What are natural kinds?

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Though the question is ontological, I will approach it through another, partially linguistic, question. What must natural kinds be like, if the conventional wisdom about natural kind terms is correct? Although answering this question won't tell us everything we want to know, it will, I think, be useful in narrowing the range of feasible ontological alternatives. I will therefore summarize what I take to be the contemporary linguistic wisdom, and then test different proposals about kinds against it. As we will see, some fare better than others.

Following Kripke, I take natural kind terms to be akin to proper names.¹ Like names, they are not synonymous with descriptions associated with them by speakers. They are also like names in the way they are introduced, and have their reference fixed. Just as ordinary names are often introduced by stipulating that they are to refer to certain individuals with which one is already acquainted, so general terms are often introduced with the intention that they are to designate natural kinds with which one is acquainted through their instances. For example, we may imagine the terms 'green', 'gold', 'water', and 'tiger' being introduced by the following stipulations:

The term 'green' is to designate the color of (nearly) all members of a certain class of paradigmatic samples – i.e. it is to designate the characteristic of object surfaces causally responsible for the fact that those samples appear similar to us (and different from paradigmatic *non-green* samples). Hence, the predicate 'is green' will apply (at a world-state) to precisely those objects the surfaces of which have the characteristic which, at the actual world-state, causally explains why the *green*-samples look similar to us.

¹ Saul Kripke, <u>Naming and Necessity</u>, (Cambridge MA: Harvard University Press) 1980.

The term 'water' is to designate the unique substance of which (nearly) all members of the class of its paradigmatic samples are instances. Substances are explanatory kinds instances of which share the same basic physical constitution, which in turn explains their most salient characteristics – in the case of *water*-samples, the fact that they boil and freeze at certain temperatures, that they are clear, potable, and necessary to life, etc. Hence, the predicate 'is water' will apply (at a world-state) to precisely those quantities that have the physical constitution which, at the actual world-state, explains the salient features of (nearly) all paradigmatic *water*-samples.

The term 'tiger' is to designate the species of animal of which (nearly) all members of the class of its paradigmatic samples are instances. Hence, the predicate 'is a tiger' will apply (at a world-state) to precisely those individuals that are members of the species of which (nearly) all paradigmatic *tiger*-samples are actually members.

These stipulations are, of course, idealized. The terms could have been introduced by them, and behave pretty much as if they had been. However formal stipulations are not required. It is enough if speakers start calling relevant things 'green', 'water', and 'tigers', with the intention that they are to apply not only to specimens speakers happen to encounter, but to all instances of the kinds to which those specimens belong. Once introduced, natural kind terms are passed from speaker to speaker, just as proper names are.

In addition to being non-descriptive, simple general terms introduced in this way are both rigid and Millian. Since they are rigid, the natural kinds they designate don't change from world-state to world-state. Since they are Millian, there is nothing more to their semantic content, or meaning, than those kinds. The semantic properties of predicates formed using these terms are different from, but determined by, the semantic properties of the terms themselves. For example, whereas the term 'green' rigidly designates the color green -- which is both its extension and semantic content -- the predicate 'is green' designates the set of individuals to which the color applies, which is its extension. Since the set of green things varies from world-state to world-state, the predicate 'is green' is non-rigid. Similar remarks apply to other natural kind terms and the predicates that contain them. The semantic content of such a predicate consists of the content of its general term plus the content of the copula – roughly, *being an instance of.*² For each world-state w, the latter assigns to the argument provided by the content of the general term at w the class of instances of that argument. Since 'green' is Millian (directly referential), its content is the color itself, which is the argument it provides to the copula at every world-state. Thus, the semantic content of 'is green' is the property of *being (an instance of the color) green*, or *being green*, for short.

Next we apply this semantics to theoretical identification sentences. Let T_P be a simple natural kind term – like 'green', 'water', or 'tiger' – and let P be the corresponding predicate – e.g. 'is green', 'is (an instance of) gold', 'is (an instance of) water', or 'is a tiger'. Corresponding to T_P , we take T_Q be a term or phrase of the same type – a common noun or noun phrase – and we take Q be the corresponding predicate. We then construct theoretical identification statements.

- 1a. $\forall x (P x \supset Qx)$
- b. (All) tigers are animals.
- c. (Every instance of) lightning is (an instance of) electricity. (i.e. *Lightning is electricity*)
- d. (Every instance of) ice is (an instance of) H_2O . (*Ice is* H_2O)
- 2a. $\forall x (Px = Qx) / \forall x, y (Px, y = Qx, y)$

² This statement is only a rough approximation. It ignores the subtle difference between the propositions *that o is green* and *that o instantiates (the color) green*. The copula may best be thought of not as contributing *instantiation* as a constituent of a proposition, but as signaling the way in which the property expressed by its argument occurs there – e.g., that *green* is being predicated of o.

