Natural phenomenon terms

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1. In lecture III of *Naming and Necessity* Kripke extends his claim that names are non-descriptive to natural kind terms, and in so doing includes a brief supporting discussion of terms for natural phenomena, in particular the terms 'light' and 'heat'. While natural kind terms continue to feature centrally in the recent literature, natural phenomenon terms have barely figured. The purpose of the present paper is to show how the apparent similarities between natural kind terms and the natural phenomenon terms on which Kripke focuses are outweighed by more significant differences. Thus, rather than providing additional support for non-descriptivism, natural phenomenon terms turn out to challenge that thesis.

2. Kripke proposes a method of fixing the referents of 'light' and 'heat' by description that is similar to that which might be used in the case of natural kind terms (e.g. Kripke talks of the way in which we might identify water 'by its characteristic feel, appearance and perhaps taste' (1980: 128)). Light can be identified 'by the characteristic internal visual impres-

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sions it can produce in us that make us able to see' (1980: 129). Hence the reference of 'light' can be fixed by 'the fact that it is whatever, out in the world, affects our eyes in a certain way' (1980: 130). In other words, the reference of 'light' can be fixed by the description 'the natural phenomenon which is sensed by sensations of type *L*' or 'the natural phenomenon which affects our eyes in a certain way'. Call this description 'D_L'. Similarly, heat can be identified by 'the characteristic effect on one aspect of our nerve endings' (1980: 129). Hence the reference of 'heat' can be fixed by the description 'the natural phenomenon which is sensed by sensations of type *H*'. Call this description 'D_H'. Kripke assumes that the two terms are used to refer to distinct natural phenomena and continue to be so used however the terms might be subsequently transmitted. He also assumes that the terms are rigid designators, viz. that we use these terms to enable us to talk counterfactually about the same natural phenomena. Kripke further notes that scientists have discovered the natures of both phenomena: light is a stream of photons and heat is the motion of molecules. Hence we use 'light' and 'heat' to refer to streams of photons and to the motion of molecules, respectively, when evaluating worlds at which there are such phenomena.[1]

To complete the case for non-descriptivism with respect to natural phenomenon terms, Kripke needs to show how 'light' and 'heat' are not equivalent in meaning with the descriptive expressions originally used to fix their references. In support of the latter objective, Kripke presents the following argument.

Imagine a world in which there are no humans, or in which the humans that there are have no visual organs. You are imagining a world in which there are no sensations of type *L* caused by any natural phenomenon available to fix the reference of 'light'. But it need not follow, simply because the properties initially used to fix the reference of 'light' in the actual world do not exist, that it is a world in which light does not exist. It might be a world in which light exists but does not cause sensations of type *L* in humans. The case is hardly implausible; after all, our world is one in which some people (the blind) are unable to sense light visually, yet light still exists. This case is intended to show how the reference of 'light' is fixed in an a priori manner by one of its contingent properties, viz. the capacity to cause sensations of type *L* in people. 'D_L', so it is claimed, is not equivalent in meaning to 'light' because, for the counter-

[1] More should be said here about how one thinks of the referent. No one stream of photons is the referent of 'light'. Nor is the set of such streams of light the referent of 'light', since it would vary from world to world. One suggestion that has been made to me by Timothy Williamson is to think of light as standing to each individual stream of photons as water stands to each individual quantity of water. Soames (2002) also considers such cases.

factual case we are conceiving, we use 'light' to denote a particular natural phenomenon (streams of photons), whereas 'D_L' cannot now be so used. Imagine next a possible world in which heat does not cause sensations of type *H* in people. This does not entail a world in which heat does not exist. It might be a world in which heat exists but no one is sensitive to it. Again, the descriptive expression, 'D_H', so it is claimed, is not equivalent in meaning to 'heat' because, for this counterfactual case, we use 'heat' to denote a particular natural phenomenon (the motion of molecules), whereas 'D_H' cannot now be so used.

