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How to recognize intruders in your niche

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ABSTRACT: One important problem concerning incommensurability is how to explain that two theories which are incommensurable and therefore mutually untranslatable and incomparable in a strictly logical, point-by-point way are still competing. The two standard approaches have been to argue either that the terms of incommensurable theories may share reference, or that incommensurable theories target roughly the same object domain as far as the world-in-itself is concerned. However, neither of these approaches to the problem pay due respect to the incommensurability thesis' insights. In this paper I shall first show the inconsistency between the basic premises underlying Kuhn's incommensurability thesis and the two standard responses to the thesis. I shall then argue that if one adopts Kuhn's position, the response must build on a notion of overlap between phenomenal worlds. Finally, I shall argue that overlap between complex structures of features can provide the basis for such a notion, and that this makes it possible to explain how incommensurable theories may compete.

1. The problem: Intruder or next-door neighbour?

At the beginning of the 1990s Thomas Kuhn introduced a new metaphor in his account of the development of science: speciation.[2] According to this view the sciences develop like an evolutionary tree in which new subspecialties emerge and gradually get isolated from each other and from the specialties from which they proliferated. The mutual isolation of the subspecialties is brought about by a growing conceptual disparity between the developed tools, hence, the specialized scientist with his highly adapted tools, refined to serve the purposes of the subspecialty, inhabits a niche isolated from the niches of other subspecialties (Kuhn 1992, p. 20).[3] Occasionally, the exploitation of the niche by its inhabitants reaches its limit, and usually reorganization and new proliferation are the result. The inhabitants of the old, exhausted niche may die out, and with them the niche vanishes. In this respect speciation resembles the revolutions which Kuhn previously used as a metaphor for certain phases of the development of science. However, in other respects the new metaphor of speciation is fundamentally different from the old metaphor of revolutions.[4] One of the most striking differences is the role played by incommensurability. In the process of speciation incommensurability is claimed to play the role of making the subspecialties distinct and keeping them apart:

> ... what makes these specialties distinct, what keeps them apart and leaves the ground

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[2] Although Kuhn had compared the development of science to biological evolution in his earlier works, his main metaphor in these works had been selection, not speciation.

[3] Wray (2005) describes how most accounts prior to Kuhn's have focused on social changes as the cause of the formation of new specialties, whereas Kuhn brings the epistemic dimension into focus. However, as Wray notes, Kuhn's work on scientific specialization has been largely neglected by the science studies research community.

[4] For a discussion of some differences between the two metaphors, see Chen 1997.

> between them as apparently empty space ... is incommensurability, a growing conceptual disparity between the tools deployed in the two specialties. Once the two specialties have grown apart, that disparity makes it impossible for the practioners of one to communicate fully with the practioners of the other. (Kuhn 1992, p. 19f.)

Ironically, this new role ascribed to incommensurability emphasizes one of the most serious problems implied by the original incommensurability thesis: how to make sense of the idea that incommensurable theories are actually competing.

Intuitively, one would say that the fact that there is no communication between the different niches – like astrophysics and immunology – reflects only that they address 'something different', that they are not 'about the same thing'. On the contrary, for such theories as, for example, oxygen theory and phlogiston theory one would say that they are indeed 'about the same thing' and therefore within this shared niche compete on offering the better account of their common domain. When formulated in terms of the speciation metaphor this amounts to the difference that scientists inhabiting a given scientific niche live in peaceful co-existence with scientists from *other niches*, but competition and combat is the immediate result if intruders, or betrayers from inside, start exploiting their *own niche*, changing it slightly as they go.

The distinction between intruders in a given niche and inhabitants of another is blurred by Kuhn's formulation of the speciation metaphor when he claims incommensurability to hold between different subspecialties and not just between a new subspecialty and an old one whose problems the new is expected to solve. In other words, there seems to be a difference for scientists working within a given subspecialty between intruders or betrayers who threaten to change their own niche, and those who are simply inhabitants of another, neighbouring niche.

The problem of how to maintain this distinction has accompanied the notion of incommensurability from the outset. Provoked by Kuhn's repeated use of wordings like "when paradigms change, the world itself changes with them" (Kuhn 1970a, p. 111), "after a revolution scientists are responding to a different world" (Kuhn 1970a, p. 111), or "the proponents of competing paradigms practice their trades in different worlds" (Kuhn 1970a, p. 121), critics have argued that there seems to be simply no point at issue between incommensurable theories – that if they are formulated in untranslatable languages, any kind of conflict between them is precluded. Hence, incommensurable theories cannot be rivals. As Shapere put it in his review of *The Structure of Scientific Revolutions*: "if they disagree as to what the facts are, and even as to the real problems to be faced and the standards which a successful theory must meet – then what are the two paradigms disagreeing about? And why does one win?" (Shapere 1964, p. 391).

In the following I shall first summarize the main points of the two standard responses to the problem. Next, I shall show that these responses build on realist premises of a kind which are incompatible with Kuhn's non-realist position. Finally, I shall suggest an alternative response that is placed between traditional realism and non-realism[5] and that does not suffer from the same problem as the two standard responses.

2. The referential stability approach

[5] For more details on this position, see Andersen 2000, 2001, 2004.

