General Terms and Relational Modality

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1. Introduction

Natural kind terms have exercised philosophical fancy ever since Kripke, in *Naming and Necessity*, claimed them to be rigid designators. He there drew attention to the peculiar, name-like behavior of a family of prima facie only loosely related general terms of ordinary English: terms such as 'water', 'tiger', 'heat', and 'red'. Just as for ordinary proper names, Kripke argued that such terms cannot be synonymous with any of the definite descriptions ordinary speakers associate with them. Rather, the name-like behavior of these so-called natural kind terms is to be explained, just as in in the case of proper names, by the doctrine of rigid designation. And as a consequence of thus extending the notion of rigid designation to general terms, he famously endorsed the claim that so-called 'theoretical identifications', i.e. statements like

(1) Water is H_2O,

are necessary, if true. Intriguingly, and just like that of identity statements involving two different proper names like

(2) Hesperus = Phosphorus,

the truth of such statements cannot be known a priori. Rigidity thus promises a semantic explanation of the modal status of the two known kinds of a posteriori necessity.

Putnam endorsed the idea of a name-like semantic category of natural kind terms. He was, however, more interested in the peculiarities of what might be called their "foundational" semantics, than that of their semantics proper. By means of the famous Twin-Earth thought experiment (cf. Putnam 1975), he brought out some widely shared intuitions presumably supporting the claim that the meaning of natural kind terms is partly determined by elements of the local environment of the speakers. The idea of "externalist" meaning determination was then generalized, amongst others by Tyler Burge (cf. Burge 1979; Burge 1982), not only to general terms other than natural kind terms, but also to natural kind concepts. Putnam/Burge style externalism has generated a huge literature, much of which is concerned with foundational semantics, or content determination, and the various problems externalist content determination engenders (for instance, with respect to self-knowledge).

More recently, however, more attention has been focused on the very semantics of natural kind terms again. In particular, it has been asked what exactly it would mean for a general term to be a rigid designator. While there is a simple and clear definition of rigidity for singular terms, the extension of the notion of rigidity to general terms is not straightforward at all. Nor is it clear whether the expressions we are most interested in here, the natural kind terms, are to be treated as singular terms, or as predicates. Different proposals for both options have been discussed, and there seems to be a rather widespread consensus at the moment that none of them does precisely the job Kripke envisaged rigidity as doing for natural kind terms. Most importantly, none of the proposals on the market is able to sustain natural kind terms as a *semantic* category.

There are, thus, two options at this point: We can either settle for explaining as much as we can of the peculiar, name-like behavior of natural kind terms by means of one of the available notions of rigidity for general terms. Or we can try to find different semantic properties of these terms that ideally would be able to explain all of the phenomena Kripke expected rigidity to explain. In this paper, we shall argue that there in fact are such semantic properties. What we shall call 'switcher-style dual-property association' is a family of semantic properties that

do for general terms what rigidity cannot do. They even single out the natural kind terms as a semantic category. Moreover, they promise to explain what rigidity, by its very nature, cannot explain: The epistemic status of both a posteriori and a priori (or analytic) necessities.

Our basic idea about natural language natural kind terms is very Kripkean, indeed. It is the idea that natural language natural kind terms are associated with two properties: a manifest, stereotypical property, and an underlying physical property realizing, instantiating, and (in many cases) explaining the manifest qualities of its instances.[1] Natural kind terms are peculiar in that their modal profile is governed by the underlying property. To implement this idea formally, we shall extend the 'evaluation switcher semantics' we have earlier suggested for proper names and modal operators (Glüer and Pagin 2006, Glüer and Pagin 2008). This 'evaluation switcher'—or, for short, 'switcher'—semantics works with more than one semantic function, and it's basic idea is that some—typically non-extensional—operators function as semantic switchers in natural language. This idea is used to explain the modal peculiarities of certain expressions, such as proper names, while at the same time allowing them to have descriptive content: Such expressions interact with (*de re*) modal operators in a peculiar way. Evaluation switcher semantics, thus, promises to combine the advantages of traditional descriptivism with Kripkean and externalist insights about the modal profiles of proper names and natural kind terms.

We shall proceed as follows: In the next section, we review what has happened in the discussion up to now. We look at the notion of rigidity as it has been suggested both for singular and for general terms. Of special interest are, of course, proper names and natural kind terms. We also look at the consequences rigidity is supposed to have for the modal status of certain identity statements. The most important question will be whether there is a satisfactory notion of rigidity for general

[1] We distinguish between natural language and scientific natural kind terms. Scientific general terms, at least in natural science, are in general intended to be natural kind terms insofar as they occur significantly in law statements. Our account does not contribute anything new concerning these terms; we are solely interested in characterizing the natural kind terms of natural language. In the rest of the paper we shall often use 'natural kind terms' to refer to natural language natural kind terms rather than to the generic category. Context should make it clear what is intended.

terms. In section 3, we shall quickly run through the basic ideas of the evaluation switcher semantics for proper names and modal operators that we have suggested. In section 4, we shall explain how to extend that semantics to general terms when they can be construed as singular terms referring to kinds, and explore the consequences for the modal status of the relevant identity statements. In section 5 we shall do the same for general terms that have to be construed as predicates. In the last section, we shall argue that the suggested semantics for dual-property associated general terms in fact singles out the natural kind terms as a semantic category. Besides explaining the modal status of identifications involving natural kind terms, switcher-style dual-property association thus also promises to explain their epistemic status. We shall add some comments on natural kind terms and reference failure, and end on a Quinean note of caution about the notions of the a priori and the analytic employed in this paper.

2. Rigidity and Necessity

In *Naming and Necessity* (1972), Kripke introduces the idea of rigid designation as follows:

> Let's call something a *rigid designator* if in every possible world it designates the same object (...). Of course we don't require that the objects exist in all possible worlds. (Kripke 1972, 48.)

This yields a straightforward definition of rigidity for singular terms:

(RD_S) A ***singular term t*** is a rigid designator iff t refers to the same object o in every possible world w in which o exists.

Kripke then presents a host of detailed and forceful arguments for the claim that *proper names* in natural language are rigid designators. If proper names are rigid designators, they cannot be synonymous with any of the (non-rigid) definite descriptions that speakers normally associate with them. Kripke presents substantial evidence to the effect that this is in fact so.

The maybe most powerful and influential argument Kripke uses to show this, is the so-called *modal argument*.[2] Take two modal sentences, for instance

(3) Aristotle might not have gone into pedagogy.

(4) The teacher of Alexander might not have gone into pedagogy.

Intuitively, (3) is true. But (4) is ambiguous. It has the following two readings:

(4a) The teacher of Alexander is such that: possibly he did not go into pedagogy.

(4b) It is possibly the case that: the teacher of Alexander did not go into pedagogy.

On one of these readings, reading (4b), (4) is intuitively false. Since (3) has no such ambiguity, 'Aristotle' and 'the teacher of Alexander' are not intersubstitutable salva veritate in all contexts, and therefore not co-intensional. Kripke concludes that proper names and the (non-rigid) definite descriptions speakers normally associate with them are not synonymous. He suggests to explain the behavior of proper names in modal contexts by construing them as rigid designators.

Rigidity is also the key to explaining another notorious modal phenomenon connected with proper names. Take identity statements involving two different

[2] Kripke also presents two further highly influential arguments against traditional descriptivist accounts of proper names, the so-called *semantic* and *epistemic* arguments. In the semantic argument, Kripke claims that ordinary speakers normally do not have the descriptive knowledge required for ascribing the relevant descriptive content to the names they use; what they 'know' might not be sufficient for identifying the referent, or even false. The epistemic argument urges that by inscribing (part of) the 'descriptive lore' ordinary speakers associate with names into the "lexicon" of their language, descriptivism not only predicts it to be knowledge, but *a priori* knowledge. Note, that only the epistemic argument is an argument against descriptivist semantics proper; the semantic argument attacks a certain picture of meaning determination (or "foundational semantics") often associated with descriptivist semantics. We do not consider either of these arguments as ultimately convincing; they do not succeed in ruling out a plausible version of cluster-theory. If a cluster-theory is read foundationally, the cluster of beliefs C a speaker S has about the referent of a name t determines t's meaning without requiring all, or even any particular, beliefs in C to be true. In the semantics, to be sure, a choice will have to be made as to which beliefs to treat as part of the meaning of t, and which as empirical. This choice, however, is restricted, but not completely determined by C; there will always be a cluster of semantic theories that can equally well be used to interpret S, but that inscribe different descriptive material from C into the lexicon. Consequently, using a particular semantic theory to interpret S does not mean ascribing any particular pieces of a priori knowledge to S. (For a little more on this, cf. fn. 36 to our (2006).)

proper names, for instance

(2) Hesperus = Phosphorus.

Let's call such identity statements 'two-name identities'. If proper names are rigid designators, two-name identities are necessary, if true. More precisely, they are true in every world in which the denoted object exists. If, as is most natural, we allow truth-value gaps where there is reference failure, two-name identities are either true or truth-valueless in all worlds, and nowhere false. Yet, two-name identities like (2) are not analytic, and their truth cannot be known a priori. Such two-name identities thus are examples of what has come to be known as *a posteriori necessities*.[3]

By contrast, a 'one-name identity' like the following

(5) Hesperus = Hesperus,

has at least a certain air of being analytic, and knowable a priori. That is, it appears to be analytic, and knowable a priori, that such a sentence is not false at any world. In this sense, it appears to be an *analytic necessity*.

Rigidity does explain why (2) is necessay, if true. But rigidity does *not* explain why (2) is a posteriori, or why it is non-analytic. Nor does it explain why (5) is both analytic and a priori. Rigidity, in other words, can only explain modal status, not epistemic or 'informational' status. That should not be surprising, as rigidity, by itself, does not tell us anything about the *meaning* of rigid terms. Nevertheless, we would of course like to have a full explanation of the peculiar modal-cum-epistemic status of two-name identities like (2). Moreover, given the strong appearance of a connection between epistemic status and meaning, we would prefer this explanation to be a semantic explanation – just as Frege wanted a semantic explanation of the non-modal informational difference between one-name and

[3] For convenience, we shall continue to call a sentence "necessary" if it is true in all worlds where it has a truth value (and it is not the case that there are no worlds where it has a truth value).