- b. Something is (an instance of) water iff it is (an instance of) H_2O . (One reading of *Water is H_2O.*)
- c. For all x,y, x is hotter than y iff the mean molecular kinetic energy of x exceeds that of y. (One way of fleshing out *Heat is mean molecular kinetic energy*)
- d. For all objects x, x is green iff x has surface spectral reflectance property SSR_{green} – the property of reflecting substantially more light in the middle wavelength part of the visible spectrum than in the long wavelength part, and approximately the same amount of light in the short wavelength part as in the non-short part.
- 3a. $T_{\rm P} = T_{\rm O}$ (if they exist)
- b. Gold is the substance made up of the element with atomic number 79 (if it exists).
- c. Water is the substance H_2O (if it exists).
- d. Green is the characteristic SSR_{green} (if the color exists).

Since simple natural kind terms, and the predicates containing them, are Millian, these sentences express propositions with kinds as constituents – just as sentences containing simple proper names express singular propositions containing their referents.

From this, two things follow. First, our examples are *necessary truths* iff the lambda abstract corresponding to the formula (minus the existence clause) that results from replacing the general term T_P, or predicate P, with a type-appropriate variable, expresses an *essential property* of the kind k designated by T_P. Second, (1-3) are instances of the *necessary aposteriori* iff, in addition, one can know, *de re*, of k that it has this property only by empirical investigation. The necessary aposteriority of these examples is thereby grounded in essentialist claims about kinds which can be known only empirically, just as a similar classification of (4a-d) is grounded in essentialist claims about individuals and things that can be known only empirically.

- 4a. David Kaplan \neq Saul Kripke
- b. Saul Kripke is a human being (if he exists).
- c. This desk (pointing to the wooden one in my office) was not originally made of metal.
- d. This desk (pointing to one in my office) is made of molecules (if it exists).

These points about the necessary aposteriori can be summarized as follows:

Let p be a true proposition that attributes a property (or relation) F to an actually existing object o/kind k (or series of such), conditional on the object/kind (or series) existing (while not attributing further properties or relations to anything). Then, p will be an instance of the necessary *aposteriori* if (a) it can be known that F is an essential property (relation) of o/k (or the series), if F is a property (relation) of o/k (or the series) at all, (b) knowledge of o/k (or the series) that it has F if it exists can only be had *aposteriori*, and (c) knowing p involves knowing of o/k (or the series) that it has F, if it exists.³

Examples like (4b,d) are basic cases from which other instances can be derived. For example, since nonidentity essentially relates any pair it actually relates, an argument of this form establishes the necessary *aposteriority* of the proposition that David Kaplan \neq Saul Kripke, if David and Saul exist. Since this proposition is trivially equivalent to proposition (4a), (4a) is also necessary and *aposteriori*. Similar remarks apply to (4c).

The same reasoning applies to certain identities. For example, let 'a' and 'b' name the sperm and egg from which Saul Kripke actually developed. The possibility of identical twins aside, the metaphysical doctrine of the essentiality of origin will then characterize (5a,b) as instances of the necessary *aposteriori*.

5a. Saul Kripke = the individual who developed from a and b (if Kripke exists).

b. $\lambda x [\forall y (y \text{ developed from a and } b \leftrightarrow y = x)]$ Saul Kripke (if Kripke exists).

The natural-kind identities (3b,c,d) are similar. In these sentences, 'gold', 'water', and 'green' designate natural kinds k_g , k_w , and k_{gn} . The proposition expressed by (3b) is trivially equivalent to the proposition p_g that predicates of k_g the property of being the substance instances of which have a certain atomic structure (if k_g exists), the proposition expressed by (3c) is trivially equivalent to the proposition p_w that predicates of k_w the

³To characterize 'Noman is human, if he exists' about a merely possible man as necessary aposteriori, without doing the same for 'Noman is an dog, if he exists', (b) needs to be changed to something like *knowledge of o that it would have F, if it were to exist, can be had, but only aposteriori.* (Thanks to Teresa Robertson.)

property of being the substance instances of which are made up of molecules consisting of two hydrogen atoms and one oxygen atom (if k_w exists), and the proposition expressed by (3d) is trivially equivalent to the proposition p_{gn} that characterizes k_{gn} as the surface reflectance property of object surfaces instances of which reflect light in certain proportions. The idea is that we can know, unproblematically, that these properties are essential to the kinds, if the kinds have them at all -- even though empirical evidence is needed to justify the claim that they have them. If this is right, then the propositions (3a,b,c) are necessary *aposteriori*.