One standard response to the incommensurability thesis is the referential stability approach. This approach was first proposed by Scheffler (1967) who argued that even if two theories are mutually untranslatable, as long as their terms share reference it is possible for statements from the two theories to conflict, hence, for the theories to be rivals and comparable.

Such a solution to the incommensurability problem would have to draw upon a theory of reference which could account for reference determination in a way that secured referential stability during theory change. The classical descriptive theory of reference according to which the reference of a term is determined by its associated descriptive content clearly did not fulfill the requirement of referential stability: change of theory entails new descriptions that may not be true of the same things as previous descriptions, and as description determines reference such changes of description will entail change of reference.[6]

The causal theory of reference may at first sight seem more suited to solve the problem of securing referential stability.[7] According to the causal theory, the extension of a term consists of objects that bear a special same-kind-as relation to each other. Thus, if a term has been introduced in an ostensive act it will in subsequent use refer to other objects of the same kind. This same-kind-as relation as a theoretical relation that is determined by the internal structural traits of the objects to which the term refers, and is therefore a relation that may discovered by scientific research (e.g. Putnam 1975, Boyd 1979, Sankey 1994). Claiming that later theories are "in general, *better* descriptions of the *same* entities that earlier theories referred to" (Putnam 1975, p. 137., italics in the original), causal theorists base their referential stability thesis on the realist premise that the objects are theory-independent entities that remain unaltered during theory-change (cf. Putnam 1975). However, as I shall argue below, this is exactly the kind of realism questioned by the incommensurability thesis.

3. Kuhn's theory of world constitution I

Kuhn's ontological viewpoint may be difficult to extract from his writings which suffer from a tension between two different meanings of key terms such as 'world' in passages like "though the world does not change with a change of paradigm, the scientist afterward works in a different world" (Kuhn 1970a, p. 121). However, a reconstruction which dissolves this tension has been provided by Hoyningen-Huene (1989, 1993). According to this reconstruction, two concepts of 'the world' have to be distinguished in Kuhn's philosophy: the *phenomenal world* which is a "perceived world" (Kuhn 1970a, p. 128), and the *world-in-itself* which is a "hypothetical fixed nature" (Kuhn 1970a, p. 118, cf. Hoyningen-Huene 1993, ch. 2.1).

The phenomenal world is "a world already perceptually and conceptually subdivided in a certain way" (Kuhn 1970a, p. 129). This subdivision is not read off from the world itself, but is a structure which is imposed on the world by means of the concepts applied to it. The

[6] To use a classical descriptive theory in the referential approach was suggested by Scheffler 1967. The inability of the classical descriptive theory to secure referential stability has been pointed out by various scholars, most notably Putnam 1973, but also e.g. Hacking 1983, Newton-Smith 1981, Nola 1980a, and Sankey 1994.

[7] This theory was originally introduced by Kripke 1972 to cover proper names and by Putnam 1973 to cover physical magnitude terms and extended to cover natural kind terms in general. Various modifications to the causal theory have been suggested by, among others, Boyd 1979, Enç 1976, Kitcher 1978, 1983, Nola 1980b, and Sankey 1991, 1994.

structure is established by relations of similarity and dissimilarity between objects.[8] These relations are thus decisive for the determination of reference and the constitution of the conceptual structure, but it is important to note that that they are not necessarily based on underlying structural traits, and that there are no restrictions on *which* characteristics can be used to judge the objects similar or dissimilar: "in matching terms with their referents, one may legitimately make use of anything one knows or believes about those referents" (Kuhn 1983, p. 681). This means that there is no distinction between defining and contingent features.[9] By the same token, different members of a given language-community may use different features to identify referents and non-referents of the concept.

4. The inadequacy of the referential stability approach

According to the causal theory, entities and the same-kind-as relation that hold between them are expected to exist objectively in the world prior to our concepts. By the same token, the internal structural traits of the entities that determine the same-kind-as relation can be discovered by scientific investigations. Kuhn, on the contrary, denies the realist assumption of the existence of theory-independent entities, and that gives the similarity and dissimilarity relations used in Kuhn's theory a different status than the same-kind-as relations used in the causal theory. Absent the world's real joints, the similarity and dissimilarity relations cannot be determined by them. Instead, Kuhn rhetorically asked

> "make better sense to speak of accommodating language to the world than of accommodating the world to language. Or is the way of talking which creates that distinction itself illusory? Is what we refer to as 'the world' perhaps a product of a mutual accommodation between experience and language?" (Kuhn 1979, p. 418).

Hence, instead of being determined by the world's real joints, the relations of similarity and dissimilarity are constitutive of the structure of the phenomenal world, that is, of which objects exist in this world. As a consequence, different sets of similarity and dissimilarity relations may constitute different ontologies – 'carve different joints'.

This difference between Kuhn's view and the causal theory is the subject of Kuhn and Putnam's discussion of Putnam's Twin Earth argument. In this argument, Putnam had imagined a Twin Earth which is exactly like our own Earth except for the single difference that what is called 'water' on Twin Earth is not the chemical compound H_2O. Instead, it a

[8] 'Object' shall here be understood as *perceived* objects and not as entities given by an observer-independent world. This may be disturbing to a traditional realist. However, as pointed out by Hoyningen-Huene and Oberheim many (Hoyningen-Huene *et al.* 1996, Oberheim & Hoyningen-Huene 1997) of the central terms used in the realism debate have different meanings in realist and non-realist contexts. The same use of the term object can be found in, for example, Putnam's internal realism is based on a similar view that "'objects' do not exist independently of conceptual schemes. We cut up the world into objects when we introduce the one or another scheme of description" (Putnam 1981, p. 52).

