Teorema
Vol. XVII/1, 1998, pp. 00-00

Natural Kinds and the Identity of Property*

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RESUMEN

El argumento de Kripke de la designación rígida de los términos de género natural es falaz porque no distingue los géneros naturales de las propiedades funcionales de segundo orden. Al aclarar los conceptos de género natural y de propiedad funcional podemos mostrar que si bien los términos de género natural designan sus referentes rígidamente, los términos de propiedad funcional no son designadores rígidos. Mis discusiones de las propiedades funcionales ayudarán también a disipar la preocupación sobre la existencia de supuestos casos de identidad contingente entre los enunciados teóricos de la ciencia. No hay ninguna identidad contingente, ni siquiera en la forma de la lógica de segundo orden: la identidad de propiedades es también una identidad necesaria. El principio de la identidad necesaria gobierna sin interrupción.

ABSTRACT

Kripke's argument for the rigid designation of natural kind terms is fallacious because he does not distinguish natural kinds from second-order functional properties; by clarifying the concepts of natural kind and functional property, we can show that natural kind terms do designate their referents rigidly, but that functional property terms are not rigid designators. My discussions of functional property will also help dispel the worry about the alleged cases of contingent identity with regard to theoretical statements in science. There is no contingent identity even in the form of second-order logic: Property identity is also a necessary identity. The principle of necessary identity rules relentlessly.

Natural kinds are by definition, roughly, naturally emerging kinds such as biological species, elements, and molecules. On Kripke's definition, a term designates its referent *rigidly* if it designates the same referent across possible worlds where the referent exists. The question I will tackle is: Does a natural kind term designate the same natural kind in every possible world where the kind exists? In other words, are "water", "gold", and "heat" rigid designators of water, gold, and molecular motion respectively? Kripke and early Putnam argue that they are. Kripke further claims that the theoretical identity statements used in science, such as "Water is H_2O", "Gold is the element with atomic number 79", and "Heat is molecular motion", are *necessarily* true if they are true.

By analyzing the concepts of natural kinds and theoretical identity statements, I will contend that Kripke's points on the rigid designation of natural kind terms have flaws that need to be corrected. His problem is that he regards second-order functional properties (*e.g.*, *heat* and *gene*) as natural kinds. This is a mistake, and I believe it eventually forces us to conclude that there are cases of *contingent identity*, contrary to his claim that identity is necessary, among theoretical statements such as "Heat is molecular motion" and "The gene is DNA". The aim of this paper is evaluate Kripke's celebrated arguments for the rigid designation of natural kind terms and the necessary truth of theoretical identity statements by clarifying the concepts of natural kinds and second-order functional properties.

I. The Designation of Natural Kind Terms

Kripke presents two closely related arguments to support his claim of rigid designation of natural kind terms. One argument appeals to the essential properties of natural kinds, and the other derives from his *picture* of an initial baptism and the causal chain of reference transmission.

I. *1. Essential Properties*

Gold is thought of as a yellow malleable metal. These phenomenal characteristics used to be used to fix the referent of a natural kind term "gold". But scientists found out that gold is an element with atomic number 79. For Kripke, *science discovers the essences of natural kinds by revealing their explanatory microstructural properties*. So, "gold" designates the element that has atomic number 79 in all the possible worlds where it exists: anything that has atomic number 79 in any world is gold regardless of its phenomenal characteristics.

We may refer to Putnam's twin earth example to support this claim. Since scientists found that water is in fact H_2O, if something is not H_2O it is not water. There cannot be a possible world in which water is not H_2O: that is, if water is H_2O, it is necessary that water is H_2O. Some liquid having molecular structure XYZ may have exactly the same phenomenal characteristics as water; but as long as it does not have the microstructure of H_2O, it is not water. Thus, the natural kind term "water" rigidly designates H_2O in every possible world where it exists.