There might be two-name identities that are both (strictly) necessary and knowable a priori; for instance identities involving names given to mathematical entities by means of (non-obviously) equivalent conditions. Thanks to Dan López de Sa for bringing up this possibility.

two-name identities.

For *singular terms*, it is thus well-understood both what rigidity amounts to, and what consequences it has for modal status. On the assumption that the proper names of natural language are rigid designators, rigidity elegantly explains their behavior in modal contexts and the modal status of two-name identities. Nevertheless, by itself, rigidity does not provide all the semantic explanation we desire for the peculiar epistemic-cum-modal properties of name identities.

When it comes to *general terms*, the situation for a long time appeared to many as just parallel to that concerning singular terms. In *Naming and Necessity*, Kripke singles out a certain kind of natural language general term: the natural kind terms. Natural kind terms, he claims, are very much like proper names; they are rigid designators. Just as for proper names, Kripke argues that if a general term is a rigid designator, it cannot be synonymous with the non-rigid, stereotypical descriptions speakers normally associate with it. And again, some evidence for this is marshaled from modal contexts. Take two modal sentences like the following:

(6) Water might not have been H_2O.

(7) The clear, thirst-quenching liquid flowing in rivers and from taps might not have been H_2O.

Intuitively, (6) is false, while (7) has a reading on which it is true. Such substitution failure indicates non-synonymy, and as in the case of proper names, Kripke proposes to explain this by means of rigid designation. It has become clear in the recent literature, however, that the supposed parallel between proper names and natural kind terms in fact is quite problematic.

The examples of natural kind terms Kripke uses are of surprising variety. There are count nouns such as 'cat', 'cow', and 'tiger', mass terms such as 'gold', 'water', and 'iron pyrites', terms for natural phenomena such as 'heat', 'sound', and 'lightning', and adjectives such as 'hot', 'loud', and 'red'. All of these are, according to Kripke, terms for *natural kinds*.

Even though these examples might prima facie look like a weird bunch, they all have something interesting in common. All these terms are such that they show a characteristic "double nature": Each of them seems to be associated with two different properties. One of these properties is specified by the descriptive stereotype normal speakers associate with the term. Thus, for instance, 'water' is associated with something like 'the clear, thirst-quenching liquid flowing in rivers and from taps', and 'tiger' with 'the carnivorous, cat-like animal with yellow and black stripes'. The stereotypical property typically is a manifest one. The second property is the physical (chemical, biological, etc.) property underlying, realizing, and (in many cases at least) explaining the manifest one. Intuitively, natural kind terms are used to talk about, or predicate, the underlying property; this is the property things need to have in order to belong to the kind, i.e. what is essential to being of that kind.[4] The manifest property is merely used to 'get at' the underlying one, to 'fix' the term to it. Consequently, speakers apply these terms to actual objects on the basis of their manifest properties, but regard the modal properties of the kind itself as determined by the underlying property. Thus, nothing but H_2O could possibly be water.[5, 6]

Now, if general terms of this kind were rigid designators, the prediction would be precisely such a modal profile. Most importantly, if they were rigid designators, that should have tell-tale consequences for the modal status of sentences such as

(1) Water is H_2O,

[4]This is not to say, of course, that red things, for instance, form a natural kind. According to Kripke, however, *redness* is a natural kind in the explained sense: It is essential for *being red*, however temporary and unessential a property of an *object* that might be, to have the underlying physical property explaining the manifest properties of red things. And analogously for 'hot' or 'loud'. For more on this, see below pp. 12f; 40ff.

[5]These characteristics of natural kind terms are also stressed by, for instance, Brown 1998 and Haukioja 2006. However, they suggest that though the application of natural kind terms or predicates is based on what they call "superficial properties", "superficial properties are not sufficient for determining their application in the actual world" (Haukioja 2006, 161f). Here, we differ. This difference is made good use of in our account of natural kind predicates in cases where there is no (or too many) underlying properties. See below, section 6.

[6]Another question concerns certain artifact terms or kinds: How much of what we just said applies also to terms like 'computer' or 'television'? These, we think are terms for *functional* kinds; the decisive difference between them and natural kinds is that their modal properties are determined by their functional properties, not their physical implementation. For a more detailed discussion, see below, section 6.

(8) Tigers are animals,

or

(9) Heat is mean molecular kinetic energy.

All of these should come out as (a posteriori) necessities. Sentences like these are called "theoretical identifications" since it is not altogether obvious what their logical form is; (1) and (9) might be identity statements, but (8) clearly is not an identity statement. Whatever their logical form, Kripke claims that – just like two-name identities – theoretical identifications indeed are necessary, if true. Moreover, he claims, theoretical identifications are not analytic, and not knowable a priori, either. They, too, thus seem to be a posteriori necessities.

In our opinion, these predictions are born out by our modal intuitions. Natural kind terms do show a peculiar, name-like behavior both when it comes to substituting stereotypical descriptions for them in modal contexts and when it comes to the modal status of theoretical identifications. These intuitions might in fact be a bit weaker than those regarding the corresponding behavior of proper names, but we take them to be strong and stable enough to be taken as data requiring (semantic) explanation.[7]

We take it to be clear that Kripke thinks that – just as in the case of proper names – the key to the explanation is rigidity (cf., for instance, Kripke 1972, 140; 162; see also Soames 2002, 244f). Again, such an explanation – if forthcoming – is limited to explaining the modal status of the relevant sentences. Rigidity by itself does not explain the epistemic status of theoretical identifications. Again, epistemic status appears to be connected with meaning, and if it is, rigidity can explain only part of the relevant semantic phenomena.

Moreover, in the case of general terms, it is not so clear in the first place what their rigidity exactly is supposed to amount to. The most natural extension of the notion of rigidity for singular terms to general terms is this:

[7] As far as we can see, there is quite widespread consensus regarding these intuitions in the literature. That is not to say that there are no dissenting voices, however. Wikforss (2005), for instance, defends a traditional cluster-descriptivism for natural kind terms committed to denying these intuitions and provides some hints as to how to 'explain them away' (cf. esp. pp. 82f).

(RD$_G$) A ***general term G*** is a rigid designator iff G has the same extension in every possible world w in in which it has a non-empty extension.

But (RD$_G$) is clearly false. Most general terms, including natural kind terms, have extensions that vary from world to world. So, what does it mean for a general term to be rigid? Before we look at the most prominent, and promising, suggestions on the market, let us follow Scott Soames (2002) in listing what seem to be rather sensible, natural desiderata on a notion of rigidity for general terms:

A satisfactory notion of rigidity for general terms must

1) be a natural extension of the notion of rigidity as defined for singular terms,

2) apply to all natural kind terms, but not to other general terms, and

3) explain the modal status of theoretical identifications.

(Cf. Soames 2002, 263.)

However, it has been contended in the recent literature that there is no notion of rigidity for general terms that satisfies all of these desiderata (cf. a.o. Soames 2002, 263; Haukioja 2006).[8]

This might not be all that surprising in the end; after all, as Kripke's examples amply demonstrate, the natural kind terms do form a syntactically rather heterogeneous bunch – including count nouns, mass nouns, and even adjectives. To deal with their semantics, it would be helpful to know whether natural kind terms primarily are *singular terms* or *predicates*. If they are primarily one or the other, it might be possible to explain what it means for a natural kind term in its primary use to be rigid, and to then treat the other use as somehow derivative. However, it might also be the case that we simply would need two notions of rigidity for gen-

[8]It should be noted that not everyone in the debate agrees that all of the listed conditions in fact are desiderata on a satisfactory notion of general term rigidity. No-one, of course, disputes 1), but for instance Marti (2004), citing reasons given in Salmon 1982 and Donnellan 1983, is happy to do without 3), and philosophers like Marti (2004), Linsky (2006), Salmon (2003; 2005), or, more recently, Soames himself (2006; 2008) do not require their notion of general term rigidity to single out precisely the natural kind terms. Those who dispute the necessity of one or more of these conditions usually agree, however, that they cannot all be satisfied together.

eral terms, one for singular terms and one for predicates.

In this paper, we are not going to take a stand on the question whether natural kind terms primarily are one or the other, singular terms or predicates. Rather, we are going to proceed on the assumption that there are (uses of) natural kind terms that clearly are singular, and that there are (uses of) natural kind terms that clearly are predicative. And in the remainder of this section, we are going to look at the two main suggestions for general term rigidity, one for predicates, and one for singular terms.

If natural kind terms are *predicates*, the main contender for rigidity on the market is what has been called "rigid application":[9]

(RD'_G) A ***predicate P*** is a rigid designator iff P is such that if it applies to an object o in any possible world w, then it applies to o in every possible world in which o exists.

Predicates satisfying (RD'_G) have also been called 'essentialist predicates'. Such predicates specify properties that any object that has them at all cannot fail to have, properties (in this sense) essential to these objects' being the objects they are.

When it comes to natural kind terms that are *singular terms*, the single most important suggestion is that such terms rigidly refer to kinds:[10]

(RD''_G) A ***general term G*** is a rigid designator iff G refers to the same kind k in every possible world w in which k exists.

These are the most important suggestions currently on the market as to how to understand rigidity for general terms, and the only ones we shall discuss here. Regarding the desiderata just listed, it is pretty clear that both of these satisfy the first one: Both are natural extensions of the notion of rigidity as defined for singular terms. But what about the other two?

[9] For proposals along these lines, see a.o. Devitt and Sterelny 1999, 85; Cook 1980; Devitt 2005, 146.

[10] For proposals along these lines, see a.o. Montadori 1978; Salmon 1982; Donnellan 1983; Boër 1985; Laporte 2000; Marti 2004; Linsky 2006; Lopez De Sa 2008*a*.

Let's look at the notion of rigid application first. Does this notion apply to all, and only, natural kind predicates? Predicates like 'is water' and 'is a tiger' would indeed seem to be rigid appliers. The corresponding stereotypes, by contrast, would seem not to be rigid appliers: That which is clear, thirst-quenching, liquid, and flowing in rivers and from taps is not essentially, or necessarily, so. And even though all animals might essentially be animals, those which are carnivorous, cat-like, and have yellow and black stripes would not seem to be essentially, or necessarily, so. Moreover, paradigm cases of non-natural kind predicates, like 'is a bachelor' or 'is a hunter' do not seem to be rigid appliers, either. It does not seem essential to (most) bachelors that they are bachelors. And the same for hunters.