Suppose we accept the modal intuitions. It is hard to deny the conclusion that 'light' and 'D_L' are not equivalent in meaning if meaning is construed in terms of the determination of reference across possible worlds. As Kripke notes (1980: 59, n. 22), in the formal semantics of modal logic, the *sense* of the term 'light' (i.e. what gives it meaning) is taken to be the function which assigns to each possible world, *w*, the referent of 'light' in *w*. Since 'light' is taken to refer to the same phenomenon in all worlds (i.e. it is a rigid designator), it has a constant function as its sense. By contrast, the description, 'D_L', which is used to fix the reference of 'light', does not refer to the same phenomenon in all worlds (i.e. it is a non-rigid designator). Therefore it does not have a constant function as its sense. Since 'light' and 'D_L' have different referents in different possible worlds, they have different functions for assigning such referents, and thus are not synonymous.

A contrary view, however, holds that 'light' refers to the same phenomenon in all possible worlds because its reference is determined across possible worlds by the descriptive expression that was initially used to fix its reference, viz. 'D_L' rigidified (or, alternatively speaking, 'actually D_L'). The constant function that is the meaning of 'light' is given by the description that relates light to our visual capacities in the actual world. It is irrelevant that D_L is not instantiated in other possible worlds; what is relevant is that 'light' picks out the natural phenomenon in all worlds that 'D_L' picks out in the actual world because 'D_L' picks it out. 'Light' is used to refer to the phenomenon that people would be able to sense if they had the perceptual capacities that they actually have.

3. Given these two accounts of the meaning of 'light', how are we to decide between them? The issue turns on whether 'light' and 'heat' are indexical. Descriptivists view 'light' and 'heat' as indexical because they equate their meanings with indexical rigidified definite descriptions. Non-descriptivists, by contrast, view 'light' and 'heat' as similar to names and natural kind terms.

One might try to resolve the issue by considering what the referents of natural phenomenon terms are taken to be when they are initially

fixed. It is a part of Kripke's account of natural kind terms and natural phenomenon terms that reference can be fixed before we know the underlying natures of the natural kinds or natural phenomena. Nevertheless, the natures of kinds and phenomena subsequently determine correct application of those terms. Kripke provides (1980: 135–36) a sketch of how communities ignorant of the scientific details might fix the referents of putative natural kind terms. Having encountered items of a similar appearance, a term is introduced to refer to a putative kind that the items appear to instantiate. The natural kind term is successfully introduced as long as there is a kind having certain essential properties to which most of the items of the original sample belong. Whether the natural kind term is then correctly applied to further items depends on whether those items possess the underlying properties possessed by most of the items of the original sample.

The motivation for the claim that reference is determined by the natural kind itself is the way in which a natural kind can actually be distinguished by scientific means from the descriptive properties that were originally used to fix its reference. In the case of gold, one type of stuff (fool's gold) has all the properties by which gold was originally identified and yet fails to be gold, and, conversely, another type of stuff (white gold) has different properties from those that were originally used to identify gold and yet is still a form of gold. Here it is apparent how the natural kind rather than the descriptive properties can determine reference across possible worlds. However, Kripke provides no evidence that similar considerations actually apply in the case of natural phenomena. Indeed, in the case of light, the relationship between the descriptive properties initially used to fix the reference of 'light' and its underlying nature is importantly different from that manifested by the standard examples of natural kinds.

Instances of light, so scientists have discovered, are not only streams of photons, they are also waves of electromagnetic radiation. But even more significantly for present purposes, scientists have discovered that the phenomenon to which we are visually sensitive belongs to a broader continuous spectrum. Whereas the duality of wave and particle has raised fundamental questions about the nature of light, the existence of a continuous spectrum, one might say, raises interesting questions about the meaning of 'light'. In particular, the question arises of whether 'light' should be used to refer only to the phenomenon to which we are actually visually sensitive, as the descriptive account would claim, or whether 'light' should also be used to refer to the electromagnetic radiation that is not directly visually perceived by us, as the non-descriptive account should claim (because there are no natural divisions (joints of nature) within the electromagnetic spectrum to which light belongs). How we decide whether something is gold when it fails to possess the properties

originally used to fix the reference of 'gold', e.g. its yellow colour, is clear. But such examples fail to provide clear guidance in the case of 'light', where the phenomenon in question extends beyond that to which we are visually sensitive in a different way from that in which the essence of a natural kind does.[2]

