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Incommensurability and Partial Reference

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ABSTRACT
The idea within the causal theory of reference that names hold (largely) the same reference over time seems to be invalid as concepts of scientific kinds have evolved. If science progresses by correcting mistakes of earlier scientists, then it must be possible to translate a different scientific theory's terms from either side of a scientific revolution. If the new theories and those they replace do not mean the same things by the terms they use, it appears as though we cannot straightforwardly say that the latter theory denies what the earlier theory asserts, in which case we cannot say that it represents a correction and improvement upon an earlier theory. Incommensurability is itself closely tied with the idea of translation and interpretation. Kuhn argues that causal theories of reference merely interpret instead of translate scientific terms, and thus scientific terms on either side of a scientific revolution remain incommensurable. If that is so, then this view holds profound consequences for scientific realism. This paper attempts to demonstrate how partial reference is a pragmatic way in which to interpret the different terms on either side of a scientific revolution thus saving at least one aspect of scientific realism from incommensurability.

KEYWORDS
Partial Reference, Incommensurability, Kuhn, Causal Theory of Reference, Translation, Interpretation

ACKNOWLEDGEMENTS
I would like to thank my family and friends for supporting my love of philosophy. I would also like to thank my professor Dr. Joseph LaPorte of Hope College for his help and guidance throughout the research and writing process of this paper and all those in attendance at the two conferences which this paper was presented at for their thoughtful comments and questions.

The idea within the causal theory of reference that names hold (largely) the same reference over time seems to be invalid as concepts of scientific kinds have evolved. If science progresses by correcting mistakes of earlier scientists, then it must be possible to translate a different scientific theory's terms from either side of a scientific revolution. If the new theories and those they replace do not mean the same things by the terms they use, it appears as though we cannot straightforwardly say that the latter theory denies what the earlier theory asserts, in which case we cannot say that it represents a correction and improvement upon an earlier theory. Thomas Kuhn holds this view that scientific terms are incommensurable, that they cannot be truly comprehended on either side of a scientific revolution. For Kuhn, incommensurability is itself closely tied with the idea of translation and interpretation. Kuhn argues that causal theories of reference merely interpret instead of translate scientific terms, and thus scientific terms on either side of a scientific revolution remain incommensurable. If that is so, then this view holds profound consequences for scientific realism.

In the first section of this paper I will discuss how incommensurability functions. In the second section of this paper I will discuss certain assumptions of incommensurability and scientific realism as well as demonstrate how partial reference offers a pragmatic way in which we can partially understand how past scientists attached scientific terms to reality thus saving at least one aspect of scientific realism though I argue that this understanding does not allow true comprehension of terms on either side of a scientific revolution.[1]

I. SCIENTIFIC INCOMMENSURABILITY

Kuhn argues that the meanings of scientific terms and concepts often change within the theory in which they are deployed. Thus, it is impossible to define all the terms of one theory in the vocabulary of the other. To describe this phenomenon Kuhn borrowed the mathematical term 'incommensurability'. Applied to scientific terms incommensurability functions metaphorically; the phrase, "no common measure" becomes "no common language". The claim that two theories are incommensurable is then the claim that there is no language, neutral or otherwise, into which both theories, conceived as sets of sentences, can

1. I would like to thank my philosophy of science class at Hope College as well as the attendees of the Michigan Undergraduate Philosophy Conference and the Eastern Michigan University Undergraduate Philosophy Conference for their questions and comments which lead me to change my mind and subsequently my thesis.

be translated without residue or loss. Kuhn's incommensurability thesis therefore hinges on the difference between translating and interpreting terms (Kuhn 1982, 670).

Interpretation is not the same as translation. They are easily confused because actual translation often involves at least a small interpretive component. Translation is something done by a person who knows two languages. The translator systematically substitutes words or strings of words in one language for words or strings of words in such a way as to produce an equivalent utterance, whether it be vocal or written, in the other language. There are two important features of translation. First, the language into which the translation is made must exist before the translation began. That is, translation cannot change the meanings of the words or phrases examined. It may have increased the number of known referents of a given term, but it cannot alter the way in which those referents are determined. Second, that translation consists exclusively of words and phrases that replace, not necessarily one-for-one, words and phrases in the original. It is extremely important for Kuhn that translations must preserve not only reference but also sense or intension (Kuhn 1982, 681).