Trouble starts when it comes to predicates like 'is hot', 'is loud', and 'is red'. These are included in Kripke's list of examples, but they clearly are not essentialist predicates. It is not essential to most (maybe all) red things that they are red. Nor is it essential of hot things that they are hot, or of loud ones that they are loud. In fact, properties like these seem rather paradigmatically accidental.

Now, at this point one might of course argue that these terms should not be counted among the natural kind terms. Kripke was wrong to include them, you might say; for surely, the red things do not form a natural kind? For one thing, the natural kind designated by the corresponding natural kind terms arguably is not so much the kind of, for instance, red things, but simply the color red itself (cf. Soames 2008). For another, as we said above, what seems to unify the examples Kripke gives is the specific way they are associated with two different properties. Whether terms for color, sound, and temperature should be included among the natural kind terms depends on whether they in fact are so associated. Clearly, in all these cases, two different properties of the right kinds are in play: In all these cases, objects are characterized in terms of their manifest, sensible qualities. And in each case, there naturally are underlying physical (or chemical, etc.) properties responsible for the objects' sensible qualities. Moreover, Kripke is very clear on the further, crucially important claim that in all of these cases it is the underlying property that forms the essence of the kind. According to him, the relevant question is thus *not* whether it is essential to a kind's instances that they are of that

kind, but whether the kind itself is such that its essence resides in its physical (or chemical, etc.) nature. Whether that is actually the case when it comes to color, for instance, is of course debatable. In the case of heat, on the other hand, intuition seems rather clear: The essence of heat is in its physical nature, not in the way it affects sensible creatures like us. Consequently, even if we disagree with Kripke on the particular case of 'red' and other color terms, there do seem to be clear examples of natural kind terms that are not rigid appliers. Moreover, there clearly *could* be any number of such terms in natural language, terms showing exactly the characteristics Kripke was after. Since the notion of rigid application would exclude these terms from the category of natural kind terms, this shows that rigid application does not capture the nature of the terms Kripke was interested in.[11]

Anyone accepting the reasoning just presented will have to conclude that the notion of rigid application does not succeed in applying to all, and only, natural kind predicates. While it clearly draws *a* distinction between different kinds of general terms, it is far from clear that it is the distinction between natural kind terms and other predicates.[12]

What might be worse, the notion of rigid application does not explain the modal status of theoretical identifications, either. Let's take (1) as our example:

(1) Water is H_2O.

[11] Mario Gómez-Torrente (2006, 255-56) argues that what matters is not whether a certain predicate itself is essentialist, but only that certain predicates associated with it are rigid appliers, or essentialist. Thus, he for instance claims that although 'is hot' is not essentialist, 'is (an instance of) heat' is. According to Gómez-Torrente, the necessity of some statements that include 'hot' are then to be explained by way of the essentiality of the associated predicate. By this move, Gómez-Torrente does change and weaken the requirements on predicate rigidity, however. It remains unclear why the original, stronger requirement isn't or couldn't be preferable, provided it can or could be met. Moreover, it is not so clear that 'is heat' is an essentialist predicate, since it is not clear what the bearer of a property like that is. It can't be a collection of spatially close molecules, since such a collection wouldn't instantiate heat necessarily. If, on the other hand, it is a property instance (or trope), then it is unclear what the transworld identity conditions are on the basis of which essentiality can be claimed. (A property instance cannot be an ordered pair of an entity and a property, since that pair exists in worlds where the entity doesn't have the property, but in such worlds the property instance intuitively does not exist.) All in all, it is thus, at best, unclear how to work out such an account.

[12] It has also been argued that natural kind terms like 'frog' are not essentialist, while some clear cases of artifact terms, for instance 'television', are (cf. Schwartz 2002, 274f). This is debatable; for discussion, see Devitt 2005, 155ff.

Since 'water' and 'H_2O' are construed as predicates, (1) has the form

(1′) $\forall x\,(\text{water}(x) \leftrightarrow H_2O(x))$.

Then, the question is: Does rigid application explain why

(10) $\Box\forall x\,(\text{water}(x) \leftrightarrow H_2O(x))$

is true if (1′) is? And the answer seems to be negative. As Soames (2002, 257ff) has argued, rigid application explains why

(11) $\forall x\Box\,(\text{water}(x) \leftrightarrow H_2O(x))$

is true, if (1′) is, but not why (10) is. That is, rigid application has the consequence, and explains, why all objects that exist in the actual world and are both water and H_20, are both water and H_20 in every world where they exist. But that does not rule out the possibility of a world w in which there is something that does not exist in the actual world and that is water in w, but not H_20. And this generalizes, of course. Consequently, the notion of rigid application does not satisfy the third desideratum on a notion of rigidity for general terms, either.[13, 14]

[13] In (2005), Devitt acknowledges this (152ff). However, according to Devitt, "[t]he primary work of a rigidity distinction for kind terms is identifying terms that are not synonymous with descriptions and hence refuting description theories of meaning for those terms" (144). Explaining the modal status of sentences containing rigid designators, by contrast, is only "secondary work" (153). Moreover, Devitt argues, rigid application only partly fails at doing its 'secondary work'; after all, the notion does explain the difference in modal status between the following two sentences:

(1) Water is H_2O.

(12) Water is the most common liquid on Earth.

Therefore, Devitt here concludes that there is "more than enough justification for rigid application" (153). Given the large role that theoretical identifications play in *Naming and Necessity*, and the ample and clear evidence Kripke gives of wanting to explain their necessity by means of the notion of rigidity (cf., for instance, Kripke 1972, 140; 162; see also Soames 2002, 244f), it can hardly be justified to qualify failing at this task as a mere "exception" (Devitt 2005, 153) to a notion's otherwise doing its explanatory work.

[14] Gómez-Torrente (2006) provides two arguments to the effect that the notion of rigid application in fact does meet the third desideratum. Both try to establish that the parallel between proper names and rigid appliers does extend to the necessity of theoretical identifications. According to the first, what follows from the truth of the identity/identification is in both cases only the necessity of a conditional. Since names can fail to refer in some worlds, we here need to conditionalize on existence, and an analogous restricting antecedent saves necessitation for rigid appliers (2006, 241f):

Let us next look at the notion of rigid designation of kinds. The idea would be that general terms designate universals, properties, or kinds, and that rigid general terms designate the same universal, property, or kind in every possible world (where they designate anything at all). Natural kind terms would seem to be rigid general terms in this sense, but does that distinguish them from other general terms?

The answer seems to be clearly negative. General terms for paradigmatically non-natural kinds like 'bachelor', 'hunter', or 'pencil' would seem to rigidly des-

(13) $\ulcorner a = b \urcorner$ is true and a, b are rigid $\Rightarrow \ulcorner \Box(a \text{ exists } \rightarrow a = b) \urcorner$ is true

(14) $\forall x(Ax \equiv Bx)$ is true; A, B are weakly essentialist $\Rightarrow$
$\ulcorner \Box$((If everything that is actually an A or a B exists
and everything that is an A or a B actually exists) $\rightarrow \forall x(Ax \equiv Bx)) \urcorner$ is true

There is not much of a parallel here, however. The antecedent imposed in the conclusion of (13) is needed to eliminate worlds where the consequent has a truth-value gap, while the antecedent in the conclusion of (14) is needed to eliminate worlds where the consequent is false. If such conditionalizing moves are allowed, *any* necessitation inference can be saved.

According to Gómez-Torrente's second argument there is as much reason to treat essentialist predicates as *obstinately* essentialist as there is to treat proper names as *obstinately* rigid. A term is obstinately rigid if it refers to the same object in all worlds, even in worlds where that object does not exist, and a predicate is obstinately essentialist if applies to the same objects in all worlds, even in worlds where some or all of these object do not exist. If essentialist predicates are obstinately essentialist, and possibilist quantification is applied (i.e. the domain of quantification is the union of all world-bound domains), then the inference

(15) $\forall x(Ax \equiv Bx)$ is true; A, B are obstinately essentialist $\Rightarrow \ulcorner \Box(\forall x(Ax \equiv Bx)) \urcorner$ is true

is indeed valid. According to Gómez-Torrente (2006, 250f), we need obstinate names and predicates (and possibilist quantification) to explain the intuitive truth of sentences like:

(16) It might have been the case that Plato had been prevented from developing [...].

(17) It might have been the case that there had been men (human beings) who had been prevented from developing [...].

However, as far as our intuitions are concerned, (17) is simply false. It needs to be distinguished from

(17′) Some men (human beings) might have been prevented from developing.

(17″) It might have been the case that some actual men (human beings) had been prevented from developing [...].

which are intuitively true. But the truth of (17′) or (17″) does not require that there is any world where the predicate '...is a man' applies to an object to which '...is prevented from developing' also applies. It only requires that '...is a man' is applicable in the actual world to objects that have been developed into human beings but in some other worlds don't. Therefore, the intended parallel breaks down in this case, too.

ignate those non-natural kinds just as much as 'water' or 'tiger' would designate their natural ones (cf. Schwartz 1980; 2002; Soames 2002; 260ff). With López de Sa, we can call this the 'over-generalization problem' (2008*b*).

The only significant contrast that could plausibly be drawn by means of the notion of rigidly designating kinds is one between all such general terms and certain complex descriptive phrases. Examples for the latter would be the explicit stereotypes associated with 'water' and 'tiger': 'clear thirst quenching liquid flowing in rivers and from taps' and 'carnivorous cat-like animal with yellow and black stripes'. Other, much discussed examples include 'Mary's favorite color' (Marti 2004) and 'the color of the sky at noon' (Salmon 2005; Linsky 2006). All of these descriptive phrases arguably designate different properties in different possible worlds.[15] There seems to be growing consensus that this contrast suffices to shield rigid designation of kinds from utter triviality.[16] But even though the contrast drawn is an interesting one, abandoning 2) has an air of making a virtue out of a necessity. After all, Kripke does single out the natural kind terms, and he clearly thinks that their characteristic double structure of manifest stereotype and underlying physical property is of semantic significance. Even though the notion of rigid

[15]It has been argued that there is an even worse problem here than the over-generalization problem, the 'trivialization problem' (again following the terminology suggested by López de Sa (2008*b*). After all, even for descriptive phrases like 'Mary's favorite color', there *is* a property, albeit a somewhat 'unnatural' one, that that phrase could rigidly designate: The property of being Mary's favorite color. (This is a property that, let's say, has red things in its actual extension, but blue ones in some possible world w_1 and green ones in w_2.) So, the argument goes, what prevents 'Mary's favorite color' from rigidly designating that property? In other words, what prevents the notion of rigidly designating kinds from being utterly trivial? (For formulations of the problem and discussion, see a.o. Schwartz 2002, Marti 2004, Devitt 2005, Laporte 2006, Lopez De Sa 2007; Lopez De Sa 2008*a*.)