[9] The latter point is similar to Shapere's rejection of the essentialism inherent in the causal theory: "it is not just one property of set of properties – the "essential" ones – that determines or affects how scientists will apply terms in new situations; all the (true) properties may ... play a role, and furthermore, the properties and behaviour of other entities (substances, etc.) may also play a role" (Shapere 1982, p. 7).

different compound with a very long and complicated chemical formula, abbreviated as XYZ. Nevertheless, this Twinearthian water is indistinguishable from the Earth's water at normal temperature and pressure. On Putnam's view, when the first astronauts from Earth came to visit Twinearth and did not know the chemical formula, they would simply take Twinearthians water to be water. However, with the development of chemical theory they would at some point discover that they only *mistook* Twinearthian water for water. Thus, Putnam argued that although the astronauts first supposition might probably be that the term 'water' has the same meaning on Earth and on Twin Earth, after doing some chemical analyses they would report back to Earth that on Twin Earth the word 'water' means XYZ.

Kuhn disagreed to this part of the scenario, arguing that the astronauts' report would rather be something like "Back to the drawing board! Something is badly wrong with chemical theory" (Kuhn 1989a, p. 27; 1990, p. 310). Kuhn argued that modern chemical theory is incompatible with the existence of a substance with properties very nearly the same as water but described by an elaborate chemical formula. Therefore, the discovery that Twin Earthian water is not H_2O but XYZ is not merely a discovery of the underlying traits of a particular substance, but the discovery of an anomaly to chemical theory as such. Resolving that anomaly might lead to a restructured chemical lexicon, and only with this "differently structured lexicon, one shaped to describe a very different sort of world, could one, without contradiction, describe the behavior of XYZ at all, and in that lexicon 'H_2O' might no longer refer to what we call 'water'" (Kuhn 1989a, p. 27).[10]

In sum, by drawing on the existence of some real joints in the world to provide the referential stability, the referential approach solves the problem how to establish sameness of object-domain for incommensurable theories, but without taking seriously that what the incommensurability thesis denies is exactly the existence of such world's real joints. Thus, on this point the causal theory and the incommensurability thesis are based on incompatible premises. Consequently, if the problem inherent in Kuhn's thesis – how can theories that are mutually untranslatable and therefore incomparable in a strictly logical, point-by-point way still compete – shall be solved within its original non-realist framework and not just be dismissed by changing to a realist framework, another approach free from traditional realist assumptions is requested.

5. The double-world approach

The reconstruction of Kuhn's position in terms of a perceived world constituted by relations of similarity and dissimilarity relations was introduced to capture Kuhn's rejection of traditional realism. At fist sight, it may appear as if the similarity and dissimilarity relations can be freely invented to constitute any arbitrary structure of the phenomenal world. However, this is not the case: "nature cannot be forced into an arbitrary set of conceptual boxes. On the contrary ... the history of the developed sciences shows that nature will not indefinitely be confined in any set which scientists have constructed so far" (Kuhn 1970b, p.

[10] Further, Kuhn attacked Putnam's claim that the term 'water' simply refers to substances with the chemical formula H_2O, pointing out that 'H_2O' not only picks out water, but also ice and steam. If one wants to specify the underlying trait of water more than just the chemical constitution is necessary, such as information about packing and relative motion of the molecules. The conjunction of this set of properties picks out a smaller class of objects than the properties taken individually, and that raises the question which property or conjunction of properties should be interpreted as cutting the world at it's joints. (cf. Kuhn 1989a).

263).

This 'resistance' against giving arbitrary structures to the phenomenal world is ascribed to the world-in-itself. Kuhn first tried to avoid the use of Kantian things-in-themselves (Kuhn 1979, p. 418f.), and the term world-in-itself was introduced by Hoyningen-Huene in his reconstruction of Kuhn's philosophy (Hoyningen-Huene 1993, sec. 2.1.a). However, Kuhn later endorsed a similar view:

> "Underlying all these processes of differentiation and change, there must, of course, be something permanent, fixed, and stable. But, like Kant's *Ding-an-sich*, it is ineffable, undescribable, undiscussible. Located outside of space and time, this Kantian source of stability is the *whole* from which have been fabricated both creatures and their niches" (Kuhn 1991, p. 12, italics added).

One here notes the difference between Kuhn's position and both extreme constructivist anti-realism and traditional realism. According to Kuhn's position, the 'resistance' appears in the form of *anomalies*, i.e. situations in which it becomes clear that something is wrong with the structure given to the phenomenal world by our concepts – that objects do not behave or situations do not develop as prescribed by the current conceptual structure. However, the anomalies only show that there is something wrong with the structure of the phenomenal world, but not how the phenomenal world has to be structured instead. If the resistance fully determined the structure of the phenomenal world there would be no need to introduce the phenomenal world as a changeable perceived world and the position would reduce to traditional realism, if there was no resistance it would be extreme constructivist anti-realism – and Kuhn's position is somewhere in-between.[11]