I believe that Kripke's account of the rigid designation of "gold" and "water" is persuasive, and that the two natural kind terms are in fact rigid designators. However, I do not think all of Kripke's natural kind terms are rigid designators. Kripke argues that a natural kind term "heat" also rigidly designates *molecular motion*; but this is not the case. As you may agree, *heat* is a functional property, not a single natural kind: that is, *whatever takes up*

the function of heat — say, melting ice, making an iron bar brittle if the bar is lack of this, and so on — *is heat*. It is now a widely accepted thesis that a functional property is multiply realized. It seems quite possible that something other than molecular motion may take up the function of heat in other possible worlds where the laws of nature and the basic material stuffs are different from ours. Then, "heat" would not designate the same referent in those worlds, and so we do not want to say that it is a rigid designator[1]. Further, the concept of *heat* has been extended to *radiation* as well even in this world: "heat" designates radiation too. The claim that natural kind terms are rigid designators is untenable as long as Kripke maintains that "heat" is a natural kind term.

Someone may argue, in support of Kripke, that "heat" rigidly designates a disjunction: *molecular motion or radiation or caloric or ...* But this seems to be a hopeless idea. Suppose that Tom is the referent of a name "Tom", Jerry "Jerry" and John "John". Is *Tom or Jerry or John* a thing that can be designated by a name? — No, it is not a thing, and it just cannot be a referent of any name. *Molecular motion or radiation or caloric or ...* is not a thing, or an event, or a phenomenon, or whatever: that is, the disjunction just cannot be a referent of any name. In other words, "heat" does not designate *molecular motion or radiation or caloric or what not*.

Heat is not a single natural kind, and "heat" does not have a fixed referent across possible worlds: so, "heat", although Kripke thinks it is a natural kind term, is not a rigid designator. The terms for functional properties are not rigid designators because functional properties are multiply realizable in a world and across possible worlds[2].

I. *2. The Causal Theory of Reference*

The second way Kripke tries to establish the rigid designation of natural kind terms is by appealing to the causal theory of reference. He imagines a hypothetical baptism situation of some natural kinds. The referent of a natural kind term, say, "gold", is picked out as by some such *definition* as, "gold is the substance instantiated by the items over there, or at any rate, by almost all of them" [Kripke (1980), p. 135]. Kripke thinks that terms for natural kinds get their reference fixed this way; the substance is defined as the kind instantiated by almost all of a given sample. The *almost all* qualification allows that some fool's gold may be present in the sample; if the original sample has a number of deviant items, they will be eventually rejected as not really gold.

Kripke imagines a baptism situation in order to fix the referent of "gold". However, his *picture* of the baptism has a flaw. I will show the problem and then try to find a way out of it.

We need a sample to fix the referent of "gold". We will say that if any substance is the same substance as the sample, then it is gold. But if there are some items of fool's gold in the sample, how should we decide? Should we

recognize that fool's gold is gold as well? — No. Kripke says that the items of fool's gold in the sample will be rejected as not really gold. But someone may wonder how we can rule them out from the sample. Presumably Kripke would rely on scientists' report that gold is the element with atomic number 79. If some items do not have atomic number 79, they should be rejected from the sample as not really gold. Here, we first used the sample *to fix the referent*. But to secure the sample, we need some characteristics of *the referent which has already been fixed*. Kripke's *picture* seems to amount to the following: *to fix the referent, the referent has had to be already fixed*. Doesn't Kripke's account form a circle? — Well, I think there is a way to remove the hint of logical problem from his account.

Let me slightly modify the baptism situation to cure this problem. We can imagine a set of samples for pre-scientifically identified substance *ggold*, not gold[3]. We may call the substance instantiated by the items over there with the name "gold"; but the referent of this "gold" in pre-scientific stage is ggold, not gold. The set of samples may have items of fool's gold; but this is not a problem yet because "gold" may refer to fool's gold as well. Only after scientists find out that the *majority* of items people call "gold" have atomic number 79 but that some others do not, can we say that "gold" in fact designates gold, not ggold. And the false items in the samples will be rejected as not really samples of gold. In this new *picture*, we do not have to secure a perfect set of samples for baptism: so, the hint of circle does not come into the new picture. With a slight modification of the original picture, I believe Kripke can be free from this kind of possible objection[4].

Once the referent of a natural kind term is fixed this way, as I think is possible in many cases of natural kinds, the name is passed across causal links through communication. And if there is an appropriate causal chain that reaches the baptism situation, a speaker can use the name "gold" to correctly designate the referent even in the counterfactual situations where he is told little, or nothing, or even incorrectly, of the atomic number of gold.