Whether descriptive phrases like 'Mary's favorite color' designate different properties across possible worlds, or not, is not a matter of metaphysical speculation, however. The mere existence of these properties does not mean that the semantics of 'Mary's favorite color' is indeterminate. There is a fact of the matter as to what we in fact do mean, and what it is can only be settled by linguistic data, for instance, by the intuitions competent speakers have towards natural language sentences where this would make a difference in truth value. Lopez De Sa 2008*a* suggests there are such data, and that they support the non-rigidity of the relevant descriptive phrases. See Schnieder 2005 for critical discussion.

[16]Marti 2004, 134ff, argues that the relevant contrast is that between directly-referential name-like *simple* terms, general or singular, and *complex* terms. All of the former are rigid *de jure*, while the latter can only be *de facto* rigid. Therefore, she claims, it is misguided to think of 2) as a desideratum at all. Even Soames has recently abandoned 2) and accepted the notion of rigid designation of kinds. He now argues that the difference between natural and non-natural kinds is an ontological one. Cf. Soames 2006; Soames 2008. See Marti and Martinez 2009 for a suggestion as to how to extend, without trivializing, the idea that general terms rigidly designate kinds even to their predicative uses.

designation of kinds does not satisfy desideratum 2) and, thus, cannot capture this semantic significance, to us at least it still seems very worthy of capture.

What about explaining the modal status of theoretical identifications, then? Take (1) again. It now has the form of a simple identity statement:

(1″) Water = H_2O.

Moreover,

(18) $\Box$ Water = H_2O,

would clearly seem to be true (where it has a truth-value) if (1″) is. The notion of rigidly designating kinds thus does account for the modal status of theoretical identifications. These are here construed as statements about property identity. The same pattern – necessary, if true – does of course also hold for sentences like the following:

(19) Water = Water.

(20) Bachelorhood = unmarried-manhood.

No distinction is drawn between these a priori, analytic necessities and the aposteriori (1). And again, even though that was not to be expected of a notion of rigidity anyway, it shows rigidity's limitations as a semantic explanans.

To summarize: Both rigid application and rigid designation of kinds are natural extensions of the notion of rigidity for singular terms. Rigid application, however, does not satisfy desiderata 2) and 3). Rigid designation of kinds satisfies 3), but fails 2).

Here is the conclusion Soames once drew from this discussion:

> [T]here is no reason to think that any notion of rigidity for [general terms] is capable of satisfying all of these demands. (...) Thus, we need to look to *other semantic properties of names that may be shared by natural kind [terms], and that may play an important role in explicat-*

> *ing the modal properties of sentences containing such predicates.* (...) Even in the case of proper names, it can be argued that their rigidity is the result of other, more fundamental, semantic properties that they possess. More specifically, the doctrine that names are rigid designators may be viewed as *a corollary of the more central thesis that they are nondescriptional*, together with an account of how their reference is fixed in the actual world.
>
> (Soames 2002, 263f, emph. ours.)

It seems clear that there is no notion of rigidity for general terms that satisfies the desiderata we considered. We tend to think that this is bad; it would be good to find semantic properties that actually do the work described by these desiderata. Settling for something like rigid designation of kinds is settling for second best. We might have to do that in the end, but only if there are no "other semantic properties of names that may be shared by natural kind [terms], and that may play an important role in explicating the modal properties of sentences containing such predicates" (ibid.). In what follows, we shall suggest that there are such properties.

As the quote just given shows, Soames himself thinks of the rigidity of proper names as a mere corollary of their non-descriptionality, and of non-descriptionality as one of the key factors underlying the analogies in the behavior of proper names and natural kind terms. It is here that we part company. In Glüer and Pagin 2006 and 2008, we have suggested what we call an 'evaluation switcher semantics' for proper names and modal operators. This semantics allows names to be descriptive while interacting with the modal operators in the intuitive way. In what follows, we shall apply the basic idea of the switcher semantics to general terms. Elaborating on a rather tentative suggestion in Glüer and Pagin 2007, we shall show that the extended switcher semantics can be used for explaining the behavior of natural kind terms without having to rely on either a notion of rigidity for general terms, or their alleged non-descriptionality. Moreover, such a semantics draws some rather interesting distinctions between a priori and a posteriori necessities, thus promising a full semantic explanation of the peculiar epistemic-cum-modal status of two-name identities and theoretical identifications.

3. Relational Modality and Proper Names or: Evaluation Switcher Semantics, Part I

In 'Proper names and relational modality' (2006), we suggested a semantics for proper names and modal operators that explains the behavior of proper names in modal contexts without assuming either their rigidity or their non-descriptionality. Before extending this semantics to general terms, we shall have to quickly recapitulate its basic ideas.

Recall the data used in Kripke's modal argument: Intuitively, there is a clear difference between sentences like the following:

(3) Aristotle might not have gone into pedagogy.

(4) The teacher of Alexander might not have gone into pedagogy.

(3) is true, while (4) (has one reading on which it) is false. We have argued that what data like these first and foremost show is that ordinary modal thinking is *de re*: In ordinary modal thinking, we are concerned with the objects we refer to, regardless of how they are designated, and we want to know what would be true of these very objects under varying possibilities. Consequently, there are two basic options for explaining the modal intuitions: by means of the semantics of proper names or by means of the semantics of modal expressions. The semantics that we have suggested makes use of both of them.

Its basic idea is to interpret modal expressions such that they treat simple singular terms differently from complex ones. More precisely, proper names occur *referentially* when in the scope of modal expressions. This is, so to speak, the 'special effect' modal operators have on simple singular terms.

To implement this idea in the semantic theory, we use two truth definition clauses. First, we define a second semantic evaluation function that we call 'actualist evaluation', and then we let this second evaluation kick in under the necessity operator.

In standard possible worlds semantic, atomic sentences are evaluated by means of

(P) $\quad \text{True}(P t_1, \ldots, t_n, \boldsymbol{w})$ iff $\langle \mathbf{I}(t_1, \boldsymbol{w}), \ldots, \mathbf{I}(t_n, \boldsymbol{w}) \rangle \in \mathbf{I}(P, \boldsymbol{w})$,

where **I** is an interpretation function assigning referents to terms and extensions to predicates in possible worlds. Evaluation by means of (P), we shall call 'possibilist evaluation'. Here, both terms and predicates are evaluated at the relevant possible world $\boldsymbol{w}$. In 'actualist evaluation', by contrast, we consider referents in the *actual* world $\boldsymbol{a}$ instead:

(A) $\quad \text{True}(P t_1, \ldots, t_n, \boldsymbol{w})$ iff $\langle \mathbf{I}(t_1, \boldsymbol{a}), \ldots, \mathbf{I}(t_n, \boldsymbol{a}) \rangle \in \mathbf{I}(P, \boldsymbol{w})$.

In other words, in actualist evaluation, we consider whether those objects that the relevant singular terms *actually* refer to belong to the predicate's extension at a possible world $\boldsymbol{w}$.

This simple idea needs to be made a little more complicated if we suppose that applied functional expressions, like '$g(u)$', where 'u' again is a singular term, simple or complex, are singular, and that definite descriptions, like 'the x such that Fx', or '$\imath xFx$', are singular too. In order to accommodate these terms with the desired result, (A) needs to be replaced by

(A+) $\quad \text{Actua-true}(P t_1, \ldots, t_n, \boldsymbol{w})$ iff $\langle \mathbf{V}(t_1, \boldsymbol{w}), \ldots, \mathbf{V}(t_n, \boldsymbol{w}) \rangle \in \mathbf{I}(P, \boldsymbol{w})$,

where the term evaluation function **V** is defined as follows:

(V)
$$\begin{aligned}
\mathbf{V}(t, \boldsymbol{w}) &= \mathbf{I}(t, \boldsymbol{a}), \text{ in case } t \text{ is simple,} \\
\mathbf{V}(g(u), \boldsymbol{w}) &= \mathbf{I}(g, \boldsymbol{w})(\mathbf{V}(u, \boldsymbol{w})), \\
\mathbf{V}(\imath xFx, \boldsymbol{w}) &= \text{the unique entity } b \text{ such that True}(Fx, \boldsymbol{w}) \text{ with } b \text{ assigned} \\
&\quad \text{to } x, \text{ and undefined if there is no such object,}
\end{aligned}$$

where $\mathbf{I}(g, \boldsymbol{w})$ is the function (in extension) assigned to g in $\boldsymbol{w}$.

By **V**, simple singular terms are evaluated with respect to the actual world while functional expressions and predicates within complex singular terms are evaluated with respect to the possible world in question.

The second relevant part of the truth definition is the clause that makes (A+) kick in under the necessity operator:

(M) True(⌜It is necessary that ϕ⌝, w) iff Actua-true(ϕ, w') at any world w' accessible from w.

This gives the desired result for our example pair; (3) is true, and (4) has a reading on which it is false.

Since it works with two different semantic evaluation functions, an evaluation switcher semantics assigns two intensions to every expression: A standard (or 'possibilist') possible worlds intension and what could be called an 'actualist intension'. We suggest to identify an expression's *linguistic meaning* with the ordered pair of these intensions. For simple singular terms, the actualist intension is different from the standard intension. From this perspective, the modal operator works as an 'evaluation switcher': it switches from evaluating an expression's standard intension to evaluating its actualist intension.

Let us now take a look at what happens with name identities and their modal and epistemic status if we adopt the suggested switcher semantics. Take

(2) Hesperus = Phosphorus.