6. The inadequacy of the double-world approach

Based on his double-world interpretation of Kuhn, Hoyningen-Huene has attempted to solve the key problem of this paper – how can incommensurable theories be rivals – by recourse to the world-in-itself: "Incommensurable theories ... target *roughly the same* object domain, *as far as the world-in-itself is concerned*, though this 'object domain' isn't graspable in any theory-neutral way, since different lexica must always produce different object domains" (1993, p. 219, italics in the original). Although this solution may have some intuitive appeal, this attempt to solve the problem within a Kuhnian non-realist framework seems inconsistent. Thus, the alleged solution consists of two parts: a suggestion to establish sameness of 'object-domain' as far as the world-in-itself is concerned, and a qualification to the concept of 'object-domain' that it *cannot* be seized in terms of the world-in-itself. Evidently, this is problematic. The two parts together amount to a quest for establishing (a rough) identity between that to which we do not have any epistemic access. That venture is inconsistent. Either we must take seriously that the world-in-itself is a hypothetical fixed nature to which we do not have any epistemic access – but then we cannot establish the required (rough)

[11] In Hoyningen-Huene's terminology, the structure of the phenomenal world, constituted by the relations of similarity and dissimilarity, has both object-sided and subject-sided moments. These are inseparable; because the resistance offered by the world-in-itself does not fully determine the structure of the phenomenal world, we cannot get rid of the subject-sided moments, and hence cannot gain full epistemic access to the purely object-sided (Kuhn 1979, p. 418. See also Hoyningen-Huene 1993, sec. 2.3 and Epilogue).

identity. Or we may establish the identity – but then we are not dealing with a world-in-itself. The world-in-itself here seems to serve as an intuitive realist foundation in the anti-realist building.[12]

7. Kuhn's theory of world constitution II

Since incommensurability cannot be based on identity between object-domains as far as the world-in-itself is concerned, what must be required instead is some sameness of object-domains as far as the phenomenal world is concerned. However, since incommensurable theories apply to different phenomenal worlds, sameness of object-domain as far as the phenomenal world is concerned can only be established if there is some *overlap* between the phenomenal worlds in question. To clarify how phenomenal worlds may overlap we must again consider the constitution of a phenomenal world and the intertwining of object-sided and subject-sided moments.

As described in section 3 above, the phenomenal world is constituted by a web of similarity and dissimilarity relations that are immediate in the sense that the relation is not based on a similarity-conferring third. Kuhn claims that this is possible because of an "empty perceptual space between the families to be discriminated" (Kuhn 1970a, p. 197, fn. 14). This can be exemplified by Kuhn's favourite example of the child who learns to recognize ducks, geese and swans. The successful recognition of three different categories presupposes that there are no intermediate forms, no duck-swans that fall between the categories of ducks and swans. If the features involved in recognizing ducks, geese and swans are thought to span the dimensions of perceptual space, there must be discontinuities along some of these dimensions. For example, while the necks of ducks are quite short, the neck of swans are relatively long, and no duck-swans with intermediate lengths are found in nature. It is such empty perceptual space between the families to be discriminated that makes discrimination possible.

Perceptual space and the relations of similarity and dissimilarity seem here to be mutually dependent. At first sight, the mutual dependence of the phenomenal joints and the relations of similarity and dissimilarity may seem circular: the phenomenal joints - categories such as ducks and geese - secure the immediacy of the relations of similarity and dissimilarity,[13] but at the same time the relations of similarity and dissimilarity are constitutive of the phenomenal joints. However, adopting a developmental view this problem of circularity dissolves.[14] The important point is that the phenomenal world is never structured from scratch by its inhabitants. Instead, the inhabitants of any phenomenal world inherit it from their predecessors. A phenomenal world is therefore always provided by the historical situation and may from there again be reshaped by introducing new relations of similarity and dissimilarity and abandoning old ones, thus providing a different phenomenal world with different phenomenal joints to the generations to come.

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[12] Similar arguments have been raised against Hoyningen-Huene's double-world reconstruction of Kuhn's position by Sankey (1997).

[13] In this way, Kuhn can be said to draw on the joints of the *phenomenal world* to substantiate the claim of the immediacy of the similarity and dissimilarity relations, but contrary to the purely objective 'world's real joints' of the causal theory, the joints of the phenomenal world have both subject-sided and object-sided moments.

[14] A more detailed version of this argument can be found in Andersen (2000).

8. Joints in the phenomenal world

In constituting the structure of the phenomenal world, Kuhn ascribes a special importance to the features which differentiate between instances of contrasting concepts. This is due to the taxonomic character of conceptual structures constituted by similarity and dissimilarity relations. Such conceptual structures are necessarily taxonomic, that is, hierarchical structures in which a general concept decomposes exhaustively into a group of more specific, non-overlapping concepts called a contrast set (cf. Chen *et al*. 1998, Andersen 2000).[15] Each of the contrasting, subordinate concepts may again decompose into yet more specific concepts, and so forth, thereby forming a taxonomic tree.