Kripke's *picture* of baptism and reference transmission fits nicely in the cases of water and gold. Natural kind terms such as "water" and "gold" surely look like rigid designators. But the joker in the deck is again "heat". A functional property *heat* can be in principle realized in innumerably many different physical bases across possible worlds. You cannot secure all the samples of these physical bases; and you cannot baptize a functional property all the samples of which you cannot secure. As long as the baptism is impossible, Kripke's picture of baptism and reference transmission cannot support his claim that "heat" is a rigid designator.

From my discussions of sections I.*1* and I.*2*, it should be by now clear that a functional property term "heat" does not really designate the same natural kind across possible worlds. I do believe, however, that natural kind terms such as "water" and "gold" are rigid designators as Kripke claims. In

the following sections, I will discuss a metaphysical problem Kripke faces if he does not distinguish natural kinds from functional properties.

II. NECESSITY OF IDENTITY

It used to be thought that even if water is actually H_2O in this world water might be something else in other possible worlds. That is, "Water is H_2O" was thought to express only a contingent truth. However, Kripke turned the tables for the talk of the identity issue. For him, if water *is* in fact H_2O, there cannot be a possible world in which water is not H_2O. It may be epistemically conceivable that water might have turned out not to be H_2O; but, if water is in fact H_2O, it is metaphysically impossible that water could have turned out to be something other than H_2O.

Another way Kripke shows the necessity of this identity statement is by appealing to the rigid designation of natural kind terms. A term "water" designates the same stuff in all the possible worlds where it exists. "H_2O" designates the same chemical substance in every possible world in which it exists. "Water" and "H_2O" designate the same substance in this world. Then, the two terms designate the same substance in all the possible worlds where it exists. So, if water is H_2O, then it is necessary that water is H_2O. I believe the same structure of account works for "Gold is the element with atomic number 79".

As I showed in sections I.*1* and I.*2*, however, we cannot say the same of "heat". If "heat" designates only the molecular motion in this world, then it will designate molecular motion in the possible worlds where the given environments and laws of nature are basically the same as ours. Where the environments and laws are different, however, it may be possible that "heat" designates, for instance, *caloric* that occurs in hot things in those worlds. If we agree that "heat" is not a rigid designator, we can easily see that "heat is molecular motion" is not a necessary truth. It can be only contingently true if true at all: that is, it is true in only some worlds where some specified environments and laws of nature are given[5].

Heat may be molecular motion in one world; but some other physical stuff may take up the function of heat in other possible worlds: "Heat is molecular motion" is not necessarily true. Should we say, then, that the statement shows us a case of contingent identity? This question may embarrass us because, although the given statement seems to indicate a case of contingent identity, our intuition that no identity is contingent is also irresistible. To figure out an answer, I will first show how Kripke should answer this question.

Kripke refers to Ruth Barcan's famous formula "$(x)(y)(x=y \supset \Box(x=y))$" to claim for the necessity of identity. Kripke says, if "a" and "b" are rigid designators, it follows that "a=b", if true, is a necessary truth. He also adds,

"If 'a' and 'b' are *not* rigid designators, no such conclusion follows about the *statement* 'a=b' [...]" [Kripke (1980), p. 3]. I think Kripke's claims are true. If you substitute a rigid designator "water" for "a" and another rigid designator "H_2O" for "b", "water = H_2O" is a necessary truth. Since "heat" is not a rigid designator, however, you cannot in this case apply the same rule to Barcan's formula and get a necessary truth. Therefore, if Kripke agrees with me on that "heat" is not a rigid designator, then he can avoid saying that "Heat is molecular motion" is a necessary truth. However, Kripke's conviction that "Heat is molecular motion" is necessarily true is much firmer than I would like it to be. He says: "The type of property identity used in science seems to be associated with *necessity* [...]: For all bodies *x* and *y*, *x* is hotter than *y* if and only if *x* has higher mean molecular kinetic energy than *y*. Here the coextensiveness of predicates is *necessary*, [...]" [Kripke (1980), p. 138]. It is obvious that he takes "Heat is molecular motion" as *an identity statement* and contends that it is necessarily true.