If we assume that 'Hesperus' and 'Phosphorus' do not have the same standard intension, (2) is not necessary. However, its *necessitation*

(21) □ Hesperus = Phosphorus

is true, if (2) is true.[17]

This, we think is as it should be. That two-name identities themselves are not (in general) necessary, even if true, is not a bug in the switcher semantics, but a feature. As we have argued at some length elsewhere (cf. Glüer and Pagin 2006, subsection 4.3), there is a conceptual difference between *semantically* evaluating simple sentences like (2) at different possible worlds, and engaging in *de re* modal reasoning. In pure semantic evaluation, what we want to know is *which object* a

[17] This holds in the sense that if (2) is true, it is actua-true in all worlds where it does have an actua-truth value (and it has an actua-truth value in some worlds). For non-necessary existants (such as Hesperus), two-name identities will, however, have actua-truth value gaps at worlds where what the names refer to in the actual world does not exist.

term with a given actual meaning refers to under different possible circumstances, and (to the extent that that is a different question) which properties that object has. In *de re* modal reasoning, by contrast, we want to know what would be true of *an actually given object*, no matter how designated, under different circumstances. This difference is implemented in the switcher semantics by means of the evaluation switcher, i.e. the modal operator that switches from possibilist evaluation to actualist evaluation. On the switcher semantics, the place to look for the *de re* necessity of a two-name identity thus is precisely its necessitation. And, of course, the necessity of a sentence like (2), assuming its truth, is a paradigm case of *de re* necessity. Switcher semantics thus explains the modal status of two-name identities just as well as rigidity does.

Moreover, switcher semantics promises to do even more; it promises to explain not only the modal, but also the epistemic status of name identities. On our switcher semantics, name-identies are necessary only if the terms used in them *have the same meaning*, i.e. the same possibilist and, thus, the same actualist intension. Take the following one-name identity and its necessitation:

(5) Hesperus = Hesperus

(22) □ Hesperus = Hesperus

Here it holds that if (5) is true, then it also is necessary (up to reference failure). That is, (5) is true wherever it has a truth value. Moreover, if it is necessary, its necessitation (22) is true, too. And the same holds for pairs like the following:

(23) The brightest star in the evening sky = the brightest star in the evening sky

(24) □ The brightest star in the evening sky = the brightest star in the evening sky

In contrast to two-name identities, identities of these latter kinds intuitively are analytic, or conceptual, truths. Their necessity is not *de re*, but *de dicto*. And, if you like and think that is a useful notion, both their truth and their necessity can be

known *a priori*. Such necessities, it seems, will both be necessary themselves and have true necessitations. Merely metaphysical necessities like (2), on the other hand, seem to lack necessity themselves. Their merely *de re* necessity seems to wholly reside in the truth of their necessitations.

In other words, it looks as if the switcher semantics were creating a pattern marking the difference between two kinds of necessities: those that intuitively are analytic or conceptual, and those that are metaphysical, those that can be known a priori and those that cannot. Switcher semantics thus seems to provide more than merely a semantic explanation of the *de re* necessity of true two-name identities: We also seem to get a semantic account of their epistemic status. It thus promises a full explanation of the peculiar phenomena around name-identities, an explanation, that is, of both their epistemic and modal status.

The next question is whether switcher semantics can be extended to general terms in a way such that we get a similarly comprehensive account for the notorious behavior of natural kind terms. Before we go into the details, however, we should be clear about what we expect of a satisfactory extension of the switcher semantics to general terms. Finding the relevant analogues to our earlier desiderata on rigidity for general terms is a pretty straightforward matter:

The extension of relational modality to natural kind terms must

- 1′) be a natural extension of the suggested switcher semantics for modal operators and simple singular terms,
- 2′) apply to all natural kind terms, but not to other general terms, and
- 3′) play a role in explaining the modal status of theoretical identifications.

Providing this much would be sufficient for showing that, indeed, there are other semantic properties that can do precisely the job Kripke intended rigidity to do. There would thus be no need to settle for the notion of rigid reference to kinds, even though that clearly seems to be the best notion of rigidity for general terms available. If the switcher semantics on top of this also points to an explanation of the epistemic status of theoretical identification, and thus to a full semantic explanation of the phenomena of natural kind terms, this is an additional advantage it

has.

4. Relational modality and Kind Terms or: Evaluation Switcher Semantics, Part II

In this section and the next, we shall extend the switcher semantics from singular terms to general terms. General terms occur either as singular terms, i.e. in subject position, referring to kinds, as in

(25) Water has three states,

or as predicates, as in

(26) There is water in the bottle.

We shall accordingly distinguish between two types of singular terms: singular *object* terms (including proper names, individual constants etc.) and singular *kind* terms. In this section we shall extend the semantics from singular object terms to singular kind terms, and in the following to predicates as well.

We shall not appeal to the concept of a natural kind or a natural kind term in providing the semantics. Rather, we shall appeal to what we take to be the basic intensional feature of certain ordinary language expressions: they are associated both with a *manifest* and with an *underlying* property. We shall call this feature '*dual-property association*'. An expression is dual-property associated iff it is associated with two different properties, one of them manifest, the other underlying, *and* its modal profile is determined by the underlying property.

Basically, the manifest property is taken as a constant feature, associated with the intension, or standing meaning, of the expression, while the underlying property will vary between worlds and contexts. For each pair (***w, c***) of a world and a context as argument, the intension of t (if defined for (***w, c***)), gives as value that property which in (***w, c***) underlies the manifest property. The appeal to context is needed to accommodate the widely accepted intuitions elicited by so-called Twin Earth thought experiments. According to Putnam's original thought experiment, for instance, on Twin Earth the substance XYZ is the kind that underlies the man-

ifest property of being a stereotypical watery liquid. Since both Earth and Twin Earth exist in the same possible world, we need to appeal to context here to distinguish between them.

A kind term t will be taken to *refer* at a world-context pair to the underlying property. More precisely, the reference of t at a pair $(\boldsymbol{w}, \boldsymbol{c})$ is the property that underlies the manifest property at $(\boldsymbol{w}, \boldsymbol{c})$. The *intension* of a kind term is a function that takes possible worlds as arguments, and gives functions from contexts to kinds as values. On this understanding, according to the thought experiment, the intension of 'water' applied to the actual world is such that, when applied to the context of Twin Earth, the value is the XYZ kind.

For kind terms like 'water' there is, by most intuitions recorded in the literature, a difference between the manifest kind and the underlying kind or kinds in various worlds and contexts. The same does not seem to hold for some other kind terms, however. Scientific terms like 'hydrogen' are not associated with any manifest kind distinct from the underlying kind. Similarly, for terms like 'carpentry' or 'telephony', there also does not seem to be any difference between underlying and manifest kind; they are associated only with a manifest kind. Although there can be diverging intuitions in each particular case, in general we shall say that for a term that does not exhibit dual-property association, the term will be taken to refer to the only property it is associated with. 'Carpentry' refers to carpentry according to our ordinary ways of recognizing examples of carpentry by manifest features, and 'hydrogen' refers to hydrogen according to scientific theory. The intension of 'hydrogen' is a constant function that gives hydrogen as value for all worlds and contexts, or maybe for all worlds where hydrogen exists.[18] On this view, 'hydrogen' and 'carpentry' are rigid, while 'water', 'tiger' and 'gold' are not.

Which of these facts will be semantic, i.e. belong to the lexical meanings of kind terms in the language? It is reasonable to think that whether a term does, or does not, purport to denote a separate underlying kind is a fact about the use of the language it belongs to, and hence that the features of dual- or single-property association belong to the lexical meaning of kind terms. On the other hand, *which*

[18] See below, fn. 19.

underlying kind, if any, such a term denotes is hardly given in the semantics, but rather a feature contributed by the world. On this picture, it is part of the ordinary conception of water that 'water' denotes some underlying kind, i.e. that water has some underlying essence. But that this underlying kind is H_2O is at best discovered by science.

Given this conception of kind terms, the switcher semantics for singular terms in modal contexts can be applied to them almost straight-off. All we need to do is extend the syntax to include kind terms, and the domain of meanings to include kinds, in the clauses for (V). Since we shall assume that context of use matters to fix the referent (as in the Earth / Twin Earth case), we shall also add a context variable. This version of the notion of reference to kinds clearly is a minimal extension of the prior switcher semantics for singular terms and modal operators. Like simple object terms, simple kind terms are given an actualist as well as a possibilist intension. The clause (A++), analogously extended to cover kind terms, provides the semantics of kind terms in modal contexts:

(A++) Actua-true($Pt_1,\ldots,t_n,\boldsymbol{w},\boldsymbol{c}$) iff $\langle \mathbf{V}(t_1,\boldsymbol{w},\boldsymbol{c}),\ldots,\mathbf{V}(t_n,\boldsymbol{w},\boldsymbol{c})\rangle \in \mathbf{I}(P,\boldsymbol{w},\boldsymbol{c})$,

where the term evaluation function **V** is re-defined in accordance with (V′):

(V′) $\mathbf{V}(t,\boldsymbol{w},\boldsymbol{c}) = \mathbf{I}(t,\boldsymbol{a},\boldsymbol{c})$, in case t is simple,
$\mathbf{V}(g(u),\boldsymbol{w},\boldsymbol{c}) = \mathbf{I}(g,\boldsymbol{w},\boldsymbol{c})(\mathbf{V}(u,\boldsymbol{w},\boldsymbol{c}))$,
$\mathbf{V}(\iota xFx,\boldsymbol{w},\boldsymbol{c}) =$ the unique entity b such that True($Fx,\boldsymbol{w},\boldsymbol{c}$) with b assigned to x, and undefined if there is no such object,

where $\mathbf{I}(g,\boldsymbol{w},\boldsymbol{c})$ is the function (in extension) assigned to g in ($\boldsymbol{w},\boldsymbol{c}$).

Again, the second relevant part of the truth definition is the clause that makes (A++) kick in under the necessity operator:

(M′) True(⌜It is necessary that ϕ⌝, $\boldsymbol{w},\boldsymbol{c}$) iff Actua-true($\phi,\boldsymbol{w}',\boldsymbol{c}$) for any world $\boldsymbol{w}'$ accessible from $\boldsymbol{w}$.

