theory may not even be expressible in the vocabulary of another. The ability to assert a particular truth becomes relative to theory. Such relativism differs from what is ordinarily meant by relativism about truth. For truth does not vary with theory in the sense that a claim that is true in one theory is false in another. Rather, truth is relative to theory in the weaker sense that a truth of one theory is not expressible within the other. While such a weak relativism about truth may fall short of the claim that truth varies with theory, it avoids the classic objection that relativism about truth is incoherent. For it does not claim that one and the same proposition is true in the context of one theory and false in another.

The third form of relativism is more extreme than either of the previous two. There is a hint of it in occasional remarks by Kuhn which emphasize the profound effects of scientific revolution, e.g., “when paradigms change, the world itself changes with them” (1996, p. 111) or “the proponents of competing paradigms practice their trades in different worlds” (1996, p. 150). Such remarks may have been intended in a figurative sense. But they are open to anti-realist

interpretation. On such an interpretation, the world investigated by science depends upon the currently accepted paradigm. The entities to which scientists refer vary with paradigm. Incommensurable paradigms are situated in their own “worlds”. Such talk of worlds which vary with paradigm reflects a position of ontological relativism, according to which the world is relative to paradigm. There is an element of idealism in such a position because it makes the world depend in some manner on human thought. It may also serve as a further basis for relativism about truth, since the states of affairs that make statements true may vary from the world of one paradigm to another. (For an influential interpretation which presents Kuhn’s position as a neo-Kantian position, see Hoyningen-Huene *Reconstructing Scientific Revolutions*.)

As this overview reveals, the notion of incommensurability is not a simple notion with an agreed or stable meaning. The notion is borrowed from mathematics where it has a standard meaning in the context of measurement. In its original setting, to say that two magnitudes are incommensurable is to say that there is no common unit of measurement which may be employed in whole units to measure both magnitudes. But, while use of the notion in the philosophy of science derives from the mathematical usage, it is an extension of the notion that is not determined in advance by its use in its original setting. Apart from the fact that its use in the philosophy of science imports concepts of a semantic and epistemological nature, there is also the question of how to interpret the idea of a unit of measurement in the context of theory choice. Perhaps the units of measurement are to be understood as individual units of signification such as words or sentences which fail to be shared by conceptually disparate theories. Or perhaps the units are alternative standards of theory appraisal adopted by the proponents of incommensurable theories.

The usual reading of the notion of incommensurability in the philosophy of science interprets the notion in terms of the comparison of theories. In the absence of a common unit of measurement, there is no common unit by means of which incommensurable theories may be compared. But while at a general level this may be an appropriate interpretation of the notion in this context, it is important not to adhere too closely to this interpretation. It is always possible to compare theories in some manner. The question is how they may be compared. The point of the thesis of incommensurability is that there may be significant limits on the extent to which theories may be compared for the purposes of theory appraisal and choice. Indeed, it may prove impossible to compare theories with respect to issues of relevance to theory appraisal and choice, though they might otherwise be comparable in ways not relevant to such choice.

Given the lack of a well-defined meaning for the term, progress on the topic of incommensurability has been fragmentary. Rather than a focused discussion using a set of common terms with agreed meanings, there have been diverse approaches to various aspects of the topic with little overall coherence. To impose a semblance of order on the topic, I employ a distinction between two broad forms of incommensurability. On the one hand, *semantic* incommensurability is incommensurability due to semantic variance of the vocabulary employed by theories. On the other hand, *methodological* incommensurability is incommensurability due to variation in methodological standards between theories.

The discussion that follows will be divided into two main parts. The first relates to semantic incommensurability, the second to methodological incommensurability. I regard semantic incommensurability as the primary form of incommensurability. Hence, more space will be devoted to semantic than to methodological incommensurability. The latter raises a number of issues in the

epistemology and methodology of science that tend not to be treated under the rubric of incommensurability. Hence, I will say less about this aspect of the topic. Once I have discussed the issues separately, I will offer some thoughts on the future prospects for the incommensurability thesis.

The distinction between semantic and methodological forms of incommensurability may not be acceptable to all parties to the discussion. Some may object on the grounds that the two forms of incommensurability are conceptually entwined in a way that undermines the distinction. It might, for example, be argued in verificationist vein that methodological standards are tied to the use conditions of scientific terms, so that variation of the one affects the other. Alternatively, one might object on the grounds that, though conceptually distinct, in practice the two forms of incommensurability always occur together in actual science. For it might be held that the effect of revolutionary change is such that it invariably extends to both conceptual and methodological aspects of science.

However, as will become apparent in what follows, the distinction between the two forms of incommensurability reflects a genuine difference between two distinct sets of philosophical concerns. The arguments relating to semantic incommensurability turn on considerations in the philosophy of language about meaning and reference, as well as translation failure between the vocabulary of theories. By contrast, the arguments relating to methodological incommensurability draw on epistemological considerations about standards of theory appraisal as well as the nature of the epistemic warrant of such standards. While it might be held that the two forms of incommensurability only ever occur together in actual theory change, it remains clear that distinct sets of philosophical considerations apply to the separate forms of incommensurability.