How, it might be asked, do we know of the substance *water* and the color *green*, that these properties are essential to them? Given our uncertainty about what kinds are, one might doubt that we have any idea what their essential properties are. However, our epistemic situation is not so dire. Recall the ostensive introduction, of the terms 'water' and 'green'. 'Water' was stipulated to designate whatever underlying physical characteristic it is that is shared by (nearly) all members of the class of paradigmatic *water*-samples that explains their most salient features – the fact that they boil and freeze at certain temperatures, that they are clear, potable, and necessary to life, etc. 'Green' was stipulated to be the characteristic of object surfaces causally responsible for the way that paradigmatic green-samples appear to us. It follows from these stipulations that *if* the terms have been successfully introduced, then the substance *water* and the color *green* just are the characteristics that causally explain the familiar properties of water and green-samples at the actual world-state. Thus, when it is discovered empirically that these characteristics are being (an instance of) H_2O and being (an instance of) SSR_{green} , we learn empirically that k_w = the substance H₂O and k_g = the characteristic SSR_{green}.

If the complex terms on the right-hand sides of these identity statements are rigid designators, it will follow the identities are necessary, and that instances of k_w will be instances of H₂O, and instances of k_g will be instances of SSR_{green}, at *every possible world-state* at which the kinds exist (in the sense of having instances at all). So, are these terms rigid? To ask this about 'the substance H₂O' is to ask whether the substance H₂O could have existed with being the substance H₂O – i.e. without having as instances all and only those quantities that are made up of molecules having two hydrogen atoms and one oxygen atom. Since the answer to this question seems clearly to be 'no', 'the substance H₂O' is a rigid designator. Since we know empirically that it designates k_w, we know that it is an essential property of k_w that its instances are all and only quantities of H₂O. Thus, water is, necessarily H₂O. The same sort of account can be given for an object's being green at a world-state w iff it's surface has the characteristic SSR_{green} at w. Variations on this theme explain the necessity of all the truths in (1-3).

It is helpful, in understanding what is going on, to contrast the rigid term, 'the substance H_2O ' with the non-rigid term 'the substance that falls from the sky in rain, and fills the lakes and rivers'. Both designate k_w . The reason we recognize the former, but not the latter, to be rigid, has to do with what we take substances to be – physically constitutive kinds, instances of which have the same underlying physical constitution. Since being H_2O is a itself such a kind, whereas falling from the sky as rain, and filling the lakes and rivers has nothing to do with physically constitutive structure, 'the substance H_2O ' designates the same substance at every world-state, whereas 'the substance that falls from the sky in rain, and fills the lakes and rivers' does not. A similar story can be told about the other cases.

In giving these explanations, I haven't said much about what natural kinds are. I have indicated that they exist and have instances at different possible world-states. The color green, though not itself a green object, has green objects as instances. Since different objects are green at different possible world-states, the color remains the same from state to state, even if its instances vary. The same is true of the substance water and the species tiger.⁴ It is natural, in light of this, to take natural kinds to be abstract objects. But abstract objects of what sort? If what I have said about the color *green* and the substance *water* is correct, they would seem to be properties possession of which by their instances explains those instances' possession of other properties. If so, then water is the property of having a certain molecular structure, and green is the property of reflecting light at different wavelengths in the visible spectrum in certain proportions.

What are we saying, when we say that these kinds are properties? Again, it is useful to proceed linguistically. The most basic fact about properties is that they are *true* of things that have them, just as predicates are *true* of things they apply to. As a first pass, then, it is natural to take properties to be the meanings, or semantic contents, of predicates. For example, the meaning of the predicate 'is water' is the property *being* made up of molecules consisting of two hydrogen atoms and one oxygen atom – or, being H_2O for short.⁵ But now there is a problem. If, in addition to being the meaning of 'is water', *being* H_2O is also the meaning of 'is H_2O ', then the two predicates mean the same thing. From this, R1-R3 would seem to follow.

⁴ This similarity doesn't prejudge whether or not the property of being an instance of the kind is an essential property of things that have it. In the case of the color green it surely isn't, since many things that are green could have existed without being green. In the case of the kinds water and tiger it is much more plausible to hold that the properties are essential.

⁵ Here, and throughout, I use 'H₂O' as short for the description 'the substance (instances of which are) made up of molecules consisting of two hydrogen atoms and one oxygen atom'. Similarly for the predicate 'is H_2O' .