The decomposition of a superordinate concept into a group of contrasting concepts is determined by the features: "To each node in a taxonomic tree is attached a name ... and a set of features useful for *distinguishing* among creatures at the next level down. ... Attached features are not shared by named creatures. They function as differentiae for the next level down" (Kuhn 1990, p. 5, emphasis in the original). Hence, differentiae are sets of features attached to a superordinate concept.[16]

It is important to note that the plurality of differentiating features serves two purposes: First, it will often be necessary to draw on several features organized in some pattern in order to distinguish the instances of the concepts in a contrast set. For example, considering Kuhn's favourite contrast set – ducks, geese and swans – neither the feature rounded beak/pointed beak nor the feature short neck/long neck alone suffice to distinguish instances of the three concepts, but taken together they do suffice to distinguish instances of ducks, geese and swans. Secondly, the possibility of basing the similarity and dissimilarity relations on different features presupposes an empirical correlation between them. As only some of those co-occurring features are necessary to use a given concept correctly, adding further features will say something not just about how to pick out instances of the concept, but also something about how an object already picked out will behave. For example, when distinguishing between ducks, geese and swans some speakers may use the combination of the two features neck and beak, while others use the combination of the two features colour and beak. Each of these sets of features are jointly sufficient to identify instances of the contrasting concepts, but none of the features are individually necessary. This equivalence of different sets of jointly sufficient features presupposes an empirical correlation between *all* features and makes it possible, for example, for the former group of speakers not only to identify ducks on the basis of neck and beak but further for them to expect a bird such identified to be brown.

The conjunction of all features can therefore be seen as a hypothesis about the behaviour of the instances of the corresponding concept – in the example above, the hypothesis that fowls classified as ducks due to neck and beak will be brown. In this way

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[15] As argued by Nersessian & Andersen 1997, whereas normic concepts are taxonomic, for nomic concepts it is the complex problem situations in which the nomic concepts are used that show taxonomic structures (similarly Hoyningen-Huene 1993, sec. 3.6.e). Hence, for nomic concepts the following argument on overlapping joints applies to the problem situations rather than to the individual concepts.

[16] Formulated in terms of perceptual space, Kuhn's emphasis on the plurality of differentiating features implies that the categories to be discriminated are separated by empty space in multiple dimensions. As described above, neck length may be one dimension in perceptual space along which discontinuities may be found, but others could be body size, or shape or colour of the beak.

conceptual structure is linked to *projectibility*. Drawing on Goodman's definition of a projectible hypothesis as a hypothesis that has some undetermined, some positive and no negative cases (Goodman 1965, p. 90), one can say that all previously examined instances of the concept which have established that the co-occurrence of the bundled features is an empirical regularity provide the positive instances of the hypothesis, while all hitherto unexamined instances of the concept provide the unexamined cases.[17]

Hence, concepts are projectible because they imply expectations of how instances of the concept already identified behave. For a concept to be projectible, the expectation must exist that the bundle of features involves more features than needed just to pick out instances of the concept, and that the classifications which the different sets of jointly sufficient features give rise to must be coextensive.

It is a key premise of Kuhn's position that nature cannot be forced into any arbitrary set of conceptual boxes. Whether the bundle of features are actually coextensive is for Kuhn an objective matter. Anomalies will inevitably appear if a set of features cannot be bundled.[18] However, as I have argued elsewhere, several qualifications are necessary here (see Andersen 2004, forthcoming): Not all anomalies are equally severe, they need not be discovered at once, and different scientists may judge the same anomaly very differently.[19] Projectibility does therefore not offer any simple algorithm for theory comparison. Due to some historically determined emphasis on specific features, the possibility of bundling a few emphasized features may be considered far more important than the possibility of bundling several other, less emphasized features. Such differences must also be taken into account when comparing theories.[20]

Further, the claim that it is an objective matter whether features can be bundles in a particular way does not rule out that features can be bundled in different ways. As argued previously, different sets of similarity and dissimilarity relations may bundle different sets of features which carve different joints in the phenomenal world. Thus, the claim is a purely negative claim that not any arbitrary bundling of features is possible; it is not a positive claim about the existence of a privileged set of features bundles constituting the world's real joints.[21]

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[17] A qualification to the requirement of no negative cases will be necessary, as anomalies, that is, instances that do not conform to the knowledge of regularities, do not always lead to conceptual change. I shall come back to this point later.

[18] This possibility that previous classifications may later turn out wrong is also one of the key points in e.g. Shapere's rejection of essentialism: "science is constantly open to the possibility that doubt may (though it need not) arise, that our present views, including the ways we "conceptualize" objects and kinds, and name and describe them, may have to be revised or rejected and replaced" (Shapere 1982, p. 14).

[19] For detailed treatments of the possibility of different reactions to anomalies, see also Kuhn 1970a, ch. VI-VIII, Hoyningen-Huene 1993, sec. 7.1, Chen *et al.* 1998, and Nersessian & Andersen 1997.

[20] Although there is here a certain similarity to Goodman's notion of entrenchment (Goodman 1965, chapter IV), the 'emphasis' on features introduced here goes beyond mere recurrence and more in the direction of recent cognitive theories on the role of causal status in determining the importance of features. For a historical case study, see Andersen [forthcoming].