2. Semantic incommensurability

The thesis that theories may be incommensurable for semantic reasons stems from reflection on the language employed to express scientific theories. Feyerabend and Kuhn both rejected the empiricist idea of an independently meaningful observation language. They held instead that the meaning of observational terms is at least in part theory-dependent. In addition, both authors adopted some form of semantic holism. They understood the meaning of both observational and theoretical vocabulary to depend significantly upon the theoretical context in which the vocabulary is employed. Because of the context-dependence of meaning, a semantic shift takes place in the transition between theories that affects some or all of the vocabulary associated with the theories involved.

Feyerabend first explicitly mentioned incommensurability in the course of a discussion of the empiricist account of inter-theory relations. Logical empiricists held that successive theories enter into relations of explanation and reduction. They sought to analyze explanation and reduction as deductive relationships whereby the laws of earlier theories are logical consequences of the laws of the theories that replace them. Feyerabend pointed out that the deductive relationship required by such an approach assumes a condition of meaning invariance between the vocabulary of the successive theories. Otherwise the laws of the displaced theory would not be derivable from the laws of the later theory that subsumes them. Against the empiricist approach, Feyerabend argued that the condition of meaning invariance is violated in actual science because of conceptual change which occurs in the process of theory-change. In addition, he argued that some of the central concepts of earlier theories are unable to be defined within the context of the theories that replace them. As a result of semantic variation between theories the deductive consequences of such

successive theories form disjoint classes, so that the logical relationships required for deductive subsumption fail to obtain. Feyerabend introduced the term ‘incommensurable’ in order to describe the lack of intersection of logical content due to the variation of meaning between theories.

As previously indicated, Kuhn originally employed the notion of incommensurability in a more expansive vein than Feyerabend, though he later restricted its scope to semantic elements. In *The Structure of Scientific Revolutions*, Kuhn argued that science is characterized by occasional periods of revolution, in the course of which a dominant paradigm is replaced by an incommensurable alternative paradigm. Like Feyerabend, Kuhn took conceptual change to undermine the reductionist model of theory succession. He placed particular emphasis on change in the categories employed by theories in classifying the items in their domain of application. In Kuhn’s view, change of classificatory apparatus is a key feature of revolutionary change in science. Such change affects what Kuhn calls the “similarity relations” which are believed to hold between objects. After a revolution, objects formerly grouped together are assigned to different classes. Conversely, objects previously allocated to different groups are classified together afterwards. Such changes in classification result in a semantic shift which affects the terms that refer to the reclassified entities. The semantic shift may involve change in both the sense and the reference of the terms. In light of the resulting semantic variation between theories, Kuhn claimed that there is no common language into which the claims of such theories may be translated in an exact manner. Especially in later work, Kuhn understood such incommensurability as a localized phenomenon. It is a semantic relation of untranslatability that holds between interdefined subsets of terms within the special vocabularies employed by theories. Because the translation failure is localized, Kuhn

allowed that there may be an overlap of shared semantically stable vocabulary between incommensurable theories.

The localized character of Kuhn's version of the incommensurability thesis permits an important distinction to be drawn between two versions of the semantic form of the incommensurability thesis. Where Kuhn held that translation failure is confined to a narrow set of terms within the vocabulary of incommensurable theories, Feyerabend instead argued that the observation language employed by a theory depends upon the theory for its semantic interpretation. As a result, the meaning of the observation language varies between theories. This tends to suggest that for Feyerabend it is the entirety of the vocabulary utilized by theories, both observational and theoretical, that is subject to semantic variation. In light of this apparent difference between their views, we may distinguish between partial meaning variance, where there is semantic variation between some of the terms used by theories, and radical meaning variance, where there is semantic variation between all of the vocabulary used by theories. This in turn permits a distinction between a restricted Kuhnian version of the incommensurability thesis and a more extreme Feyerabendian version of the doctrine.

For both Kuhn and Feyerabend, semantic incommensurability involves variation of meaning between the language used to express theories. Commentators have tended to focus on one crucial apparent implication of meaning variance with respect to the comparison of the content of theories. Namely, if theories are unable to be stated in a common, semantically stable vocabulary, then the content of such theories is unable to be compared. For what one theory says about the world neither asserts nor denies the same thing as what the other theory says about the world. In the absence of shared meaning, theories fail to engage with one another. They neither agree nor disagree with

respect to any substantive claim that either makes about the world. Given this, many commentators take incommensurability to imply the incomparability of the content of theories. Of course, where semantic variance between theories is less than complete, the comparability of content is restricted to assertions which may be expressed using vocabulary that is shared between theories.

In light of the incomparability of content, the incommensurability thesis is open to an important objection that is sometimes known as *the rivalry objection*. To make the point vivid, I will state the objection in terms of radical rather than partial meaning variance. The objection arises because incommensurable theories are supposed to enter into a relation of rivalry. After all, incommensurable theories are competing or alternative theories between which scientists are meant to make a choice in the context of scientific theory change or revolution. But if incommensurable theories neither agree nor disagree with respect to any claim about the world, then they are unable to enter into a relation of rivalry. For if there is no point on which such theories may enter into conflict, then they do not compete with respect to the purported truth or falsity of any particular claim about the world. There is no claim with respect to which the theories are rivals. Given the lack of rivalry, it is entirely unclear why there is a need to choose between incommensurable theories in the first place. Indeed, given that incommensurable theories fail to agree on any particular point, one wonders how they may even be about the same things, much less enter into a relation of rivalry with respect to the same things. As will emerge in what follows, the rivalry objection poses less of a threat to the localized version of semantic incommensurability that involves only partial meaning variance.