- R1 The proposition expressed by 'the stuff in the bath tub is water' is the same as that expressed by 'the stuff in the bath tub is H_2O' ,
- R2 Anyone who believes that the stuff in the bath tub is water thereby believes that the stuff in the bath tub is H₂O, and
- R3 The proposition that all and only water is H_2O is knowable apriori, since it is just the proposition that all and only H_2O is H_2O .

But these results seem wrong.

Does this mean that natural kinds like water aren't properties? A parallel problem about propositions suggests that we should be cautious about drawing this conclusion. In addition to being designated by *that*-clauses, propositions can also be named. For example, the proposition that mathematics is reducible to logic may be named 'Logicism'. If, as I believe, Millianism is correct, then this proposition is the meaning, or semantic content, both of the name and of the clause 'that mathematics is reducible to logic'. But then, the same assumptions that led to R1-R3 will lead to R4-R6.

- R4 The proposition expressed by 'Russell affirmed Logicism' is the same as the proposition expressed by 'Russell affirmed that mathematics is reducible to logic'.
- R5 Anyone who believes that Russell affirmed Logicism thereby believes that Russell affirmed that mathematics is reducible to logic.
- R6 The proposition that Logicism = the proposition that mathematics is reducible to logic is knowable apriori, since it is just the proposition that Logicism = Logicism.

Like the earlier results about kinds, these results about propositions seem wrong.

Consider, for example, a student attending his first lecture in the philosophy of mathematics. He is told that Logicism is a proposition about the relationship between logic and mathematics, that Formalism is a doctrine about the interpretation of mathematics, and so on. At this stage, he is unable to distinguish Logicism from other propositions about the relationship between logic and mathematics, or to describe it in

any informative way. Nevertheless, he may acquire beliefs about Logicism. He may be told, "Russell affirmed Logicism," and thereby come to believe that Russell affirmed Logicism.⁶ Since it doesn't seem that he thereby comes to believe that Russell affirmed that mathematics is reducible to logic, there appears to be something wrong with the reasoning leading to R4-R6.

Mark Richard has a diagnosis of what it is.⁷ It's not that 'Logicism' and 'that mathematics is reducible to logic' don't have the same proposition as semantic content. They do. However, the *that*-clause, being syntactically complex, can be understood only by understanding its grammatically significant constituents. To Richard, this suggests that the *that*-clause contributes not only its own content to the proposition expressed by sentences containing it, but also the contents of its constituents. Since the name 'Logicism' is syntactically simple, it has no such constituents, and thus contributes only its content to propositions expressed by sentences containing it. Of course, the proposition which is the semantic content of both the name and the clause *itself* has constituents. However, when one's epistemic contact with that proposition is mediated by one's competence with the name 'Logicism', one can be aware of the proposition, without being acquainted with, or able to articulate, its constituents. By contrast, when one's epistemic contact with the proposition is mediated by one's understanding of the corresponding *that*-clause, one is acquainted with, and can articulate, the constituents of the proposition – which are just the contents of the grammatically significant constituents of the clause. For Richard, this means that a complex content can occur in a larger

⁶ See page 586 of Soames, "Semantics and Semantic Competence," *Philosophical Perspectives 3*, 1989, 575-596.

⁷ Richard, "Articulated Terms," *Philosophical Perspectives* 7, 1993, 207-230.

proposition in two different ways – one way in which the contents that make it up are themselves constituents of the larger proposition, and one way in which they aren't.

For our purposes, it doesn't matter which of various ways to formally mark this distinction we choose, so long as the distinction is marked. When it is, we can distinguish propositions expressed by sentences containing the name 'Logicism' from those expressed by sentences in which the clause 'that mathematics is reducible to logic' is substituted for it. In this way, we block the problematic R4 -- without giving up the idea that the name and the *that*-clause are both Millian terms for the same thing. We also block R5. To believe that Russell affirmed Logicism is to *believe of* the proposition that Russell affirmed it – without necessarily knowing how to express that proposition, or articulate its constituents. To believe that Russell affirmed that mathematics is reducible to logic is to believe the same thing of the same proposition, while appreciating how it is articulated and broken down into parts.⁸ We therefore get the plausible result R7.

R7 One can know/believe that Russell affirmed Logicism without knowing/ believing that he affirmed that mathematics is reducible to logic, but one cannot know/believe the latter without thereby knowing/believing the former.