[21] It may be questioned whether this negative claim suffices for a realist position. However, comparing to Sankey's (2001) description of the principles by which scientific realism can be

9. The alternative response: Overlapping phenomenal worlds

Given Kuhn's theory of the constitution of phenomenal worlds and their joints, *identical* phenomenal worlds are those which are carved into the same joints, that is, phenomenal worlds which share ontology. For phenomenal worlds to be carved into the same joints presupposes shared conceptual structure, and that again presupposes shared relations of similarity and dissimilarity. However, as argued above, the similarity and dissimilarity relations constitutive of the conceptual structure need not be attached by means of the same features by all speakers. Hence, it is shared structure, not shared features, that yields shared ontology. The only requirement is that in so far as features are not shared, it is expected that they are all compatible:

> "homologous structures, structures mirroring the same world, may be fashioned using different sets of criterial linkages. ... What members of a language community share is homology of lexical structure. Their criteria need not be the same, for those they can learn from each other as needed." (Kuhn 1983, p. 683, similarly Kuhn 1990, p. 7).

Hence, in so far as the features for a given set of contrasting concepts are not shared, it is expected that they can in principle all be bundled, that is, that all the different sets of jointly sufficient features used by different members of the language community carve the same joints in the phenomenal world. Only in this case will members of the language community who use different features to distinguish instances of a set of contrasting concepts categorize these instances in the same way.

The question now is how to develop a notion of *overlap* between the phenomenal worlds which can serve to identify incommensurable theories. Still lacking of a notion of object-domain, I shall start from a developmental perspective and later generalize to cover the ahistorical perspective as well. On a developmental view, incommensurable theories are (usually) the result of a historical process which has required changes of conceptual structure that go beyond mere additions and refinements (Kuhn 1991, p. 7, Kuhn 1992, p. 16).[22] Such changes are made as the response to severe anomalies, that is, they are made when an object has been discovered which does not fit into the similarity classes of the conceptual structure. More specifically, since conceptual structures constituted by relations of similarity and dissimilarity are characterized by a hierarchy of contrast sets, any object which challenges the non-overlapping division of the contrast set to which it belongs calls the conceptual structure into question. This is what Kuhn introduced as *the no-overlap principle*:

> no two kind terms, no two terms with the kind label, may overlap in their referents unless they are related as species to genus. There are no dogs that are also cats, no gold rings that are also silver rings, and so on: that's what makes dogs, cats, silver, and gold each a kind. Therefore, if the members of a language community encounter

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characterized it can be noted that this position can well be characterized by the principles that the world investigated by science is an objective reality that exists independently of human thought, that it is the external world that renders our claims about the world true or false, and that truth consists in a correspondence between a claim about the world and the world.

[22] For historical case-studies of such developments, see e.g. Andersen (1996), (forthcoming), Barker, Chen & Andersen (2003).

> a dog that's also a cat (or, more realistically, a creature like the duck-billed platypus), they cannot just enrich the set of category terms but must instead redesign a part of the taxonomy (Kuhn 1991, p. 4).

Hence, conceptual structure is challenged when an object is encountered which on the basis of different differentiating features can be ascribed to different contrasting categories. In this case, the anomaly reveals that the previously assumed bundling of features is not projectible after all.

When this happens, conceptual structure must be changed. However, as noted previously, an anomaly reveals only that the previous bundling of features was not projectible after all, but it does not determine any alternative way to bundle the features. The only requirement is that the conceptual structure must be brought to comply with the no-overlap principle again, that is, the similarity classes must be changed in such a way that also the anomalous object will be ascribed to only one of the contrasting concepts. Such a change implies changes in the relations of similarity and dissimilarity and hence changes of the bundlings of features, where the only guideline is that projectibility must be reestablished by bundling the features such that the new combinations of features can be seen as hypotheses with some positive, but no negative cases. This requirement that projectibility must be reestablished therefore provides *reasons* for conceptual change. For a conceptual structure that develops gradually through several incremental changes, each step will be based on such considerations of how concepts remain projectible. From step to step, these considerations provide reasons for conceptual change, and as the conceptual structure gradyally develops, these new considerations about projectibiliy are linked to the old as links in a chain. Adopting an expression from Shapere, the bundles at different stages in a theory's development can be said to be related by chains-of-reasoning (Shapere 1982, similarly Nersessian 1984).

However, it is possible to imagine several different changes of the bundling of features which all have some positive, but no negative cases. If these different bundlings overlap, that is, share some but not all features in the bundle, and if these different bundlings lead to differing similarity classes, then the different bundlings can be seen as incompatible hypotheses, which are nevertheless all projectible. As the different bundlings carve different joints in the phenomenal worlds to which they give rise, although they are all projectible, they are projectible in different phenomenal worlds.

But these phenomenal worlds do not differ in any arbitrary sense. They are not unrelated. The important point is that the different bundles are incompatible due to the shared features. That means that they give rise to different phenomenal worlds that are also mutually exclusive. If you adopt one, you simultaneously reject the others. Hence, while it is shared structure and not shared features that yields shared ontology, when structure is no longer shared, it is shared features that provides the overlap between different phenomenal world necessary for them to compete in offering the better account of the world in the form of more successful or more promising bundlings. Thus, it is shared features that yield incommensurability in the original sense of combat and competition. Or, to put it in terms of niches, it is the shared features which provide the overlap between portions of the two niches necessary for their inhabitants to see each other not as inhabitants of another niche, but as intruders wanting to change their own niche.