In reply to the rivalry objection, proponents of incommensurability may insist that the relation of incommensurability is one of deep rivalry that goes beyond relations between specific

assertions. Semantic variance prevents theories from entering into ordinary relations of conflict or agreement. But incommensurable theories are incompatible at the level of basic ontology. The way the world is according to one theory is completely at odds with the way it is according to the other. The central principles of one theory may not be upheld unless the central principles of the other are rejected. The categories of one theory may not be employed unless the categories of the other are eliminated. But while defenders of incommensurability suppose that such a relation of deep rivalry may obtain between theories, it remains unclear how the point is to be reconciled with semantic variance between theories. For it is natural to suppose that the relevant relationship of incompatibility must manifest itself in a disagreement between sentences which state the basic principles of the theories or which describe their categorical structures. But it is difficult to see how such relations may obtain without some elements of common meaning shared between the theories.

The rivalry objection raises issues about the relations between theories that have never been satisfactorily resolved by advocates of the incommensurability thesis. However, the outlines of a resolution will emerge as we consider the two main approaches that have been proposed in response to the incommensurability thesis. The first approach, which I call *the translational response*, challenges the coherence of the idea of an untranslatable language to which the incommensurability gives rise. As we shall see, the response to this approach in terms of restricted translation failure against the background of a common language enables some sense to be made of a rivalry between incommensurable theories. The second approach, which I call *the referential response*, holds that there are relations of referential overlap between semantically variant theories on the basis of which the content of such theories may be compared. Relations of referential overlap provide a further basis on which a relation of rivalry may obtain between theories, since assertions which contain co-

referring terms are able to enter into relations of agreement and disagreement with respect to shared referents.

2.1 The translational response

The primary source for the translational response is an influential paper by Donald Davidson, 'On the Very Idea of a Conceptual Scheme' (1984). Davidson sought to challenge the intelligibility of the idea of a conceptual scheme by attacking the dualism of content and scheme on which it rests. As part of this task, Davidson argued that no coherent sense may be made of the idea of an untranslatable language. Given the connection between incommensurability and untranslatability, Davidson's attack on the scheme-content dualism serves as a forceful critique of the idea of incommensurability. However, as we shall see, it is possible to respond to Davidson in a way that leads to a more defensible formulation of the incommensurability thesis.

Davidson develops a number of different lines of objection to the notion of an untranslatable language. He notes the paradoxical nature of any argument for translation failure which proceeds by expressing the content of a purportedly untranslatable term in the very language into which it is unable to be translated. He also points to the problematic character of evidence for untranslatability: failure to translate provides no more support for the claim that a language is untranslatable than it does for the claim that it is not a language in the first place. However, he does not take translation as criterial for language. That function is served by truth. The criterion for an alternative conceptual scheme, and for the intertranslatable languages that embody it, is fit with experience or reality. Davidson argues that this amounts to the view that a conceptual scheme is an alternative scheme if what is said in it is "largely true but not translatable" (1984, p. 194). Against this, he objects that

we do not understand the notion of truth at all if it is divorced from translation. The extension of the truth-predicate is fixed for English and languages translatable into English. Hence, we have no grip on the notion of truth in application to languages not translatable into our own. Davidson also draws on his well-known principle of interpretative charity to argue that in order to understand others we must attribute a large measure of truth to their utterances. Charity militates against failure of translation because charitable attribution of truth requires translation.

The primary thrust of Davidson's critique of the scheme-content dualism is directed against the idea that there may be complete translation failure between alternative conceptual schemes. This enables an important clarification to be made in relation to incommensurability. Namely, it is a mistake to understand the incommensurability thesis as a thesis about radically alternative or total conceptual schemes. It is a restricted thesis about the relationship between the vocabulary of semantically variant theories. The claim that translation may fail between theories is therefore a claim that there may be translation failure within a language. Such translation failure obtains within the context of an embracing natural language which contains the vocabulary of both theories. Of course, the extent of the translation failure involved depends on whether Kuhn's localized or Feyerabend's more extreme version of the thesis is at issue. But, in either case, incommensurability involves a relation of translation failure between delimited areas within a background natural language.

The point that incommensurability involves translation failure within a language removes some of the problematic consequences highlighted by Davidson. As I have argued in an earlier paper, 'In Defence of Untranslatability' (1990), it is possible to employ the background natural language as a metalanguage within which it may be shown that terms from one theory are unable

to be translated into the specialized vocabulary of an alternative theory. Moreover, the evidential problem of showing that an untranslatable language is indeed linguistic does not arise in the case of such circumscribed failure of translation. Given that the vocabulary is embedded in an embracing natural language, as well as within the broader linguistic practices of the scientists who employ the vocabulary, no question arises of whether the vocabulary is linguistic in nature. It is important, in addition, to note that the limited nature of the translation failure provides a basis on which to reduce the threat of the rivalry objection. For it may be possible to employ the linguistic resources of the background natural language, as well as any scientific vocabulary that is shared across theories, to specify a common domain of application for incommensurable theories, as well as to identify areas of conflict to the extent that vocabulary is shared.