Thus, we have a plausible solution to the problem about propositions -- which can also be applied to our earlier problem about properties.⁹ Just as we can block the unwanted conclusions R4 and R5 (about propositions), while identifying the semantic content of a linguistically simple name with the content of a syntactically complex *that*-

⁸ Richard acknowledges this point on p. 216, where he says, "When p is an articulation of q, one who asserts or believes p generally does so, in part, by asserting or believing q. For example, to assert that Russell defended the proposition that mathematics reduces to logic is, *inter alia*, to assert that Russell defended Logicism...If we exclude propositions expressed by sentences in which an articulated term [e.g. a *that*clause] is within the scope of a modal or temporal operator...it seems there are no exceptions to the principle, that if one believes or asserts p, and p is an articulation of q, then one has the attitude toward q, too."

⁹ Richard does this in "Analysis, Synonymy and Sense," in C.A. Anderson and M. Zeleny, eds., *Logic, Meaning and Computation*, (Dordrecht: Kluwer), 2000.

clause, so we can block the unwanted conclusions R1 and R2 (about properties), while identifying the semantic content of the simple predicate 'is water' with that of the syntactically complex predicate 'is made up of molecules containing two hydrogen atoms and one oxygen atom' -- or 'is H_2O ' for short. As before, we distinguish two ways in which the complex content can occur in a proposition – one way, contributed by 'is H_2O' , in which the contents that make up the complex are themselves constituents of the proposition, and one way, contributed by 'is water', in which they aren't. In this way, we distinguish propositions expressed by sentences containing 'is water' from those expressed by sentences in which 'is H₂O' is substituted for it -- thereby blocking R1. We also block R2. To believe that the stuff in the tub is water is, on this account, to *believe* of the property of being H_2O that the stuff in the tub is an instance of it – without necessarily knowing how to informatively characterize the property, or articulate its constituents. To believe that the stuff in the tub is H₂O is to believe the same thing of the same property, while appreciating how the property is articulated and being acquainted with its parts. This leads directly to R8, which parallels R7.

R8 One can know/believe that the stuff in the bath tub is water without knowing/ believing that the stuff in the bath tub is H₂O, but one cannot know/believe the latter without thereby knowing/believing the former.

What is gained from this way of looking at things, and what problems, if any, remain? Can the property *being water* be identified with the property *being* H_2O , while also taking it to be the meaning of both 'is water' and 'is H_2O ? We have seen that there is a defensible way of doing this that correctly distinguishes the propositions that water is water, that H_2O is H_2O , and that water is H_2O from one another. The account also accommodates the fact that one can believe that water is water, without believing that water is H_2O . However, a problem remains. The account predicts that anyone who

knows or believes that H_2O is H_2O knows or believes of the property water that it is H_2O , and so knows or believes that water is H_2O . This seems wrong. It is possible, we are inclined to think, to learn enough chemistry to have beliefs about hydrogen, oxygen, and H_2O -including the belief that H_2O is H_2O --while still being unaware that water is H_2O .¹⁰ The account also predicts that one can know apriori that water is H_2O , which the conventional wisdom rightly denies.¹¹

These difficulties suggest that the relationship between the simple predicate 'is water' and the grammatically complex predicate 'is H_2O ' is *not* analogous to the relationship between the name 'Logicism' and the clause 'that mathematics is reducible to logic'.¹² Whereas Logicism *is* the proposition that mathematics is reducible to logic,

¹⁰Remember that 'H₂O' is not here used as a name. Rather, it is short for 'the substance instances of which are made up of molecules consisting of two hydrogen atoms and one oxygen atom.' When R8 is understood in this way, it is intuitively obvious that its second half is false. This may lead one to wonder why the second half of R7 isn't also false. There is a reason for this – though as long as R8 is rejected, it doesn't matter for my argument about kinds what we say about R7. Why then, do I find the second half of R7 plausible because it is clear that believing that Russell affirmed that mathematics is reducible to logic involves being *en rapport* with the proposition p named by the 'that'-clause, and believing the bare singular proposition about p, it follows that one who believes that Russell affirmed that mathematics is reducible to logic believes that Russell affirmed Logicism. By contrast, since *the description* 'H₂O' rigidly designates the kind water, *but it does not name it*, [H₂O is F] and [Water is F] express different propositions. Moreover, believing the descriptive proposition expressed by the former does not require being *en rapport* with the kind k designated by 'H₂O', and believing the bare singular proposition about k to support the description the second by 'H₂O'. Hence one can believe that H₂O is so and so without believing the twater is so and so.

¹¹ The conventional wisdom is right to deny this, just as it is right to deny that it is knowable apriori that the first person to publish an axiomatic formalization of quantified modal logic is Ruth Marcus. Whether or not it is wrong to deny that it is knowable apriori that *Ruth Barcan is Ruth Marcus* – or, more properly, to deny that the proposition semantically expressed by the italicized sentence is knowable apriori -- is another matter. For discussion, see chapters 3 and 8 of my *Beyond Rigidity* (Princeton: Princeton University Press), 2002; also "Naming and Asserting," in Szabo, ed., *Semantics versus. Pragmatics* (Oxford: Oxford University Press), 2005. Though the examples there involve singular rather than general terms, the points carry over. Some explicit discussion of examples involving general terms can be found in chapters 10 and 11 of *Beyond Rigidity*.