Interpretation only requires the knowledge of a single language. Interpretation is the process by which the use of a term is discovered. Once it has been completed and the word acquired, we use it and teach it to others. Translation does not occur. When an interpreter succeeds, what he or she has in the first instance done is learn a new language, one in which terms functioned differently. But acquiring a new language is not the same as translating from it into one's own.

For example imagine an American with no knowledge of any French terms or their referents living in Paris. This American is presented with a long loaf of bread with a hard crust and hears the term 'baguette'. Observing the circumstances around the utterance of the term 'baguette' he forms a hypothesis akin to 'baguette' means long loaf of bread with a hard crust. What that American has done in this instance is simply to learn a new language, one in which 'baguette' is a term.

That American may not merely introduce the term 'baguette' into her own language, English. That introduction would alter English and the result would not be a translation. Though English speakers may learn to use the term 'baguette', they speak the original language when they do so. When English speakers use

French terms such as 'esprit de corps' it is because the long English paraphrases for these French terms do not provide a true substitute since they are terms with inherent cultural meanings, meanings that can only be expressed within the cultural language which the term is employed. This cultural meaning is part of the sense and intension of the term 'esprit de corps' which would be lost in it's translation into English. Thus, terms such as 'baguette' and 'esprit de corps' are incommensurable in the English language since translation is not achieved without a loss of both sense and intension.

To further illustrate how incommensurability affects a possible translation, like the example given above, Kuhn discusses the Newtonian term 'mass'. When learning Newtonian mechanics the terms 'mass' and 'force' must be acquired together, and Newton's Second Law must play a role in their acquisition. 'Mass' and 'force' cannot be learned independently and then used empirically to discover that force equals mass times acceleration. Nor can 'mass', or 'force', be first learnt and then used to define 'force', or 'mass' respectively with the aid of the Second Law. In formalizing mechanics one may select either 'mass' or 'force' as primitive and then introduce the other as a defined term. But that formalization supplies no information about how either the primitive or the defined terms attach to nature, how the forces and masses are picked out in the actual physical situations (Kuhn 1982, 677).

Though 'force' may be a primitive in some particular formalization of mechanics, one cannot learn to recognize forces without simultaneously learning to pick out masses and without recourse to the Second Law. That is why Newtonian 'force' and 'mass' are incommensurable with a physical theory, say Einsteinian, in which Newton's Second Law does not apply. Kuhn argues that 'mass' and 'force' simply cannot mean the same thing in both theories since Newton's Second Law is required for their definition in Newtonian mechanics but not in Einsteinian mechanics. Translation is impossible because no neutral language can be created. To learn either way of doing mechanics, Newtonian or Einsteinian, the interrelated terms, 'mass' and 'force', must be learned or relearned together and similarly applied, not in a piece meal fashion, but on nature whole.

Similarly, before Einstein's special theory of relativity, physicists accepted many assertions involving the term 'mass' that are not longer accepted today. The novelty of Einstein's theory is that Newton's assertions involving 'mass' were given up. It was found that the referent of the Newtonian term 'mass' was indeterminate. It either referred to relativistic mass or proper mass. But, the physical referents of Einsteinian special relativity, proper mass or relativistic mass, are by no means identical with those of the Newtonian concept that bear the same name, 'mass'. Therefore Newton was not referring either to proper mass or relativistic mass, but instead he was referring to a non-existent quantity called "Newtonian mass" which has some properties of each. Therefore, Kuhn argues that after the scientific revolution brought about by Einsteinian special relativity, the Newtonian term 'mass' is incommensurable. However, partial reference, an idea within the causal theory of reference, offers a the scientific realist a pragmatic way in which the referent of 'mass', and other scientific terms in general, can be interpreted and understood.