A further point of relevance to Davidson's critique derives from a distinction that may be found in the writings of both Kuhn and Feyerabend. Both authors employ a distinction between understanding (or interpreting) what is said in a language and translating what is said in one language into another. Both deny that translation is required for new language acquisition. The ability to translate into a language depends on the semantic resources of the language. By contrast, understanding is a relation between a language user and a language, which involves no relation between languages. On the basis of this distinction, Kuhn and Feyerabend argue that a speaker may come to understand what is said in a newly encountered language whether or not it is translatable into the speaker's native language. The distinction between translation and understanding is supported by reflection upon first language acquisition as well as the immersion technique in foreign-language teaching. The plausibility of the claim that one may understand the vocabulary

of an incommensurable theory is increased if it is borne in mind that the acquisition of such vocabulary may take place within the context of a shared natural language.

Given the possibility of direct language-acquisition, it is possible to dispel Davidson's concern that interpretative charity requires translation. For if it is possible to acquire a language without translation, understanding does not require translation of sentences of a foreign language into true sentences of the home language. At the same time, ability to understand what is said using the vocabulary of an incommensurable theory provides a further basis on which to address the rivalry objection. For without translating between the semantically variant vocabularies, a speaker who understands both will recognize that they are employed to speak about a common domain of entities and phenomena. As we shall see in the next section, however, a more substantive basis for rivalry requires that it be possible to identify specific overlaps of reference between the terms of semantically variant theories.

2.2 The referential response

As we have just seen, it is possible to deal with the translational response in a way that yields a more plausible version of the incommensurability thesis. But no account of incommensurability that fails to address the issue of reference can be complete. Reference plays a crucial role in agreement and disagreement. It is what enables theories to enter relations of agreement and disagreement. It is therefore of essential relevance to the comparability of the content of theories.

In his 1967 book, *Science and Subjectivity*, Israel Scheffler draws upon the Fregean distinction between sense and reference in his analysis of the problem of meaning variance. Scheffler pointed out that terms may refer to the same thing even though they differ in sense.

Sameness of reference is all that is needed for the comparison of content. Sentences whose constituent terms refer to the same things are able to enter into relations of agreement and disagreement with respect to the those same things. On the basis of the sense-reference distinction, it may therefore be denied that the incomparability of content follows from meaning variance. Provided that the terms used by theories co-refer, their content may be compared, even if the sense of the terms varies between theories.

Scheffler's point need not be restricted to relations of strict identity of reference. There is a variety of relations of referential overlap which Michael Devitt describes as 'quasi-logical relations' (Devitt 1991, p. 170). These relations include extensional inclusion and intersection, partial reference and the co-reference of term-tokens. Such quasi-logical relations serve as a basis on which the content of theories may be compared, since theories may agree or disagree with respect to items that fall within the area of referential overlap. Provided that theories are applied to the same domain, relations of referential overlap obtain which suffice for the comparison of content. Nor is the point restricted to cases in which theories succeed in referring to entities that actually exist. There may be cases in which a theoretical term fails to refer (e.g. 'phlogiston'). But competing theories may still be compared by means of such terms. All that is needed is that the terms would refer to the same thing in both theories, if they refer to anything at all. Given sameness of intended reference, the term may be employed as a basis on which to compare the theories.

The point that shared reference suffices for the comparability of content is not a matter of controversy. It is doubtful, however, whether the semantic variation of relevance to incommensurability is limited to variation in the sense of terms used by theories. Both Kuhn and Feyerabend took change of meaning between theories to include variation of reference as well as

sense (e.g. Kuhn 1996, p. 102; Feyerabend 1981, p. 98). Indeed, both Kuhn and Feyerabend seemed to hold that theory change involves wholesale discontinuity of reference, though Kuhn later restricted reference change to shifts of membership between the central “taxonomic categories” employed by theories (2000, p. 30). But if reference is not preserved between theories, then it cannot be assumed that the content of theories may be compared on the basis of common reference.

The possibility that reference may vary as a result of theory change raises the question of how reference is determined. For the manner in which reference is affected by theory change depends on whether factors which determine reference are altered in theory change. According to the traditional Fregean description theory of reference, reference is determined by a description which expresses the sense of a term. Items which satisfy the description belong to the extension of the term. Although Feyerabend and Kuhn do not explicitly endorse a description theory of reference, they tend to assume that description plays an important role in determining reference. As I have sought to show in *The Incommensurability Thesis* (1994), their treatment of reference often assumes that description is the principal determinant of reference. But if reference is determined by description, then change of reference will be a routine consequence of theory change. For as theories are modified and replaced, the descriptions they give of the objects in their domain are likewise modified and replaced. Where later descriptions are incompatible with earlier descriptions, or a whole new set of entities is described, theory change gives rise to reference change.