This argument was built on the developmental view, that usually incommensurable theories are *successive* theories. However, in principle nothing prevents the result being generalized in such a way that it is applicable independently of how the theories in question have developed. Chinese astronomy may overlap – and hence compete – with Western

astronomy by sharing features, despite its origin in a totally separate tradition. Shared features bundled differently yields incommensurability whether or not the shared features are inherited from the same predecessor; the developmental perspective simply make more plausible that, among the staggering amount of possible bundlings of features, two different theories will actually overlap in their bundlings because they are connected through chains-of-reasoning.

10. The incommensurability thesis revisited

As Kuhn has repeatedly pointed out since the publication of *The Structure of Scientific Revolutions*, the incommensurability thesis is much more modest than many of its critics have supposed (e.g. Kuhn 1983, p. 671). The problems related to incommensurability only relate to a small part of the scientific lexicon, while most of the lexicon functions the same way in both theories (e.g. Kuhn 1983, p. 670f.). Hence, most bundles of features are shared by the incommensurable theories. It is only a few, overlapping bundlings of features establishing differing similarity classes which are responsible for the incommensurability. Further, it is important to remember that incommensurability arise because these different bundles provide incompatible hypotheses. Many pairs of theories may share large parts of their conceptual structure, but they only compete on explaining the same object-domain when some bundlings of features overlap.

Astrophysics and health physics, for example, may share large parts of their conceptual structure – parts dealing, for example, with nuclei and radiation. They may also develop unshared parts – the interaction between radiation and tissue in health physics, or the production of heavy elements in astrophysics – but none of the bundlings of features in these unshared parts overlap. They do not offer incompatible hypotheses about some object which can be classified differently in the two theories, leading to different expectations of its behaviour. Such theories have nothing to compete about, but live in peaceful coexistence, each in their own niche. The situation is different for Ptolemaic astronomy and astronomy after Kepler. These theories may also share large parts of their conceptual structure, but the unshared parts provide incompatible hypotheses due to overlapping bundling of features. In this case scientists adopting different theories agree on some features, but bundle them in different, incompatible ways.

Hence, a second no-overlap principle can be formulated that has to hold between different niches. For two niches to be different and their inhabitants to live in peaceful co-existence, each in their own niche, all bundlings of features must be either identical, that is, totally overlapping, or not overlap at all. Of course, if *all* bundlings of features are identical, the two niches are identical, and its inhabitants are scientists who work within the same subdiscipline, but with the same concepts and hence without any disagreement about which tool is the better one for investigating the niche. But if only *some* bundlings of features are identical, the non-identical bundlings are not allowed to overlap. As long as they do not overlap, the different sets of bundlings are directed towards different niches, and hence, again, there is no disagreement about which tool is the better one because they use it in investigating different niches.

If, however, this new no-overlap principle for features is violated, that is, if some bundles of features overlap, the niches are neither identical, nor distinct. Instead, the niches overlap in the sense that their inhabitants compete on which tool to use in exploring the niche, and how the niche shall be developed as a result. Hence, it is through the overlapping bundles of features that intruders can be recognized. The different bundling may arise as the result of a development *within* the niche among the scientists of which some have become betrayers who

attempt to simultaneously change the niche and develop a tool for investigating it in its changed form, or it may be a result of intruders from *outside* who have discovered a niche sufficiently overlapping with their own to attempt an invasion, but in both cases the result is competition and combat among the scientists and incommensurability between the theories they employ.

References

Andersen, H. (1996): Categorization, Anomalies, and the Discovery of Nuclear Fission, *Stud. Hist. Phil. Mod. Phys.* **27**: 463-492 (1996)

Andersen, H. (2000): Kuhn's account of family resemblance: A solution to the problem of wide-open texture, *Erkenntnis* **52**: 313-337

Andersen, H. (2001): Reference and Resemblance, *Philosophy of Science* **68** (Proceedings): S50-S61

Andersen, H. (2004): A Dynamic Account of Conceptual Structures, in Li Ping, Xiang Chen, Zhang Zhilin & Zhang Huaxia (ed.): *Science, Cognition, and ConsciousnessThe Proceeding of the International Conference of Philosophy and Cognitive Sciences*, Guangzhou: JiangXi People's Press, pp. 118-140

Andersen, H. [forthcoming]: Unexpected discoveries, graded structures, and the difference between acceptance and neglect, to appear in T. Nickles & J. Meheus: *Proceedings of the International Congress on Discovery and Creativity*, Dordrecht: Kluwer

Barker, P., X. Chen & H. Andersen (2000): Thomas Kuhn and Cognitive Science, in T. Nickles (ed.): *Thomas Kuhn*, Cambridge University Press, pp. 212-245 (2003)

Barker, P. & B.R. Goldstein (1994), "Distance and velocity in Kepler's astronomy", in: *Annals of Science* **51**: 59-73

Boyd, R. (1979), "Metaphor and theory change: What is "metahpor" a metaphor for?", in: A. Ortony (ed.): *Metaphor and Thought*, Cambridge: Cambridge University Press, 2nd ed. 1993, pp. 481-532

Chen, X. (1997), "Thomas Kuhn's Latest Notion of Incommensurability", in: *Journal for the General Philosophy of Science*, forthcoming

Chen, X., H. Andersen & P. Barker (1998), "Kuhn's Theory of Scientific Revolutions and Cognitive Psychology", in: *Philosophical Psychology* **11**: 5-28

Enç, B. (1976), "Reference of Theoretical Terms", in: *Noûs* **10**: 261-282

Goodman, Nelson (1965), *Fact, Fiction and Forecast*, 2nd ed., Indianapolis: Bobbs-Merril