¹² Note the contrast between R3 and R6. The proposition *that Logicism* = *the proposition that mathematics is reducible to logic* is apriori, though not for the reason given in R6. By contrast, the proposition that water is H_2O is not apriori.

which is the meaning of both the name and the clause, the property *being* H_2O can't be the meaning of both 'is water' and 'is H_2O '. Either *being water* isn't *being* H_2O , or one of the two predicates fails to have the associated property as its meaning.

Perhaps, then, the property *being water* isn't the property *being* H_2O . If it isn't, then the identity statement (6a) in which the general terms 'water' and 'H₂O' flank the identity sign will, of course, be false. However, (6b), understood as having the logical form (6c) or (6d), will still be true.

6a. water = H_2O

b. Water is H_2O .

c. $\forall x \ [x \ is \ (an \ instance \ of) \ water \supset x \ is \ (an \ instance \ of) \ H_2O]$

d. $\forall x [x \text{ is (an instance of) water}) = x \text{ is (an instance of) } H_2O]$

Since many theoretical identification statements standardly taken to be instances of the Kripkean necessary aposteriori have logical forms along the lines of (6c,d), understanding (6b) in this way presents no special problem. So understood, the proposition expressed by (6b) will be necessary, provided that the properties *being water* and *being H₂O* are necessarily equivalent. This proposition will be knowable only aposteriori provided two natural conditions are met – first, that we can acquire knowledge of the property *being water* by being acquainted with its instances and learning their molecular structure, and second, that having *de re* knowledge either of the property *being Water*, or of the property *being H₂O*, (that instances of it are so and so) doesn't guarantee that that one has corresponding knowledge of the other property (that its instances are also so and so). And indeed why should it? If properties, like propositions, are hyperintensional, then knowledge of a property P, that it is so and so, should no more guarantee knowledge of a necessarily equivalent property O, that it is so and so, than

knowledge of the truth of one proposition guarantees knowledge of the truth every proposition necessarily equivalent to it.

Put this way, the view seems attractive. However, it can't be correct -- if the sketch I have given of natural kind terms is. Recall the idealized stipulation by which I imagined the term 'water' being introduced. 'Water' (I said) was to designate the physically constitutive characteristic shared by (nearly) all members of the class of its paradigmatic samples that explains their most salient features. Since we have learned that these features of *water*-samples are explained by their having the molecular structure H₂O, *being water* must be the property *being H₂O*, which, in turn, must be the meaning of the predicate 'is water' (but not of the predicate 'is H₂O'). Note also that the stipulation introducing 'water' implicitly presupposes that there is only one property that explains the salient features of *water*-samples – since otherwise the stipulation would fail to determine a unique semantic value. So, if the stipulation was successful, no property other than *being H₂O* explains those features. This suggests that properties – *in the sense in which we talk about them in connection with scientific explanation involving natural kinds* -- are not hyperintensional.

This can be seen more easily by looking at a different case. Consider the natural kind term 'green', introduced by the stipulation that it is to designate the property of object surfaces causally responsible for the appearance of paradigmatic *green*-samples. Physicalists about color tell us that this property is a certain surface spectral reflectance property that specifies proportions of light reflected at different wavelengths.¹³ Let Q be

¹³ See Alex Byrne and David R. Hilbert, "Colors and Reflectances," in Byrne and Hilbert, <u>Readings on</u> <u>Color, Volume 1: the Philosophy of Color</u> (Cambridge MA: MIT Press), 1997.

a complex phrase of English explicitly mentioning those proportions. The color green is then the property being Q, even though the predicate 'is green' is clearly not synonymous with the predicate [is Q]. Suppose there is a different complex predicate [is Q*] that specifies the minute physical structure of object surfaces, such that [is Q*] turns out to be necessarily equivalent to [is Q]. Since, under this assumption, being Q^* will explain the appearance of paradigmatic green-samples just as well as being Q does, the conception of properties presupposed by the stipulative introduction of 'green' requires being Q, being Q^* , and being green to be one and the same property, even though the corresponding predicates clearly differ in meaning.