Since the work of Saul Kripke, however, the description theory of reference has been considered problematic. On the one hand, a term may be successfully used to refer even though it is associated with an incorrect description of its referent. On the other hand, a term may fail to refer to items despite the fact that they satisfy the description associated with the term. Thus, to at least

some extent, reference is independent of description. As opposed to the description theory of reference, advocates of the causal theory of reference have argued that language users enter into pragmatic relations with their environment which play an important role in the determination of reference. Causal theorists emphasize the role played by ostensive definition in naming ceremonies at which natural kind terms are introduced in the presence of samples of the kind to which they are then taken to refer. Later speakers are able to use the term to refer to the kind identified at the introduction of the term by way of a causal chain that links their use of the term to the introductory event. If reference is independent of description, and is established at initial term introductions, then it is insensitive to variation in descriptive content. Thus, even if the descriptions that theories provide of the entities in their domain undergo significant change, it may be denied that discontinuity of reference is the inevitable accompaniment of theory change.

But, despite the initial promise of the causal theory, the situation is not as clear-cut as the above suggests. The causal theory of reference does not admit of straightforward application to the problem of reference change in science. For one thing, there appear to be genuine cases of reference change in the history of science (e.g. 'atom', 'electron', 'gene'). As a result, post-introductory use of terms must be granted a role in reference determination. Otherwise, it is unclear how to reconcile the causal theory with the facts about reference change. For another thing, ostensive introduction of terms for observable natural kinds is problematic. Individual members of natural kinds belong to a variety of different kinds (e.g. species, genus, animate object). Unless the relevant kind is specified by means of description, ostensive term-introduction is subject to an indeterminacy of reference. Ostension alone is unable to distinguish between the multiple kinds instantiated by the sample-set. Related issues arise for theoretical terms. The entities postulated by theories may fail

to exist. Likewise, the terms introduced to refer to such entities may fail to refer. To allow for such reference failure, descriptive content must play a role in the reference of theoretical terms. This may involve the specification of kind-constitutive properties or perhaps a description of the causal role played by theoretical entities in producing phenomena. In light of such points as these, the causal theory of reference must be modified to allow for post-introductory change of reference, as well as to allow descriptive apparatus to play a role in the determination of reference for observational and theoretical terms. The modified theory which results is a version of what has come to be known as the causal-descriptive theory of reference.

Such an account removes the threat of widespread discontinuity of reference while allowing for limited change of reference to occur in theory change. If reference is not fully determined by description, it may remain stable despite variation in the descriptive content associated with terms. Some shift of reference may take place as a result of change in use following initial term introduction, as well as due to changes which alter the descriptive apparatus required to remove indeterminacy of ostension or to functionally specify theoretical entities. But, given the role of pragmatic factors in reference determination, there is sufficient continuity of reference between theories to ensure the comparability of content. For if theories are genuinely applied to the same domain, there will always be at least some overlap in the reference of the terms employed by theories in relation to the common domain.

We are now in a position to propose a response to the objection from rivalry. Earlier, we saw that the issue of how incommensurable theories may enter a relation of rivalry may be partially resolved by the localized nature of semantic variance as well as the ability of scientists to understand untranslatable theories. But the ultimate resolution of this issue rests on the possibility of shared or

overlapping reference. If the terms of alternative theories are able to refer to at least some of the same things, then it will be possible for them to enter into a relation of rivalry. Semantically incommensurable theories properly constitute rivals between which a choice must be made only if they may be expressed using terms which enter into one or another relation of referential overlap. Given the modified causal account of reference sketched above, we may be confident that theories applied to the same domain do refer to the same things, so that they are able to enter into a relation of rivalry. At the same time, however, the problem of the incomparability of the content of incommensurable theories has also been resolved. For, on the basis of such overlap of reference, it is entirely possible to compare claims that one theory makes about the world with those that a semantically variant alternative makes about the world. In light of such considerations about reference and content comparison, it seems to me that the thesis of semantic incommensurability has collapsed. Indeed, use of the term ‘incommensurable’ to describe the relationship between semantically variant theories has now become otiose.

3. Methodological incommensurability

While the semantic form of incommensurability is the primary form of incommensurability, it is important to consider methodological incommensurability as well. The idea that competing paradigms are incommensurable due to variation in standards of scientific theory appraisal is found in Kuhn’s original discussion in *The Structure of Scientific Revolutions*, where it is conjoined with semantic and perceptual difference between paradigms (e.g. pp. 103-110, 148). In later work, Kuhn restricted the notion of incommensurability to the semantic sphere. However, the immense popularity and influence of the book ensures that the notion continues to be associated in some

quarters with methodological differences between paradigms. The situation is different with Feyerabend, whose views about the limitations of method resonate significantly with some aspects of Kuhn's treatment of method. However, Feyerabend restricted his use of the notion of incommensurability to the absence of logical relations between theories which he took to follow from meaning variance. For this reason, I will not explicitly discuss Feyerabend's 'epistemological anarchist' critique of scientific method here. (Feyerabend explicitly distinguishes his view of incommensurability from Kuhn's in his (1978, p. 68). See Nola and Sankey 2007, ch. 11 for Feyerabend's view of method.)