II. A CAUSAL RESPONSE: PARTIAL REFERENCE

If scientific incommensurability exists then it would be impossible to say that theories evolve over time and that we come closer to the truth through that process, which is against the belief of scientific realism. Scientific realism can be described as such: the aim of science is to arrive at the truth about the world; scientific progress consists in progress toward that aim. The world which we inhabit, and which science investigates, is an objective reality, it exists independently of human cognitive activity. The result of successful scientific investigation is knowledge of both observable and unobservable aspects of the world. Scientists discover facts about unobservable entities whose behavior is responsible for the behavior of observable entities. Scientists propose theories which refer to unobservable entities in order to explain observed phenomena. As science progresses, theories approach the truth by providing increasingly accurate descriptions of entities identified by earlier scientists. Truth then is a relation of correspondence between language and reality. Whether a claim about the world is true is an objective matter. It depends on how things are in the mind-independent world, rather than on what scientists believe to be the case (Sanky 2009, 197).

In order to determine whether successive theories approach truth, the content of those theories must be compared, but comparison of the content of theories requires that the terms employed by those theories refer to the same object. In order for there to be an increase in truth known about a field of investigation, successive theories must refer to a common domain of entities. Thus progress requires continuity of reference between theories. Scientific incommensurability argues that this continuity of reference does not hold and therefore the realist account of scientific progress as an increase in truth about a common domain of entities seems untenable. If later theories do not refer to the same entities to which earlier theories in the same domain referred, then it is not possible for later theories to increase the truth known about the same entities as those referred to by earlier theories. Under such circumstances, progress for a scientific realist is impossible; replacement of one theory by another is unable to constitute progress toward the truth about a common domain of entities.

However, for the scientific realist, semantic variance does not entail incomparability of content. Theories whose terms share reference may agree or disagree with respect to specific assertions even if the terms differ in sense. Co-reference of constituent terms is all that is needed for assertions to agree or disagree. Scientific theories may be compared with respect to content, provided only that the terms employed by the theories are related to a common domain.

Sanky argues that only in exceptional cases of wholesale ontological error is there any serious prospect of total incomparability of content. If theories are genuinely applied to the same domain, then, given the role of pragmatic factors in causal reference determination there will always be at least some overlap in the reference of the terms employed by theories in relation to the common domain such that they can be understood (Sanky 2009, 197).

In the causal theory of reference, reference is initially fixed with a dubbing, usually by perception. Reference is fixed during the initial baptism when a speaker says of a perceived object: “You are to be called ‘N’.” Reference is fixed via description when a speaker stipulates: “Whatever the unique such-and-such is to be called ‘N’.” After this initial reference fixing, the name is passed on from speaker to speaker through communicative exchanges. Speakers succeed in referring to something by means of its name because underlying their uses of the name are links in a causal chain stretching back to the dubbing of the object with that name. Subsequent speakers borrow their reference from speakers earlier in the chain. All that is required is that borrowers are appropriately linked to their lenders through causal chains of communication and that reference remains the same over time.

Partial reference theorists like Field, however, argue that many scientific terms are referentially indeterminate. It can be clearly seen throughout the history of science that words do change reference. For example, the term 'water', as it was once used, referenced the principle element water. The term 'water', as it is currently used, references the compound H_2O. Science is replete with cases such as this. That is because until 'water' was found out to be H_2O its referent was indeterminate. Many scientific terms are referentially indeterminate. If they are singular terms, there is no fact of the matter as to what they denote. If they are general terms there is no fact of the matter as to what their extension is. This indeterminacy exists until the scientific community negotiates and sets the term's referent. Newtonian 'mass' is one such example. After Newtonian mechanics was replaced by the special theory of relativity, Newtonian 'mass' could either denote proper mass or relativistic mass (Field 1973, 462).

After the advent of the special theory of relativity the Newtonian term 'mass' still refers, (i.e, maintains continuity of reference), albeit partially, to both relativistic mass and proper mass. Using the structure of the sentence, the term 'mass' can even be applied on a case by case basis to determine truth values. But this case by case determination of truth values raises many issues along with the fact that partial reference sometimes produces unsatisfactory answers.

Take for example the term 'mass'. When used in Newtonian mechanics 'mass' is the proportion constant between force and acceleration. Now with the advent of relativity theory 'mass' refers to either "proper mass" or "relativistic mass". Whether Newton was referring to proper mass or relativistic mass when he uses the term 'mass' can be determined using the sentence structure. So we then substitute the referentially indeterminate word, in this case 'mass', for it's referentially determinate counterpart, which may lead to an unsatisfactory answer.