Before we extend the switcher semantics to kind predicates, let us conclude this section by having a look at the consequences the semantics has for the status

of theoretical identifications involving kind terms. On this construal, these again have the form of identity statements. For instance, (1) has the form

(1″) Water = H_2O

We can treat 'H_2O' either as simple scientific kind term, or as a complex functional term or definite description (the substance such that each molecule consists of two hydrogen atoms and one oxygen atom); assuming that there is no manifest/underlying difference for the components 'H' and 'O', there will be none for the complex either. Then, on the assumption that 'water' and 'H_2O' do not have the same possibilist intension, (1″) is true, but not necessary: with respect to some worlds and contexts, 'water' denotes kinds different from H_2O. However, if (1″) is true, its necessitation is true, too, by (M′) and (A++).[19]

Thus, we see the pattern again that we suggest is distinctive of metaphysical necessity. It distinguishes necessities like (1″) from analytic necessities. Take the following example of an analytic identity statement involving two singular terms referring to kinds:

(27) Bachelorhood = unmarried-man-hood

(27) is necessary (if true). And if (27) is true, so is its necessitation, assuming that there is no manifest/underlying difference associated with these terms.

Let's assume that there are contingent analyticities, too.[20] For instance, let's assume that

[19]More precisely, (1″)'s necessitation is true at a world **w** iff (1″) is actua-true at any world **w'** accessible from **w**. And (1″) is actua-true at a world **w** iff the actual referent of 'water' and 'H_2O' exists in **w**.

We shall here assume a metaphysics of properties according to which properties, like mathematical entities, exist in all worlds. The existence of a property in a world does not then depend on whether the property is instantiated in that world. So if (1″) is true, so is its necessitation.

On an alternative metaphysics, where properties exist only if instantiated, there will be truth-value gaps with respect to worlds where e.g. H_2O does not exist. In that case the necessitation of (1″) is true wherever it has a truth-value, but it will lack truth-value in some worlds.

[20]Kripke himself does not think there are contingent analyticities (cf.Kripke 1972, 39; 56, fn. 21; 122, fn. 63), but other philosophers do, for instance Rabinowicz 2006. We don't commit, but would like to illustrate the power of switcher semantics for accounting for the full matrix of the orthogonal a priori – a posteriori and necessary – contingent distinctions.

(28) Water = the clear, thirst-quenching liquid flowing in rivers and from taps

is a contingent analyticity. In that case, we get the reversed pattern: If (28) is true, then it is necessary. But its necessitation

(29) □ Water = the clear, thirst-quenching liquid flowing in rivers and from taps

is false. Thus, it seems that on the extended switcher semantics, we not only get semantic explanations of the modal and epistemic status of theoretical identifications, which are necessary, if true. Rather, the switcher semantics induces differences that seem to correspond to the full matrix created by the intuitive, orthogonal distinctions between the necessary and the contingent, and the analytic or a priori and the a posteriori. The hypothesis about the switcher semantics at this point thus is the following. On the assumption that a sentence S is true, S's modal and epistemic status is determined by the following pattern:

S	necessary	necessitation
a priori necessary	yes	true
a posteriori necessary	no	true
a priori contingent	yes	false
a posteriori contingent	no	false

Let's call this pattern the 'NN-pattern'.

5. Relational modality and Kind Predicates or: Evaluation Switcher Semantics, Part III

Extending the framework to cover the semantics of kind predicates is more complicated. Since the extension of a predicate is always a set of entities, objects or n-tuples of objects, we cannot treat the underlying property associated with a kind predicate F at a world-context pair as its *extension* at that pair. Concerning the extension of a predicate with dual-property association, the crucial question in each case rather is the following: It must be the extension of one of the two properties associated with F, the manifest property or the underlying property, but *which*?

Instead of letting one of the properties act as intension and one as extension, as in the singular terms case, we must in the case of predicates associate each of the properties with a distinct *intension*. Hence, predicates will have a *two-layered* intension structure. We shall in general distinguish between $\mathbf{I}_m(F)$, the *m-intension* of a predicate F, and $\mathbf{I}_u(F)$, its *u-intension*. All predicates will be assigned both an m-intension and a u-intension.

As in the case of terms, some predicates will have identical manifest and underlying properties, and hence the m- and u-intensions will be identical. This will be the case with scientific predicates and artifact predicates. But natural language natural kind predicates like '…is water', '…is (of) gold' will have different m- and u-intensions. Again, we take it to be facts about the use of dual-property kind predicates in English *what* the m-intension is and *that* the u-intension is different, but not *what* the u-intension is. That is determined by the world.[21]

Implementing these ideas in the possible worlds framework again is a natural extension of the switcher semantics for singular (object and kind) terms. The common idea throughout is that in modal contexts, the underlying property is what matters. Thus, the m-intension of a predicate F will be relevant at a world-context pair ($\boldsymbol{w}$, $\boldsymbol{c}$) in just those cases (linguistic contexts) where for a singular term t the referent at ($\boldsymbol{w}$, $\boldsymbol{c}$) is relevant. And the u-intension will be relevant at ($\boldsymbol{w}$, $\boldsymbol{c}$) just in

[21] The appeal to two different intensions is a feature that is shared between our approach and two-dimensionalism. Cf. esp. Jackson 1998; Chalmers 2006. Since we don't use pairs of worlds for evaluation, our theory is not, however, two-dimensionalist.

As far as we are aware, a two-dimensionalist account of predicates has not been worked out. Nor does it seem that one can be derived from the present account in any obvious way. The natural hypothesis would be that the m-intension is really the primary intension in David Chalmer's terminology, while the u-intension is the secondary intension. As usual, we have an original two-dimensional intension $\mathbf{I}^2(\boldsymbol{w}, \boldsymbol{w}')$, such that the primary intension is $\lambda \boldsymbol{w}(\mathbf{I}^2(\boldsymbol{w}, \boldsymbol{w}))$ (the diagonal), and the secondary intension at a world $\boldsymbol{w}$ is $\lambda \boldsymbol{w}'(\mathbf{I}^2(\boldsymbol{w}, \boldsymbol{w}'))$.

But it is not easy to see now how the two-dimensionalist way of relating the primary and the secondary intension can be combined with the relation between the m- and u-intensions. One problem is the following. In the two-dimensionalist framework, the extension of the secondary intension of a predicate F in a world $\boldsymbol{w}$, as *determined* in $\boldsymbol{w}$, is the same as the extension of the primary intension of F in $\boldsymbol{w}$. This means that the secondary intension as determined in $\boldsymbol{w}$ must be defined for $\boldsymbol{w}$. But the secondary intension was supposed to be equal to the u-intension, and there is no guarantee for any world $\boldsymbol{w}$ that the u-intension of F is defined for $\boldsymbol{w}$, unless F is *not* a dual-property predicate. Hence, trying to combine the manifest-underlying relation with the standard primary intension-secondary intension relation simply eliminates the dual-property association that we are trying to account for.

For further comparison of our switcher semantics and two-dimensional semantics for singular object terms, see Glüer and Pagin 2006.

those cases (modal contexts) where for the term the referent at (***a***, ***c***), the actual world context, is relevant.

The extension at a world-context pair (***w***, ***c***) corresponding to m-intension [u-intension] is the set of objects (or in general n-tuples of objects) that have the property in (***w***, ***c***) that is associated with the m-intension [u-intension] in (***w***, ***c***). Since we need to define intensions for whole sentences, we also have to define m-intension and u-intension for singular terms, but only in the trivial way that the m-intension is always the same as the u-intension, which is the same as the standard intension for the term. For terms we shall therefore simply write ***I***.

Implementing these ideas results in the following clauses:

(P*) True($P t_1, \ldots, t_n, \boldsymbol{w}, \boldsymbol{c}$) iff $\langle \mathbf{I}(t_1, \boldsymbol{w}, \boldsymbol{c}), ..., \mathbf{I}(t_n, \boldsymbol{w}, \boldsymbol{c})\rangle \in \mathbf{I}_m(P, \boldsymbol{w}, \boldsymbol{c})$,

(A*) Actua-true($P t_1, \ldots, t_n, \boldsymbol{w}, \boldsymbol{c}$) iff $\langle \mathbf{V}(t_1, \boldsymbol{w}, \boldsymbol{c}), ..., \mathbf{V}(t_n, \boldsymbol{w}, \boldsymbol{c})\rangle \in \mathbf{I}_u(P, \boldsymbol{w}, \boldsymbol{c})$,

where the term evaluation function **V** is defined as before:

(V*) $\mathbf{V}(t, \boldsymbol{w}, \boldsymbol{c}) = \mathbf{I}(t, \boldsymbol{a}, \boldsymbol{c})$, in case t is simple,
$\mathbf{V}(g(u), \boldsymbol{w}, \boldsymbol{c}) = \mathbf{I}(g, \boldsymbol{w}, \boldsymbol{c})(\mathbf{V}(u, \boldsymbol{w}, \boldsymbol{c}))$,
$\mathbf{V}(\iota x F x, \boldsymbol{w}, \boldsymbol{c}) =$ the unique entity b such that True($Fx, \boldsymbol{w}, \boldsymbol{c}$) with b assigned to x, and undefined if there is no such object,

where $\mathbf{I}(g, \boldsymbol{w}, \boldsymbol{c})$ is the function (in extension) assigned to g in (***w***, ***c***).

Again, we use (M*) for the necessity operator:

(M*) True($\ulcorner$It is necessary that $\phi\urcorner, \boldsymbol{w}, \boldsymbol{c}$) iff Actua-true($\phi, \boldsymbol{w}', \boldsymbol{c}$), for any world $\boldsymbol{w}'$ accessible from ***w***.

This is to be completed with clauses for the sentential connectives and the quantifiers in the usual way (cf. Glüer and Pagin 2008 for a fully worked out semantics for singular (object) terms.) That completes the extension of switcher semantics to general terms.[22]

[22]This semantics, properly completed, has the form of a truth definition. It is straightforward to give it instead as an explicit semantics, i.e. with a semantic function μ mapping disambiguated expressions, worlds, contexts, and assignment functions on truth values in $\{0, 1\}$. By abstracting over

Before embarking on discussing the more philosophical issues around the extended switcher semantics and its promise to explain the behavior of natural kind terms in the next section, we shall end this one by drawing out some of the features and consequences of the semantics. Let us start by looking at theoretical (and other) identifications again. Take (1) and assume, in analogy with the singular kind term case, that the u-intension for 'water' is the same as the m-intension (and the u-intension) for 'H_2O'. With the general terms construed as predicates, (1) has the form

(1′) $\forall x\,(\text{water}(x) \leftrightarrow \text{H}_2\text{O}(x))$

Again, the by now familiar typical NN-pattern emerges. (1′) is simply true, for by (P*) (and the usual clauses for the quantifier and the biconditional), it is true at (***a***, ***c***) just in case the extensions of the m-intension of 'water' at (***a***, ***c***) coincides

these arguments (or some of them), we get meanings: $\lambda \boldsymbol{w}\lambda \boldsymbol{c}\lambda f(\mu(e, \boldsymbol{w}, \boldsymbol{c}, f))$. In an explicit switcher semantics, the shifting potential of the necessity operator will be realized by shifting to a new semantic function μ_a that applies in modal contexts and corresponds to actua-truth. This is specified by

(EM) $\mu(\Box p, \boldsymbol{w}, \boldsymbol{c}, f) = 1$ iff it holds for all $\boldsymbol{w}'$ accessible from $\boldsymbol{w}$ that $\mu_a(p, \boldsymbol{w}', \boldsymbol{c}, f) = 1$.