In *The Structure of Scientific Revolutions*, Kuhn endorsed two views which suggest that there may be no objective epistemic basis for the choice that scientists make between competing paradigms in the context of a revolution. On the one hand, Kuhn argued that the perceptual experience of scientists is deeply influenced by the paradigm within which they work. As a result, observation is unable to play a neutral role in the choice between paradigms. On the other hand, Kuhn also argued that the standards employed by scientists in the appraisal of theories or paradigms are themselves dependent upon the paradigm that they adopt. He combined this with a denial that there are any paradigm-independent standards. At one point, he even commented that "As in political revolutions, so in paradigm choice – there is no standard higher than the assent of the relevant community" (1996, p. 94).

Kuhn's idea that scientific theories or paradigms may be incommensurable due to variation in methodological standards creates the impression of a relativistic view of the rationality of science. For if observation is unable to function in a neutral manner and there are no shared standards of theory appraisal, then there may be no objective ground on which to base the choice between

competing theories or paradigms. The only way that a scientist may justify adoption of a paradigm would be by appeal to standards that are internal to the paradigm, as well as to observations that are interpreted in light of the paradigm. But this entails that there may be no objective basis for the adoption of the paradigm itself. For if no grounds independent of paradigm exist, then there may be no objective basis on which to adopt the paradigm as opposed to a competitor.

The impression of a relativistic conception of scientific rationality is reinforced by Kuhn's remark that "there is no standard higher than the assent of the relevant community". This suggests that there is no objective epistemically rational basis for theory choice. At most, such choice is grounded in social consensus that is not subject to objective epistemic constraint. This apparent implication of Kuhn's views about theory choice has been the subject of sustained criticism by philosophers who have sought to defend the epistemic rationality of science against the onslaught of relativism. By contrast, it has been welcomed by advocates of the sociology of science who embrace a relativistic conception of scientific knowledge. Indeed, sociologists who seek to understand scientific change in terms of the play of political and social forces derive considerable inspiration from this aspect of Kuhn's views.

Yet throughout much of his later work Kuhn sought to distance himself from the relativistic implications of his original account of theory change. In a postscript to later editions of *The Structure of Scientific Revolutions*, and especially in his paper 'Objectivity, Value Judgment and Theory Choice' (1977), Kuhn maintained a less extreme position. He did not wish to deny the rationality of science. His point, instead, is that the standards of scientific theory appraisal fail to provide a "neutral algorithm of theory-choice", which mechanically determines choice of theory (1996, p. 200). Nor did he wish to deny that there are universal standards. There is a set of

standards (e.g. accuracy, consistency, breadth, simplicity) which is largely stable, though they may not always have been employed in a uniform manner throughout the history of science. Rather than dictate theory choice, the standards serve as a guide to such choice. For this reason, Kuhn describes the standards as values rather than rules; they “function not as rules, which determine choice, but as values, which influence it” (1977, p. 331).

Kuhn’s revision betokens a moderate stance on which theory choice is informed by epistemic values which provide a rational basis for such choice. But while the revised position may evoke fewer philosophical qualms about objectivity, it leaves scope for a limited form of incommensurability that may arise within the system of standards. This is due to lack of precision and potential conflict between the standards which Kuhn sees as guiding theory choice. In the first place, Kuhn argues that the same standard of theory appraisal may be applied or interpreted in different ways in the context of different theories. For example, simplicity might be interpreted as ease of use in one theory, but as absence of complexity in another. Or competing theories might be accurate in different areas of application. In the second place, Kuhn holds that competing theories may differentially satisfy the system of values. For example, one theory might be more accurate but less simple than another. Or the simpler of two theories might not cohere as well as a competitor with established theories.

In sum, scientists who employ the same standards may disagree in choice of paradigm. They may disagree about how shared standards are to be applied or understood, as well as the relative weighting to be assigned to such standards. As a result, Kuhn’s admission of shared standards does not remove the threat of incommensurability. For scientists who adopt opposing paradigms may defend their choice by appeal to common standards, but understand the standards differently and

attach a different relative importance to them. In the absence of “higher” standards to adjudicate between such conflicting valuations, it is unclear how such a stand-off may be resolved.

Despite this, Kuhn’s revised position is less objectionable than the original. Indeed, I wish to suggest that the revised position contains the seeds of a promising conception of scientific rationality. The key is Kuhn’s idea that scientific rationality is not governed by an algorithm of theory choice. There is no binding set of rules that leads to a single, determinate outcome in every case of theory choice. As has been argued by H.I. Brown in his book *Rationality* (1988), a significant role is played in rational decision-making by a capacity to form judgement that is not governed by rules. Such judgement is employed to interpret and apply standards of theory appraisal, as well as to assign relative importance to such standards. Judgement is exemplified in the way that the standards are understood and put into practice. Because there may be alternative ways to understand, apply and rank the standards, the exercise of judgement may not always lead to the same decision for all scientists. In the context of theory choice, scientists may arrive at opposing decisions on a rational basis. Because of the role played by judgement, and the imprecision and lack of order of the operative standards, scientists may have rational grounds for disagreement. As a result, we must allow that there may be rational disagreement in science, rather than assume that rationality entails agreement.

No doubt, some philosophers will resist such talk of rational disagreement. They may detect a hint of relativism in the idea that scientists may disagree on the basis of shared standards. For if scientists rationally disagree despite sharing standards, this may suggest that there are no objective standards of rationality after all. For, surely, it might be argued, if there are objective standards, then

there is no room for scientists to disagree. The whole idea of objectivity is that shared standards provide a neutral basis on which to decide between conflicting beliefs.