What then, are these properties, and how are they related to the meanings of complex predicates? The argument to this point suggests that natural kinds of the sort we have been discussing are coarse-grained properties that are individuated by their possible instances. If natural kind properties a and b have precisely the same instances in all (metaphysically) possible world-states, then a is identical with b. Intuitively this seems plausible. It is hard to imagine two distinct species of animal, two distinct substances, or two distinct colors which have precisely the same instances in every possible world-state. On this picture, *being* H_2O --- which is identical with the property *being water* --- has the same individuation conditions as the intension of 'is H₂O' and 'is water'. Since 'water' is Millian, it has this coarse-grained property as both its meaning and referent, which is the key constituent of the meaning of the predicate 'is water'. By contrast, the meaning of the complex term 'H₂O' can be identified with the structurally complex property of *being the unique substance instances of which are mapped onto truth by the propositional function that assigns to any object o, the structured proposition that o is made up of molecules*

with two hydrogen atoms and one oxygen atom. Unlike the coarse-grained property being H_2O , this complex structural property is fine-grained -- having the properties being hydrogen, being oxygen, being an atom, the number 2, and the relation being made up of as constituents. The term 'H₂O' rigidly designates the coarse-grained property determined by the fine-grained structural property that is its meaning. Since the course-grained property is also associated with 'water', each of the statements in (6) is necessary.

The characterization of these truths as aposteriori depends on two assumptions – one extremely plausible, and the other at least defensible. The plausible assumption, which has already been mentioned, is that we can acquire knowledge of the property *being water* by being acquainted with its instances and learning their molecular structure. This ensures that we can come to know that water is H_2O empirically. To seal the deal, we must rule out that the possibility that the same proposition can also be known apriori. There is no problem distinguishing the proposition that water is H₂O (which contains both the coarse-grained property *being water* and the fine-grained structural property involving hydrogen and oxygen) from the proposition that water is water, or the proposition that H_2O is H_2O . There is also no problem recognizing that one can believe that water is water, without having any beliefs about hydrogen or oxygen, and hence without believing that water is H_2O . The defensible, but less than fully transparent, further assumption needed to ensure aposteriority is this: that believing the proposition that H_2O is so and so doesn't, in and of itself, guarantee believing (or being in position to come, by further reasoning, to believe), of the coarse-grained property that is the referent (but not meaning) of ' H_2O ', that it is so and so -- any more than believing that the biological father of Saul Kripke is such and such guarantees believing (or being in position to come to believe) of Meyer Kripke that he is such and such. Nothing in the account given so far dictates a position on this epistemic assumption. However, the treatment of natural kinds as non-hyperintensional properties – on a par with objects both as constituents of reality and as things we become acquainted with through our causal interaction with the world – makes the assumption a natural one. Since it is also needed to conform to the conventional wisdom about the aposteriority of *that water is* H_2O , it is, I think, reasonable to accept it.

The end result is an account according to which natural kinds are coarse-grained properties, individuated by their possible instances. These properties are both the meanings and referents of simple natural kind terms, as well as being crucial components of the semantic contents of simple natural kind predicates constructed from them. Like individuals, the coarse-grained properties that are the kinds may themselves have properties that are essential to them, even though knowing that they have these properties often requires empirical investigation. Unlike simple natural kind terms, grammatically complex natural kind phrases are not Millian. Although they designate coarse-grained natural kind properties, their meanings are fine-grained, structurally complex properties. Hence they are not synonymous with simple natural kind terms, and the complex predicates constructed from them are not synonymous with the predicates built from simple natural kind terms. Understood in this way, instances of the necessary aposteriori involving natural kind terms parallel those involving Millian singular terms.¹⁴

¹⁴ The position taken here has important similarities with, and some differences from, that taken by Jeff King in "Structured Propositions and Complex Predicates," *Nous* 29, 1995, 516-535; and "What is a Philosophical Analysis?," *Philosophical Studies* 90, 1998, 155-179. There, King sketches a unified

In order to appreciate this, it is important not to become confused about the use of the term 'property'. Sometimes in philosophy it is used linguistically, for meanings of predicates whether simple or complex, and sometimes it is used ontologically, as it is in connection with natural kinds and scientific explanation. Although both uses are