Clearly, this semantics is not compositional with respect to *intension* (m-intension, u-intension). A simple term and a definite description or functional expression may have the same intension but not be intersubstitutable in modal contexts. Two predicates can have the same m-intension and not be intersubstitutable in modal contexts, or the same u-intension and not be intersubstitutable in non-modal contexts. There is, however, a straightforward generalization of compositionality, call it "compositionality*" that preserves the essential properties of standard compositionality and subsumes the proposed semantics. Call a semantic function μ *initial* in a set S of semantic functions for a language L iff μ applies to all *unembedded* occurrences of grammatical terms (disambiguated expressions) for L. Then

(PC*) A semantic function μ_1 for a language L is *compositional** iff μ_1 is intitial in a finite set $S = \{\mu_1, \ldots, \mu_k\}$ of semantic functions such that for each pair $\langle \mu_i, \sigma_j \rangle$ in $S \times \Sigma_L$ there is a meaning composition function ρ_{ij} and members $\mu_{d_1}, \ldots, \mu_{d_n} \in S$ such that for all terms $t_1, \ldots, t_n$ for which σ_j is defined,

$$\mu_i(\sigma_j(t_1, \ldots, t_n)) = \rho_{ij}(\mu_{d_1}(t_1), \ldots, \mu_{d_n}(t_n))$$

provided μ_i is defined for $\sigma_j(t_1, \ldots, t_n)$. Here Σ_L is the set of syntactic operations for constructing complex grammatical terms (disambiguated expressions) out of simpler terms.

Instead of a simple recursion over syntax, we have simultaneous recursion over syntax in the definition of all semantic functions in the set S. Standard compositionality is the special case where the S contains exactly one member, the initial and only semantic function. The proposed switcher semantics is compositional*. Cf. Pagin 2008.

with the extension of the m-intension of 'H_2O' at (***a***, ***c***), and by assumption it does (with Earth as context). (1′) is not necessary, however, for by common intuitions there are worlds where thirst-quenching (etc.) liquids are other than 'H_2O'. But if (1′) is true, its necessitation

(10) $\Box \forall x$ (water(x) $\leftrightarrow$ $H_2O(x)$)

is true, too. This is so since (10) is true just in case (1′) is actua-true at (***w***, ***c***), for any world ***w*** accessible from ***a***, and this holds just in case the extension of the u-intension of 'water' at (***w***, ***c***) is the same as the extension of the u-intension of 'H_2O' at (***w***, ***c***). This follows immediately, since we have assumed that u-intensions are the same. By hypothesis, the pattern indicates that (1′) is a metaphysical, a posteriori necessity.

By contrast,

(27′) $\forall x$ (bachelor(x) $\leftrightarrow$ unmarried(x) & man(x)),

an analytic necessity, is necessary. And its necessitation is true, too. Again, let's assume that there are contingent analyticities, and that

(28′) $\forall x$ (water(x) $\leftrightarrow$ clear(x) & thirst-quenching(x) & liquid(x) & flowing in rivers and from taps(x)),

is one. The prediction is born out here, too: (28′) is necessary, since the m-intensions of the left-hand side and the complex right-hand side predicates coincide, but its necessitation is false, for the respective u-intensions of the two predicates diverge. So we have the same pattern as in the singular terms case.

We would like to conclude our presentation of the switcher semantics with a few remarks on the relation between kind terms and kind predicates. In the course of these, we shall also find that the interpretation of the NN-pattern allows for some necessary further sharpening. Some kind terms and predicates show dual-property association, and we naturally assume that whenever a kind term is dual-

property associated, so is the corresponding predicate.[23] Nevertheless, the semantic machinery of dual-property association is importantly different for kind terms and kind predicates: As observed above, for kind terms, manifest and underlying property play the role of intension and extension, while kind predicates have pairs of m-intensions and u-intensions as their linguistic meanings. In the following examples, we shall assume that 'water' does show dual-property association, and use 'Water' for the kind term and 'water' for the predicate.

One consequence of the different mechanics of dual-property association is that kind terms *fail to refer* with respect to world-context pairs where the manifest property does not determine any underlying property as the kind the term refers to.[24] Since the truth predicate is not defined for such arguments, the semantic evaluation function **I** will be only partial for kind terms with dual-property association (that fail to refer in any world-context pairs). Consequently, simple, non-modal sentences containing such kind terms, i.e. sentences of the form

(30) Fg,

where 'g' is a kind term, for instance

(31) Water is instantiated,

will have a truth value at those world-context pairs where the term refers ((31) itself will of course be true at any world-context pair where 'Water' refers). But they will not have one at those world-context pairs where 'Water' fails to refer.

For kind predicates with dual-property association, on the other hand, it holds that a sentence of the form

(32) $G(u)$,

predicating the property of an object, will be true or false at any world-context pair

[23] Equally naturally, we assume that in this case both term and predicate are associated with the same manifest and underlying properties.

[24] This is what should be expected if a term is used to 'get at', i.e. *refer to*, an (epistemically inaccessible) underlying kind by means of its presumed instances' (accessible) manifest qualities. For more on kind terms and reference failure, see below, section 6.

(***w***, ***c***). This holds even in cases where the u-intension is undefined, for whether it is true or false only depends on whether the object belongs to the extension of the *m*-intension at (***w***, ***c***). In non-modal contexts the intension for the predicate therefore is totally defined, while for the kind term, as we just saw, it is only partially defined in such contexts.[25]

Putting these two observations together, we see that a sentence like

(33) $\forall x$ (x is water iff x instantiates Water),

will not be false at any world-context pair (***w***, ***c***). This is so since by (P*), the extension relevant for truth at (***w***, ***c***) of the predicate '...is water' is the extension of its m-intension, and the extension of the referent of the kind term 'Water' at (***w***, ***c***) is the extension of the underlying property, which is the same at (***w***, ***c***) as the extension of the manifest property, i.e. the extension of the m-intension, at (***w***, ***c***). (33) therefore is true at all world-context pairs at which there *is* an underlying property determined. The corresponding general schema

(34) $\forall x$ (x is G iff x instantiates g),

with 'G' as predicate and 'g' as the corresponding term, thus does not have any false instances.[26]

We get an analogous result for necessitation. The sentence

(35) $\Box\forall x$ (x is water iff x instantiates Water),

is true. This is so by (A*) since an object o belongs to the extension of the u-intension of 'water' at a world-pair (***w***, ***c***) iff o belongs to the extension of H_2O in (***w***, ***c***), which holds iff o instantiates H_2O in (***w***, ***c***), which in turn holds just in case o instantiates $\mathbf{V}$('Water', ***w***, ***c***), which by assumption is H_2O (assuming Earth

[25]The u-intension of a dual-property associated kind predicate is undefined in precisely those cases in which the corresponding kind terms fails to refer *in the actual world (and relevant context)*: It is undefined, if in the relevant context of the actual world there is no underlying property determined by the manifest property. In such cases, neither the kind term, nor the kind predicate has an intension that is defined in modal contexts.

[26]But, of course, for those term-predicate and world-context pairs where the kind term fails to refer, there is a truth-value gap.

as context). The general schema

(36) $\Box\forall x$ (x is G iff x instantiates g),

does not have any false instances.[27]

Does this mean, as the NN-pattern would seem to indicate, that sentences of form (34) are analytic necessities and can be known a priori? Not quite; it is here, that the pattern allows for further sharpening. For there is an important difference between sentences of form (34) and 'real' analytic necessities such as (27′). We already hinted at this difference above when observing that one-name identities like (5) were analytic or a priori only in a certain sense (p. 6):[28] Just like such one-name identities (i.e. identities where what is named is not a necessary existant), sentences of form (34) are not true at every world-context pair; rather, they are such that they are true wherever they have a truth-value. Whether their necessitation is true depends on whether the name or kind term refers in the actual world (and relevant context). If it does, the necessitation is true, if not, there is a truth-value gap.

This, we suggest to take to be a specific pattern of its own. Sentences falling under it are not strictly speaking necessities. Nor is it desirable to classify them as sentences the truth of which can be known a priori: These sentences are such that we cannot know a priori whether they are (fully) interpreted.[29] This is not to

[27] But again the truth-predicate is undefined in those instances where the kind term fails to refer in the actual world and relevant current context.

[28] Cf. p. 22 on their necessity according to switcher semantics.

[29] There is, of course, a parallel here with discussions familiar from the debates surrounding certain *reductio* arguments leveled at Putnam/Burge-style content externalism (cf. for instance McKinsey 1991; Boghossian 1997). Such content externalism has been charged with the absurd consequence of making it knowable a priori that there is water in the environment. Against this, it has been argued that externalism does not have this consequence for the very reason that we cannot know a priori whether 'water' is in fact a term that refers (to a natural kind) (cf., for instance, McLaughlin and Tye 1998).

Note, however, that the parallel is not very close. On our semantics, the interpretation function **I** is partial for kind terms with dual-property association iff there are world-context pairs in which there is no underlying kind. Since there are bound to be such pairs (the instantiating relation being contingent), **I** is partial for each and every such kind term. This does not depend on whether the kind term in question actually refers or not. Moreover, even for those cases where the kind term actually fails to refer, there is no danger of it's losing all meaning or content; since kind terms on our semantics (can) have descriptive (manifest) intensions, it only lacks an extension, not an intension. There is consequently no threat to self-knowledge here comparable to that facing mainstream

say that there is nothing in the vicinity here that can be known a priori. Intuitively, given the kind of term 'Water' is, we can know a priori that wherever there is an underlying water-kind, anything that is water will belong to that kind.