But this idea of objectivity may be usefully contested on the basis of Kuhn's denial of an algorithm of theory choice. There are two main reasons why the position I ascribe to the later Kuhn need not be construed as relativist. In the first place, rational belief admits of greater flexibility than does true belief. On a non-relativist conception of truth, it is not possible for both members of a pair of contradictory propositions to be true. But it may be possible for both members of a pair of contradictory propositions to be justifiably believed. Different epistemic agents may diverge in their assessment of the evidence. They may appeal to different – or differently interpreted – standards in justifying their opposing attitudes toward the same proposition. Given the sensitivity of rational belief to evidence, as well as the possibility of legitimate alternative standards, it is possible for believers to be justified in accepting contradictory propositions as true. The flexible nature of justification compared to truth is what permits such difference of opinion to obtain without falling into a position of epistemic relativism.

In the second place, it is a mistake to suppose that a non-algorithmic account of the kind suggested by Kuhn must give rise to an unduly permissive account of rationality. The account does not allow that any belief whatsoever may be justified. For it imposes constraints on justified belief. The account lays down a set of shared standards of theory appraisal, rather than postulating the existence of distinct sets of radically alternative epistemic norms. The shared standards provide the basis for criteria of scientific acceptability which may be used to demarcate science from non-science. Beliefs or theories that fail to satisfy any or most of the standards of theory appraisal are to be rejected as unscientific. Rational disagreement in science is restricted to disagreement about

theories which minimally satisfy the set of operative epistemic standards. Satisfaction of shared standards serves as the threshold for admission into the set of scientifically viable options. Rational disagreement is possible between scientists who favour one of the scientifically viable alternatives over another. A scientist who endorsed a theory that failed to satisfy any of the standards would thereby fail to satisfy minimal conditions of scientific rationality. An account that is able to screen out inadequate theories which fail to minimally satisfy shared standards of scientific rationality, though allowing for divergence of opinion with respect to theories which surpass the threshold, is not a relativistic conception of rationality. For it requires that such theories satisfy shared standards of epistemic justification in order to be adopted on a rational basis.

The one outstanding question that remains about this account of scientific rationality relates to the epistemic foundation of the shared standards of theory appraisal. Why is it epistemically justified to adopt these standards as the basis of scientific theory choice? This is a question to which Kuhn did not provide a settled answer. As we have seen, in his original account, he suggested the ultimate justification of epistemic standards may rest on consensus within the scientific community. He later flirted with an inductivist approach according to which the fact that previous scientific practice led to scientific advance justifies the continuation of such practice (Kuhn 2000, p. 130). But he came to favour an approach on which epistemic justification rests on semantic considerations about the meaning of the word 'science' (e.g., Kuhn 2000, 214-215).

It is difficult to see how reflection on the meaning of the term 'science' can provide the normative basis for standards of theory appraisal (for discussion, see Nola and Sankey 2007, pp. 293-297). A more promising approach lies in the inductivist approach which Kuhn at one point mentioned almost in passing. Such an approach has much in common with a naturalistic approach

to epistemic justification that has considerable following in epistemology and the philosophy of science. This approach treats standards of theory appraisal as tools of inquiry which are subject to empirical evaluation.

A salient example of this approach is the normative naturalist meta-methodology proposed by Larry Laudan in *Beyond Positivism and Relativism*. According to this approach, proposed standards or norms of scientific method may be put to empirical test by determining whether there is evidence to show that the use of such standards leads to specified goals. Laudan treats standards or norms in instrumental fashion as means for the realization of epistemic ends. On such an account, it is a matter of empirical fact whether or not a particular methodological standard is indeed a reliable means of advancing the epistemic goals of science. Those standards which are reliable in advancing such goals are bearers of epistemic warrant which may be employed to justify the acceptance of a scientific belief or theory. Those standards which fail to reliably conduce to such ends do not carry epistemic warrant, so are unable to provide scientists with justification for their beliefs. Such an empirical approach to the appraisal of standards provides an objective basis on which standards may be compared. Some standards may be shown on the basis of empirical evidence to be capable of providing epistemic warrant. Others may be shown on the basis of such evidence to be incapable of providing such warrant. Such an approach provides an objective response to the question of the epistemic grounds for standards of theory appraisal.

The normative naturalist account of epistemic warrant provides a way to place Kuhn's shared standards in an anti-relativistic framework. But it is not an uncontroversial position. Some object to the naturalist project, arguing, for example, that normative naturalism itself must rest on an *a priori* principle of induction in order to supply the warrant for methodological standards. Others

attempt to reconcile Kuhn's views with Bayesian confirmation theory by taking Kuhn's values as a guide for assigning prior probabilities to hypotheses, which may be fed into an algorithm in the form of Bayes' theorem. Nevertheless, I suggest that the combination of a naturalistic account of warrant with a judgement-based model of rationality provides a promising way to accommodate Kuhn's later ideas about shared standards within a non-relativistic approach that allows for rational divergence of opinion. There may be other ways to derive insight from Kuhn's work without landing up in a position of epistemic relativism. But the position I have outlined seems to usefully combine Kuhn's idea that scientific rationality is non-algorithmic with the anti-relativist idea that methodological standards require objective epistemic warrant.