For example, to accelerate a body uniformly between any pair of different velocities, more force is required if the mass of the body is greater. In this example the term 'mass' partially refers to both relativistic mass and proper mass, no precise answer is achieved. The term 'mass' could not have referred both to proper mass and relativistic mass to Newton for obvious reasons, mainly Newton did not know that such things as proper mass and relativistic mass existed. Therefore, partial reference allows only for an ex post facto examination of past scientific theories with modern scientific knowledge in order to explain why some theory's hypotheses were confirmed by experience. Within a common domain of scientific inquiry this pragmatically allows for the kind of progression towards truth which is the keystone of scientific realism.

Another problem arises with regards to partial reference mainly that examining the referential success or failure of scientific terms on an individual basis disregards how scientific terms are interrelated within any particular scientific theory. Think of the terms 'mass' and 'force' in Newtonian mechanics. They must be learned together and the theory within which they are deployed must be applied on nature whole, not in the piece meal fashion partial reference purports.

As stated before, Kuhn argues that translation must preserve not only reference but also sense or intension. In matching terms with their referents, a person may make use of anything a person knows or believes about those referents. Two people may speak the same language and nevertheless use different criteria in picking out the referents of its terms. This is because language is adapted to the social and natural world in which people live, and that world does not present the sorts of objects and situations which would, by exploiting their criterial differences, lead them to make different identifications. Members of the same language community are members of a common culture, and each member may therefore expect to be presented with the same range of objects and situations. If they are to co-refer, each must associate each individual term with a set of criteria sufficient to distinguish its referents from other sorts of objects or situations which the community's world actually presents (Kuhn 1982, 682).

It is essential that sets of terms must be learned together by those raised inside a culture. Foreigners encountering that culture must consider those terms together during interpretation, otherwise they are incommensurable. Inherent in this assumption is the fact that different languages impose different structures on the world. As Kuhn writes:

> Imagine, for a moment, that for each individual a referring term is a node in a lexical network from which radiate labels for the criteria that he or she uses in identifying the referents of the nodal term. Those criteria will tie some terms together and distance them from others, thus building a multi-dimensional structure within the lexicon. That structure mirrors aspects of the structure of the world which the lexicon can be used to describe,

> and it simultaneously limits the phenomena that can be described with the lexicon's aid....
>
> Note, now, that homologous structures, structures mirroring the same world, may be fashioned using different sets of criterial linkages. What such homologous structures preserve, bare of criterial labels, is the taxonomic categories of the world and the similarity/difference relationships between them...What members of a language community share is a homology of lexical structure. Their criteria need not be the same, for those they can learn from each other as needed. But their taxonomic structures must match, for where structure is different, the world is different, language is private, and communication ceases until one party acquires the language of the other (Kuhn 1982, 682).

It is this emphasis on the social and cultural foundation of language which, I believe, makes the strong thesis of partial reference, i.e. that partial reference entirely defeats incommensurability as a translation schema, untenable. Partial reference allows the scientific realist to use modern scientific knowledge to interpret terms on either side of a scientific revolution but the understanding of those scientific terms can only be partial due to the fact we are removed from the lexical network within which the previous theory functioned. Scientific terms remain truly untranslatable, i.e. they lose sense and intension, but are made pragmatically understandable to our modern scientific knowledge base.

III. CONCLUSION

Kuhn argues that meanings of scientific terms and concepts often change with the theory in which they are deployed. Thus, it is impossible to define all the terms of one theory in the vocabulary of the other. To describe this phenomenon Kuhn borrowed the mathematical term 'incommensurability'. Applied to scientific terms 'incommensurability' functions metaphorically. The phrase, 'no common measure' becomes 'no common language'. For Kuhn the claim that two theories are incommensurable is then the claim that there is no language, neutral or otherwise, into which both theories, conceived as sets of sentences, can be translated without residue or loss.

If scientific incommensurability exists then it would be impossible to say that theories evolve over time and that we come closer to the truth through that process, which is against the beliefs of scientific realism. However, partial reference offers a pragmatic way in which different scientific terms from theories on either side of a scientific revolution can be partially understood allowing for the progression necessary for scientific realism. In this way partial reference provides a realist response to explain how terms can be understood between different scientific theories as knowledge progresses.

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