The way the nature of light has been elucidated by scientists is pertinent here. Scientists first discovered that instances of light are waves of electromagnetic radiation in the nineteenth century. This immediately suggested the possibility of the existence of electromagnetic waves beyond those to which we are visually sensitive. The existence of radio waves, X-rays and gamma-rays, as various forms of electromagnetic radiation, was demonstrated soon afterwards. At about the same time the dual nature of light was established. Significantly, scientists now talk of radio waves, X-rays and gamma-rays all as instances of electromagnetic radiation or photons, rather than light, because they do not differ from the electromagnetic radiation or photons to which we are visually sensitive in any intrinsic respect that differentiates them as distinct natural phenomena; non-visible radiation differs from the radiation to which we are sensitive with respect to the energy of photons (or wavelength) in the same way as the radiation to which we are sensitive varies.

Kripke uses the identity statement 'light is a stream of photons' to exemplify his claim that, while our knowledge of theoretical identity statements is a posteriori, those statements nevertheless concern necessary truths. If this were a genuine identity statement, the converse statement would also be true: 'a stream of photons is light'. Hence the reference of 'light' would extend beyond the phenomenon to which we are visually sensitive. Indeed, this is the view that seems should follow if 'light' were relevantly like natural kind terms. However, whereas one might accept that light is a stream of photons, the statement that all streams of photons are light is highly questionable.

In fact, there can be little doubt that 'light' is standardly used by scientists to refer only to that portion of the electromagnetic spectrum to which we are visually sensitive. One might here recall how, on Kripke's model, it is scientists who are best placed to classify natural kinds and

[2] Brown (1998) provides a development of Kripke's sketch drawing on recognitional capacities to correct some of its shortcomings, in particular, what she dubs 'the higher-level natural kinds problem' and the 'composition problem'. However, her account of higher-level natural kinds, which addresses the question of how we actually recognize gold as opposed to metal, does not directly address the present problem, which is not the one of how we would distinguish 'light' from a higher-level natural phenomenon, given that they are distinct, but the prior issue of whether 'light' refers to a particular type of electromagnetic radiation or to electromagnetic radiation more generally.

natural phenomena. *The Concise Oxford Dictionary* describes light as 'the natural agent (electromagnetic radiation of wavelength between about 390 and 740 mm) that stimulates sight and makes things visible'. Other ranges of the electromagnetic spectrum radiation, which do not help us to see, are typically regarded as types of phenomena distinct from light. The upshot is that the term 'light' is standardly used to denote a natural phenomenon in accordance with the way its reference was initially fixed, rather than being determined by the natural phenomenon itself.[3]

4. At this point it might be suggested that Kripke's original argument concerning the different modal profiles of natural phenomenon terms and descriptions can be reiterated. Whereas we use 'light' to refer to the same phenomenon in all possible worlds, the natural phenomenon to which we are visually sensitive might have been different. Suppose people were additionally sensitive to shorter frequencies of electromagnetic radiation (UV radiation), as some birds and bees are. The natural way of expressing this is to say that such is a world in which people are not merely visually sensitive to light but also to other frequencies of electromagnetic radiation. So 'light' and 'D_L' would have different meanings because they have different functions to possible worlds. This, however, fails to make the non-descriptivist case. For, as the present modal example shows, the meaning of 'light' at the possible worlds we are interested in crucially depends on the way in which people are actually sensitive to electromagnetic radiation.[4]

Evans draws a distinction between the superficially contingent and the deeply contingent to explain statements that are both contingent and known to be true a priori.[5] For Evans, there is nothing unduly problematic about statements that are known to be true a priori and yet are superficially contingent. A sentence, *s*, known to be true a priori, is superficially contingent if there exists a world *w* such that it is not the case that *s* is true at *w*. But it would be 'intolerable', according to Evans, for there to

[3] Some might respond that 'light' is ambiguous. On one meaning of 'light', it applies to the range of radiation to which we are sensitive; on the other meaning, it applies to electromagnetic radiation more generally. This response would recognize the problem of the extension of 'light' without resolving it.