4. Prospects for incommensurability

In my treatment of the issue of incommensurability I have employed a distinction between semantic and methodological forms of incommensurability. In his original discussion of the topic in *The Structure of Scientific Revolutions*, Kuhn presented both forms of incommensurability as aspects of a single more general form of incommensurability. I choose to treat the semantic and methodological forms of incommensurability separately for two main reasons. First, Kuhn came to recognize that the issues are distinct, as is evident from the fact that he treated them as separate matters in later work. Moreover, Feyerabend explicitly distinguished his understanding of incommensurability from Kuhn's precisely in virtue of his own more restricted semantic form of the doctrine. Second, the considerations about meaning, reference and translation that arise in relation to the former are distinct from the considerations about method, rationality and warrant that arise with regard to the second. While it might be the case that methodological and conceptual change

occur together in the same historical episode, there is no sense in which they constitute the same phenomena. The only reason why they might be dealt with conjointly is that their co-occurrence may increase obstacles to scientific communication and rational decision-making in the context of revolutionary theory change.

It may now be asked what to make of the prospects of the thesis of incommensurability. Is there anything further to be said on its behalf? In my estimation, little of substance remains to be said about either aspect of the topic. The claim that scientific theories are incommensurable for semantic reasons seems unsustainable in light of the considerations in the theory of reference that have been canvassed here. The claim that scientific theories are incommensurable in a methodological sense seems equally untenable in light of Kuhn's admission of the existence of shared standards of theory appraisal, though an innocuous form of incommensurability may arise within those standards. Future work in the theory of reference or in the theory of method may lead to an increasingly refined account of semantic and methodological change. It will not lead to a fundamental change of outlook in relation to the topic of incommensurability.

This is not to say that there is nothing of substance in the claims that Feyerabend and Kuhn made on behalf of incommensurability. It seems clear that scientific theory change is characterized by conceptual and semantic change of the kinds highlighted by Feyerabend and Kuhn, though the consequences of such change are not as dramatic as at first appeared on the basis of their early writings about the topic. A similar remark applies in the case of methodological incommensurability. Kuhn's discussion of standards of theory appraisal, as well as Feyerabend's writing on the changes and limitations of method – which he treats as separate from the topic of incommensurability – have drawn attention to variations of a methodological nature that have

occurred in the history of science. But, especially in light of Kuhn's admission of shared standards of theory appraisal, the consequences of such methodological change for the rationality of scientific theory change are, again, far less dramatic than at first appeared to be the case.

For these reasons, I do not anticipate that a sustained philosophical discussion of the topic of incommensurability will continue into the future. It is an idea whose time has passed. It does little substantive work in the philosophy of science. The notion of incommensurability has broken down under analysis, leaving little but the idea that conceptual and methodological change occur as part of the development of science. There is little sense that such change throws either the rationality or the objectivity of science into question.

Of course, my view of the future prospects for the thesis of incommensurability may not be shared by all parties to the discussion. To cite just one example, the influential Kuhn scholar, Paul Hoyningen-Huene, appears to hold that the incommensurability thesis may be sustained within the context of a neo-Kantian interpretation of Kuhn's metaphysics. Moreover, Hoyningen-Huene and his co-workers, Hanne Andersen and Eric Oberheim, have even argued that there is a relationship of meta-incommensurability that obtains between conflicting views in the philosophy of science. They argue, in particular, that my own earlier discussion of the topic in *The Incommensurability Thesis* falls prey to such meta-incommensurability by uncritically presupposing a realist stance in its treatment of semantic incommensurability (Hoyningen-Huene *et al* 1996).

As for the question of relativism, and the consequences for relativism of incommensurability, it seems clear that no extreme relativistic consequences may be sustained on the basis of the claim of incommensurability. The content of semantically variant theories may be compared by means of overlapping reference, and there are at least some shared standards of theory appraisal applicable

to competing theories. Hence, common semantic and epistemic ground exists on the basis of which an objective rational choice may be made between competing theories. As indicated in my opening remarks, the translation failure associated with semantic incommensurability might be employed as the basis for a constrained form of relativism about truth. A true sentence that is asserted by one theory may be untranslatable into the vocabulary of a semantically variant theory. But while this suggests that the capacity to express a truth depends on the semantic resources of a language, it provides no support for the classic relativist view that the truth-value of a proposition depends on context.

This leaves the possibility of an ontological form of relativism that might be based on the thesis of semantic incommensurability. Kuhn's talk of the world changing with change of paradigm may be taken to suggest the idealist thesis that reality is itself dependent upon belief system, theory or conceptual scheme. But Kuhn's talk of world change should be interpreted as at most a metaphorical expression of the idea that in scientific revolution there is a profound change in the way that scientists take the world to be. It is not the world itself that changes. Rather, it is the purported referents of theoretical terms that are no longer taken to be the same thing as in previous theory. To think that the world changes, even in the weaker sense of a Kantian phenomenal world, does such violence to common sense that it may be dismissed out of hand. As we reflect upon philosophical matters, we must not lose touch with the world around us that is given in our everyday experience. Common sense may be the starting-point in philosophy. But it is not to be abandoned as inquiry proceeds.

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