I have so far argued that the given statement is not necessarily true. If you agree with me on this, but if you still think that the statement stands for an identity relation, our problem remains unsolved: Does "Heat is molecular motion" shows us a contingent identity?

III. Second-Order Property and the Identity of Properties

Is heat only contingently identical with molecular motion? — Well, my answer to this question is rather simple: I think "Heat is molecular motion" is not an identity statement. It is, as we may call it, *a realization statement* because it actually says that heat *is realized in* molecular motion. If it is not an identity statement at all, thus, it does not show us a case of contingent identity either. To support this view in detail, let me first introduce the definitions of second-order property and functional property.

III .*1 Second-Order Property*

Let D be a domain of first-order properties. We may define the second-order property[6] as follows:

> *F* is a second-order property over D = def. *F* is the property of having some property *P* in D such that S(*P*), where S is a specification of members of D.

The property of being a primary color (for painters) is a second-order property over the set of first-order properties {red, yellow, blue}. You have a primary color if you have one of the three colors. The primary colors are

specified such that you can mix them to create any other color but you cannot get any of the three colors by mixing any other colors.
Functional properties constitute a subset of second-order properties where a specification S specifies *a causal/nomic role*:

> *F* is a functional property over D = def. *F* is a second-order property over D defined in terms of a specification S that states causal/nomic relations of the members of D.

Heat is a functional property defined over the domain of the first-order properties {molecular motion, radiation, caloric, ...}. It is specified such that something, some phenomenon, or some event is heat as long as it takes up the function of heat, that is, if it melts ice, keeps you warm, makes iron bar brittle if the bar is lack of it, and so on. From the definition of functional property, it is clear that a function of heat can be in principle realized in indefinitely varied physical bases.

We are now conceptually equipped to deny that "Heat is molecular motion" is an identity statement. *Heat* is a second-order functional property, and *molecular motion* is one of its first-order realizers. A second-order functional property *is not identical with* one of its first-order realizers; rather, the former *is realized in* the latter. Since "Heat is molecular motion" is not an identity statement, it does not suggest that there is contingent identity.

III. *2 Identity of Properties*

Let me finally tackle the issue of property identity in relation to Wilson's claim that the principle of necessary identity cannot be maintained at least in second-order form [(F)(G)(F=G then necessarily F=G)][7]. His point is that the property identity is not necessary but only contingent. To evaluate his claim, I believe we need to sort out varied cases of alleged property identity and see if they are really cases of contingent identity as he claims.

(1) "If the property of being water is the property of being composed of H_2O, then it is necessary that being water is being composed of H_2O". This sentence can be translated to the form of second-order logic, but it surely shows us a case of necessary identity. We should here notice that this is an identity relation between the properties of the same order; and neither of the properties is a functional property. The principle of necessary identity is maintained in this kind of cases of property identity.

Wilson thinks, however, that "Being a water molecule is being an H_2O molecule" is not a necessary truth because, in a certain situation where the laws of quantum mechanics were somewhat altered, "water" can be used to name H_2N. I believe that this is not true, and that Wilson may not be seriously considering the metaphysical aspects of Kripke's and Putnam's claims. For something to be water, Putnam argues, it should stand in the *same* liquid

relation to *our water*, which is in fact composed of H_2O molecules. A stuff composed of H_2N molecules does not stand in the same liquid relation to *this water* here: so, an H_2N molecule is not a water molecule. If this water here is in fact H_2O, there is no possible world in which water exists but is not H_2O. Thus, "Being a water molecule is being an H_2O molecule" is, *pace* Wilson, not a case of contingent identity; it is a necessary truth.

(2) "If heat is molecular motion, then necessarily heat is molecular motion". As I have so far argued, this is not true. This does not show, however, that the necessity of property identity cannot be maintained in the statement involving a second-order property term because "Heat is molecular motion" is not an identity statement. Higher-order properties are realized in lower-order properties; but the former are not identical with the latter. We cannot find a case of contingent identity in realization statements[8].