account of all statements of property identity - called 'analyses' - whether they be philosophical or scientific analyses. Central to his position is the doctrine that the semantic contents grammatically simple predicates (of all sorts) are properties (whether simple or complex), while the semantic contents of grammatically complex predicates are never properties, but instead are combinations of the semantic contents of their constituents. Applied to the case of water/H₂O, this means that the property being H_2O is the meaning of 'is water', but not the meaning of 'is H_2O '. In this respect, our views are alike. However, we differ on several significant details, including the following: (i) Whereas I take natural kind properties, like being H_2O to be intensional, rather than hyper-intensional, King apparently takes them to be hyperintensional -- since he takes them to be complex entities individuated, in part, by their constituent properties (e.g. the property being hydrogen and being oxygen). (ii) His reason for denying that the semantic contents of complex predicates are properties (of any sort) is (therefore) different from mine. For him, the meaning of a complex predicate P is a structured complex, the constituents of which are the objects and properties designated by its simple subconstituents -- related by a highly complex relation that is parasitic on the abstract linguistic structure of P. Since this relation encodes every aspect of the grammatical structure of the predicate, no matter how trivial, he assigns different meanings even to trivially differing predicates -- like 'is an unmarried man' and 'is a man who's not married'. By contrast, he wouldn't deny that the property *being an unmarried* is the property *being a man who's not married*. Thus, he rejects the claim that properties are meanings of complex predicates. (iii) King's metaphysical account of what meaning is provides him with a further reason for rejecting this claim. On his account, the meanings of grammatically complex expressions are ontologically dependent on the existence of expressions used by agents (whether of a public language or a "language of thought"). This means that if properties were the meanings of complex predicates, then they couldn't exist, or have existed, without speakers. Since he, quite naturally, doesn't want to say this about properties, he concludes that properties are never the meanings of complex predicates. (He does think that these meanings uniquely determine properties, which they are said to represent – but he doesn't go into detail about what this relation consists in.) For my part, in addition to finding the ultra-fine-grained view of the meanings of complex predicates in (ii) questionable, I reject the metaphysics of meaning in (iii). If it were true, prior to the use of expressions by agents there could be no propositions and hence no propositional attitudes – beliefs, intentions, etc. However, the existence of these attitudes is surely required in order for their subsequent "thought," or use of language, to endow anything with meaning. A final point of contention concerns the informativeness of "the analysis" of 'Water is H_2O '. For King this informativeness is to be explained by different competence conditions for the terms 'water' and ' H_2O' – plus the uncontested fact that the proposition expressed by the sentence is different from that expressed by ' H_2O is H_2O '. The key point for King is that competence with 'water' does not require one to know of the complex property associated with the word that it is the property being made up of molecules with two hydrogen and one oxygen atom. (See pp. 162-3, ft. 16, and 169-71 of "What is a Philosophical Analysis?".) Presumably, however, competence with the complex term 'H₂O' does require this. However, if it does, then being competent with 'H₂O' should involve knowing of the property being H_2O that it is the property of being made up of molecules with two hydrogen and one oxygen atom. Since, on King's account, to know this is to know that water is the property being made up of molecules with two hydrogen and one oxygen atom, it should follow that the non-linguistic belief that water is H_2O is trivial -- even though the metalinguistic belief that 'water is H_2O ' expresses a truth is not. This, I think, is questionable.

legitimate, they do not coincide. In one sense of 'property' the property of *being* H_2O is identical with the property *being water*, while in another sense it isn't. If one wants a single, disambiguated terminology, perhaps the appellations 'coarse-grained property', standing for intension-like things, and 'fine-grained property', standing for meanings of structurally complex phrases will do. In either case, we can make sense of what it is for a property to be true of something, either essentially or accidentally. We must simply be careful about their identity conditions.

I close with an observation about the notion *natural* in discussing natural kinds, and natural kind terms. Roughly put, I take *natural* kinds to be the things designated by natural kind terms, and natural kind terms to be those it would make sense to introduce by reference-fixing stipulations like the ones for 'green', 'water', and 'tiger'. When does it make sense to introduce general terms in this way? Only, I think, when three prerequisites are satisfied.

- P1. The objects to which we wish to apply the term are similar in some respects, which guides our application of it, and allows us, fallibly but reliably, to apply it to new cases.
- P2. These similarities have, and are believed by us to have, a single unifying explanation, which, although we typically don't know it, we rightly believe to involve counterfactual-supporting generalizations relating unspecified features of (nearly) all the similar-appearing objects to the respects in which they are similar.
- P3. We wish to use the term in law-like generalizations and explanations and so don't want to identify its semantic content with the cluster of observed similarities.

Satisfaction of P1 is what allows us to consistently and competently use the term prior to discovering the unknown explanatory property that its use is intended to track. Satisfaction of P2 and P3 is what makes the term something more than a tool for noting observed similarities, and what calls for the coarse-grained individuation of the kind

designated by the term. Given these prerequisites, one should, I think, expect the ontological and epistemological features of natural kinds, and the linguistic characteristics of natural kind terms, to fall out pretty much as I have outlined.¹⁵

¹⁵ Thanks to Teresa Robertson for helpful discussions of the manuscript.