Hacking, I. (1983), *Representing and Intervening. Introductory Topics in the Philosophy of Modern Science*, Cambridge: Cambridge University Press

Hacking, I. (1990), "Natural Kinds", in: R.B. Barrett & R.F. Gibson: *Perspectives on Quine*, Cambridge MA: Basil Blackwell, pp. 129-141

Hoyningen-Huene, P. (1989), "Idealist elements in Thomas Kuhn's philosophy of science", in: *History of Philosophy Quarterly***6**: 393-401

Hoyningen-Huene, P. (1993), *Reconstructing Scientific Revolutions. Thomas S. Kuhn's Philosophy of Science*, Chicago: University of Chicago Press

Hoyningen-Huene, P., E. Oberheim & H. Andersen (1996): On Incommensurability, *Stud. Hist. Phil. Sci.* **27**: 131-141

Kitcher, P. (1978), "Theories, Theorists and Theoretical Change", in: *Philosophical Review* **LXXXVII**: 519-547

Kitcher, P. (1983), "Implications of Incommensurability", in: *PSA 1982*, Vol. 2, pp. 689-703

Kripke, S. (1972), "Identity and Necessity", in: M.K. Munitz (ed.): *Identity and Individuation*, New York: New York University Press

Kuhn, T.S. (1970a), *The Structure of Scientific Revolutions*, 2nd ed., Chicago: University of Chicago Press

Kuhn, T.S. (1970b), "Reflections on my critics", in: I. Lakatos & A. Musgrave: *Criticism and the Growth of Knowledge*, Cambridge: Cambridge University Press, pp. 231-278

Kuhn, T.S. (1979), "Metaphor in science", in: A. Ortony (ed.): *Metaphor and Thought*, Cambridge: Cambridge University Press, pp. 409-419

Kuhn, T.S. (1983), “Commensurability, Comparability, Communicability”, in: *PSA 1982*, Vol. 2, pp. 669-688
Kuhn, T.S. (1990), An Historians Theory of Meaning, Talk to the Cognitive Science Colloquium, UCLA 4/26/90
Kuhn, T.S. (1991), “The Road since Structure”, in: *PSA 1990*, Vol. 2, pp. 3-13
Kuhn, T.S. (1992), The Trouble with the Historical Philosophy of Science. Robert and Maurine Rotschild Distinguished Lecture, 19. Nov. 1991. Cambridge, MA: Department of the History of Science, Harvard University
Nersessian, N. (1984), *Faraday to Einstein: Constructing Meaning in Scientific Theories*, Dordrecht: Martinus Nijhoff
Nersessian, N. & H. Andersen (1997), “Conceptual Change and Incommensurability: A Cognitive-Historical View”, in: *Danish Yearbook of Philosophy* **32**: 111-151
Newton-Smith, W.H. (1981), *The Rationality of Science*, Boston: Routledge & Kegan Paul
Nola, R. (1980a), “ ‘Paradigm lost, or the world regained’ – an excursion into realism and idealism in science”, in: *Synthese* **45**: 317-350
Nola, R. (1980b), “Fixing the reference of theoretical terms”, in: *Philosophy of Science* **47**: 505-531
Oberheim, E. & P. Hoyningen-Huene (1997): Incommensurability, Realism and Meta-incommensurability, *Theoria* **12**: 447-465
Putnam, H. (1973), “Explanation and reference”, in: G. Pearce and P. Maynard (eds.): *Conceptual Change*, Dordrecht: Reidel, pp. 199-221. Reprinted in: H. Putnam: *Mind, Language and Reality. Philosophical Papers Volume 2*, Cambridge: Cambridge University Press 1975, pp. 196-214
Putnam, H. (1975), “The meaning of ‘meaning’”, in: K. Gunderson (ed.): *Language, Mind and Knowledge*, Minnesota Studies in the Philosophy of Science, Vol. VII, Minneapolis: University of Minnesota Press. Reprinted in: H. Putnam: *Mind, Language and Reality. Philosophical Papers Volume 2*, Cambridge: Cambridge University Press 1975, pp. 215-271
Putnam, H. (1981), *Reason, Truth and History*, Cambridge: Cambridge University Press
Sankey, H. (1991), “Translation failure between theories”, in: *Studies in the History and Philosophy of Science*, **22**: 223-236
Sankey, H. (1994), *The Incommensurability Thesis*, Aldershot: Avesbury
Sankey, H. (1997): Incommensurability: The Current State of Play, *Theoria* **12**: 425-445
Sankey, H. (1998): Taxonomic incommensurability, *International Studies in the Philosophy of Science* **12**: 4-16
Sankey, H. (2001): Scientific Realism: An Elaboration And A Defence, *Theoria* **98**: 35-54
Scheffler, I. (1967), *Science and Subjectivity*, Indianapolis: Bobbs-Merrill
Shapere, D. (1964), “The Structure of Scientific Revolutions”, in: *Philosophical Review* **LXXIII**: 383-394
Shapere, D. (1982), “Reason, Reference, and the Quest for Knowledge”, in: *Philosophy of Science* **49**: 1-23
Wray, K. Brad (2005), "Rethinking Scientific Specialization", *Social Studies of Science* **35**: 151-164