[4] Kripke says (1980: 139) that 'a blind man who uses the term 'light', even though he uses it as a rigid designator for the very same phenomenon as we do, seems to us to have lost a great deal, perhaps enough for us to declare that he has a different concept'. The blind indeed use the term 'light' as a rigid designator, but with the meaning that it has from its use by the sighted. As such the concept they have would be the same concept as the sighted, though they may have a different grasp of it.

[5] Evans (1978) considers the contingent a priori in the context of descriptive names, that is, a name the reference of which is fixed by description, which he takes to be the way Kripke originally formulates the issue.

be a statement the truth of which is knowable a priori and yet which is deeply contingent, that is, a statement the truth of which is knowable a priori and yet for which 'there is no guarantee that there exists a verifying state of affairs'. Kripke claims that the way we fix the reference of 'light' involves statements that are both known to be true a priori and contingent. If Evans is right, the distinction between superficially contingent and deeply contingent can be applied to the statements used to fix the reference of 'light'. We stipulate that 'light' refers to whatever causes our visual experiences. In this way we can know a priori that it is true that light is the phenomenon that causes our visual experiences. Our sensitivity to light is superficially contingent because there is a world in which we are sensitive to other ranges of electromagnetic radiation. But the truth of the fact that light is the phenomenon that causes our visual experiences is not deeply contingent because that is what we mean by 'light'. It is, nevertheless, worth noting one feature of the present case. How we are to understand the meaning of 'light', by contrast with, for instance, the meaning of 'metre', is informed by empirical enquiry about the nature of light and electromagnetic radiation, which is not to dispute the fact that the meaning of 'light' is fixed a priori.

So even though we can imagine a world in which light exists but no one is sensitive to it, this fails to show that the meaning of 'light' is not dependent on the way in which people are actually sensitive to light. Could we have used the term 'light' to refer to the same phenomenon, viz. light, without having fixed its reference in the way that it was initially fixed? Here it might be pointed out that we can talk about different types of photons and ranges of electromagnetic radiation, such as radio waves, X-rays and gamma-rays, even though we cannot directly visually sense them. This does not decide the matter in favour of non-descriptivism for the reason that these types of electromagnetic radiation are individuated by reference to certain relational descriptions they satisfy, rather than any intrinsic differences. Assuming that 'light' refers to the range of electromagnetic radiation to which we are actually visually sensitive, a case has yet to be made that there are other features of that range of electromagnetic radiation that distinguish it from other ranges of electromagnetic radiation. It is far from clear that light, unlike natural kinds, has such distinguishing properties.

5. 'Heat' is, in one respect, distinct from 'light'. We take molecular motion to be a property that things not only possess independently of our perception of them, but may also possess in quantities greater than those to which we are sensitive. However, this does not show that the meaning of 'heat' is determined by the natural phenomenon itself, as is required by the non-descriptivist account. To show that, examples are required in

which the natural phenomenon outweighs the description initially used to fix the reference of the natural phenomenon term, as in the examples where a natural kind, e.g. gold, outweighs the description initially used to fix the reference of the natural kind term.

Kripke suggests cases. There is, however, a significant difference between these cases and the standard natural kind examples. Non-descriptivism gains its plausibility with respect to natural kind terms, which are typically drawn from chemistry (or geology) and biology, because there actually are different chemical and biological kinds, as individuated by scientifically relevant essential properties, which have similar appearances. By contrast, the natural phenomenon terms that are drawn from physics do not refer to phenomena having the same underlying complexity that is required for a similarity in appearance to be combined with a difference in underlying essence. Nor has science discovered other phenomena that have some underlying properties in common with light and heat but not others in the way that they have with chemical and biological kinds. For this reason, Kripke at once formulates his cases in modal terms: in a possible world, sound causes sensations of type *L* and light causes sensations of type *H*. The problem now is that these possible world cases, unlike the natural kind cases, are based on highly contentious theory-driven intuitions that are unlikely to be widely shared.

6. So Kripke has failed to show that either the reference of 'light' or the reference of 'heat' is determined by the relevant natural phenomenon rather than the way in which it was initially fixed. Indeed, in the case of 'light', the discussion of terms for natural phenomena, which Kripke introduces in order to support further non-descriptivism, turns out to present a counter-example to that thesis.[6]

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