Wilson may want to use one of his examples to support his claim of contingent identity. The property *force* is equated with the physical quantity *ma* ($f = ma$) in Newtonian physics (or Newtonian possible world, if you like); but it may be equated with different quantity in another physical theory (or another possible world). Doesn't this show that there is contingent identity? Well, notice that *force* is a functional property that may have varied realization bases. Further, the mathematical notation "=" for equation does not always stand for the metaphysical identity relation. For instance, the four sides *a*, *b*, *c*, and *d* of a square are equal in length and are usually written "$a = b = c = d$". "=" signs are used, and *a*, *b*, *c*, and *d* are equal in length; but they are *not identical* in a metaphysical sense, that is, they are *not one and the same*. We may say the same of force. Force may be equated with other physical quantity using "=" sign; but this does not show that force is metaphysically identical with the physical quantity. And non-identity statements cannot be used to prove the existence of contingent identity.

No one seems to have suggested a successful counter-argument to the principle of the necessary identity with regard to the property identity: A property *F* and a property *G* are necessarily identical if *F* and *G* are identical at all. Kripke's mistake is that he does not distinguish identity statements from non-identity statements, and this invites alleged counter-examples to the principle of necessary identity. I believe that my discussions of the second-order functional properties and realization statements can correct this mistake and reconfirm the principle of necessary identity in the cases of property identity as well.

CONCLUSION

Kripke's argument for the rigid designation of natural kind terms is fallacious because he does not distinguish natural kinds from second-order func-

tional properties; by clarifying the concepts of natural kind and functional property, we can show that natural kind terms do designate their referents rigidly, but that functional property terms are not rigid designators. My discussions of functional property will also help dispel the worry about the alleged cases of contingent identity with regard to theoretical statements in science. There is no contingent identity even in the form of second-order logic: property identity is also a necessary identity. The principle of necessary identity rules relentlessly.

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NOTES

* I would like to thank Justin Broackes, Victor Caston, Jaegwon Kim, and Tomoji Shogenji for their helpful comments on the earlier versions of this paper.

[1] Presumably Kripke would say, "[...] when something's physically necessary, it always is necessary *tout court*" [Kripke, S. (1980), p. 99]. He would deny that the laws of nature in other possible worlds may be different from those of our world. And he would contend that heat cannot be something other than molecular motion because the laws of nature cannot be different even in other possible worlds. But this seems highly dubious. The laws of nature are each different even among Newtonian structure, Einstein's world, and quantum mechanics. Couldn't we say that even these three are each a different possible world? I do not see why we could not legitimately say that other metaphysically possible worlds may have different laws of nature.

[2] One may argue that the term "heat" is *a rigid designator of a functional property*. For her, "heat" rigidly designates the same thing — a functional property — that exists out there in the world. But the issue of the ontological status of a functional property is controversial. One strong intuition is that heat is not a property that really exists out there. What really exists is molecular motion, or radiation, or whatever; and something has heat only when it has one of these. It may be the case that *heat* is only a *concept* that helps us pick out one of the members of a set {molecular motion, radiation, caloric, ...}. As long as the ontological status of a functional property is dubious, I believe we had better avoid saying that a term rigidly designates the functional property.

[3] For this idea of *ggold*, I have benefited from email correspondence with Justin Broackes. But I am not sure if he would agree with me in adopting the idea of *ggold* to solve the problem of Kripke's accounts.

[4] As Putnam says in a bit different context, however, Kripke's picture is a defeasible one. We may be lucky in the cases of "water" and "gold"; but jade is jadeite and nephrite, and some baptism may not fix the referent of any natural kind when the

original samples do not at all form a natural kind but are composed of many different stuffs. For this, see Putnam (1975).

[5] Kim suggests that we call "semi-rigid" or "nomologically rigid" those terms that designate the same referents in the possible worlds where the laws of nature are basically the same. For this, see his "The Mind-Body Problem: Taking Stock after Forty Years", forthcoming in *Philosophical Perspectives*.

[6] For more accounts of second-order property, see Putnam (1970) and Block (1990).

[7] For this, see Wilson (1983).

[8] Someone may argue that "heat" rigidly designates a disjunctive property; but, as I argued in section I.*1*, an appeal to the disjunctive property cannot be a solution.

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