Thus, we suggest that this specific pattern indicates sentences where it cannot be known a priori whether they are fully interpreted, while it can be known a priori that they are true wherever they are fully interpreted. Given the switcher semantics, this is precisely what can be known a priori on the basis of the meanings of these terms. According to the switcher semantics, it is not part of the meaning of the kind term 'Water', for instance, that its intension determines a referent. What is part of its meaning, and thus knowable a priori, is only that the kind term refers to an underlying property, if any such property is determined by its intension in cooperation with world and context.[30] This, we take it, is in accord with intuition: If there are kind terms and predicates that show dual-property association in a natural language, and in particular, if there are kind terms that are used to "get at", or refer to, underlying essences by means of manifest properties, this is precisely how they behave. The next question, then, is whether there are such terms and predicates in natural language, and if so, which they are.

6. Apriority, Analyticity, and Natural Kind Terms

The considerations at the end of the last section have led us back to the concerns and requirements we started from: We set out to extend the relational semantics in order to accommodate those semantic properties that explain the name-like behavior of natural kind terms and predicates. It is now time to get back to these concerns.

In the last two sections, we have been elaborating on the semantics of dual-property association. So far, we have done this in complete abstraction from the question whether there are any natural language expressions with dual-property association. But of course we have argued earlier (see above, section 2) that dual-

externalism. For more on reference failure, see below, section 6.

[30] Again, this is precisely what should be expected if a term is used to 'get at', i.e. *refer to*, an (epistemically inaccessible) underlying kind by means of its presumed instances' (accessible) manifest qualities.

property association is precisely the feature uniting the prima facie rather disparate collection of examples that Kripke originally used in his observations about natural kind terms. Consequently, our claim now is that natural language natural kind terms and predicates do show dual-property association. They are, that is, associated with stereotypical manifest qualities which ordinary speakers take their instances to satisfy. However, they also take these manifest qualities as indicative of, and often as explained by, the underlying nature of the kind these objects are instances of.[31] Therefore, it is the underlying essence, the underlying property or kind, not the manifest one, that determines the modal profile of these expressions. This, we claim, is very well captured by the switcher semantics of dual-property association we have suggested.

The claim thus is: Switcher-style dual-property association is the wanted semantic property that does for natural kind terms what the notion of rigidity failed to do. Switcher-style dual-property association is the semantic property explaining the peculiar, name-like behavior of natural kind terms and expressions. To fully substantiate this claim, we shall go back to the three requirements on the wanted semantic property set up above (p. 23): First, the extension of relational modality to natural kind terms must be a natural extension of the switcher semantics for modal operators and simple singular terms, we said. This it clearly is: The basic idea of switcher semantics is the idea that intensional operators are evaluation switchers. In particular, modal operators effect a switch from standard, or possibilist, evaluation to actualist evaluation. What proper names and dual-property associated kind terms and predicates all have in common is that this switch makes a difference to how they are evaluated at other possible worlds. At this level of description, the semantic feature these expressions share is having different actualist and possibilist intensions. As should be clear from the preceding sections, the similarity runs much deeper, however; these expressions all have different actualist intensions, because the actual world plays a specific "actualist" role in their evaluation when in the scope of modal operators.

[31] This is *not* to say that these objects essentially are of the kind they are instances of. It is to say, rather, that whether an object is an instance of the kind in question depends on the kind's essence, on what is essential for being of that kind – a rather harmless and obvious claim. What is special to natural kinds, is simply that the essence 'resides' in the underlying property, not the manifest one.

Secondly, the relevant feature of the semantics must apply to all natural kind terms, but not to other general terms, and it must play a role in explaining the modal status of theoretical identifications. In the last two sections, we have already shown that, if certain assumptions are made, switcher-style dual-property association assigns to theoretical identifications the same NN-pattern as it assigns to two-name identities such as

(2) Hesperus = Phosphorus.

Such sentences, if true, are not necessary, but their necessitations are true. For instance, on the assumption that 'Water' is a dual-property associated kind term, and that 'H_2O' is not, the truth of

(18) $\Box$ Water = H_2O

is explained by the switcher semantics. As in the case of proper names, we think that this is as it should be; that necessity and truth of necessitation can come apart indicates precisely the *de re* nature of the modal truths and the modal reasoning we are concerned with here.[32] That is, for a kind term that is dual-property associated, truth of necessitation is exactly where *de re* necessity is to be found. In *de re* modal reasoning about kinds, we are interested in the designated kind, no matter how it is designated. And we want to know what is true of that actually given kind under different circumstances. If we designate the kind by means of a manifest intension, however, the purely semantic question what underlying kind is determined by this intension in different circumstances also makes sense. Moreover, since the relation between manifest intension and underlying extension is contingent, the extension will vary across worlds.[33]

[32]Thanks to an anonymous referee for prompting the clarifications provided in this and the following two paragraphs.

[33]To the extent that speakers have direct intuitions regarding the truth values of simple, non-modal sentences at different possible worlds, and these intuitions support the necessity of two-name identities such as (2) and theoretical identifications such as (18), these intuitions need to be given a pragmatic explanation: They are due to the *de re* nature of the modal reasoning the speakers are engaging in. In effect, that is, the speakers are evaluating the actualist intension of the relevant terms. (For more on this with respect to proper names, cf. Glüer and Pagin 2006, 4.3.) Even in the case of proper names, moreover, there are of course speakers whose modal intuitions provide

When it comes to dual-property associated predicates, an analogous distinction can be drawn: When we evaluate such a predicate in different circumstances, are we interested in its instances as instances of the manifest property or as instances of the underlying property? On switcher semantics, it is part of the "lexicon" what the manifest property associated with a dual-property associated predicate is, but not what the underlying property is. That is determined by the manifest property in cooperation with the world. Reasoning about what would be true of instances of the underlying kind therefore is very similar to *de re* modal reasoning in the following sense: It is reasoning about what would be true of instances of the underlying property, no matter what descriptive semantic material determines that property.

Both when it comes to two-name identities such as (2) and to theoretical identifications the place to locate their (*de re*) necessity thus is their necessitation. Switcher style dual-property association therefore does explain the modal status of theoretical identifications, at least if certain assumptions – such as the assumption that 'Water' and 'water' are dual-property associated, while H_2O is not – are fulfilled. To complete our case, we have to argue that these assumptions are in fact fulfilled, and that they generalize in the right way. In other words, we have to argue, and do in fact want to claim, that it is *precisely* the ordinary natural kind terms and predicates that are dual-property associated.

That it is precisely the ordinary natural kind terms and predicates that are dual-property associated seems extremely plausible to us. In particular, it seems extremely plausible that ordinary natural kind terms are, in this respect, different from both scientific natural kind terms like 'H_2O' or '*felis tigris*', and explicit stereotypical natural kind descriptions like 'transparent, thirst-quenching liquid flowing in rivers and from taps' or 'carnivorous, cat-like animal with yellow and black stripes': Neither of these are dual-property associated. Intuitively, scien-

evidence for there being a (*de dicto* or epistemic) sense of 'it might have been the case' in which Hesperus, for instance, might not have been Phosphorus. In this (*de dicto* or epistemic) sense, (2) would not be necessary. Intuitions regarding *de dicto* or epistemic modality thus would seem to provide some evidence for the possibility, predicted by switcher semantics, of pure semantic evaluation: evaluation of the possibilist intension. As far as we can tell, this evidence only gets stronger when it comes to natural kind terms; there seem to be quite a number of speakers willing to say that there is a (*de dicto* or epistemic) sense of 'might' in which water might not have been H_2O.

tific natural kind terms or predicates are associated only with underlying properties or kinds, while explicit stereotypes are associated only with manifest qualities. Switcher semantics neatly captures this difference: As predicates, scientific natural kind terms/predicates and explicit stereotypes are construed as having identical m- and u-intensions. Both as kind terms and as predicates, they consequently have identical actualist and possibilist intensions. Thus, they do not exhibit any differential behavior with respect to modal operators. This is reserved for the natural language natural kind terms and predicates.

Analogously for the usual test cases of non-natural kind terms or predicates like 'pencil', 'bachelor', and 'hunter'. Intuitively, none of these are associated with manifest-underlying property pairs. On the switcher semantics, they consequently receive identical m- and u-intensions, when predicates, and identical actualist and possibilist intensions in general.

What we see here is that, on the switcher semantics, the difference between dual-property associated kind terms and predicates and other kind terms and predicates is a *purely semantic* one. It is not underwritten or "anchored" by any specific syntactic feature, in particular, it is not "anchored" by the syntactic simplicity of the relevant kind terms and predicates.[34]

The purely semantic nature of the phenomenon of dual-property association needs to be kept in mind when we now consider two further sets of examples: certain artifact terms or predicates such as 'computer', 'telephone', or 'radio', and those among Kripke's examples that have created difficulties for the notion of rigid application: expressions like 'hot', 'loud', and 'red'. Let's start with artifact expressions like 'computer'.[35] It is fairly clear that such expressions are in fact related to two properties, one of which is an underlying property in our sense. It is less clear, however, that the second property is a manifest property in our sense. In the appli-

[34]This is the main difference between the original switcher semantics for names and modal operators and the extended version: In the original semantics, it was the syntactic category of simple singular (object) terms that interacted in a special way with modal operators. We think that giving up this syntactic anchoring of the special semantic feature explaining the behavior of both names and natural kind terms is obviously mandated by the syntactic diversity of Kripke's original examples themselves. No-one aiming to capture what is semantically special to these examples can plausibly offer any syntactic anchor for it.

[35]Thanks to an anonymous referee for prompting consideration of these examples.

cation of expressions like these, it seems to us, functional properties are far more important than sensible ones. Moreover, the main question here is whether the relation of these expressions to the relevant manifest and underlying properties is one of *semantic* dual-property association. This depends on the modal profile: Is it the case that the modal profile of an expression like 'computer' is governed by the underlying property? We don't think so; even though there is no agreement on which particular machine was the first computer, there is vast agreement that the first computers were purely mechanical devices.[36] Their underlying properties were radically different from those of today's machines. Similarly, the physical implementation of tele- or radio-communication has undergone significant changes in the course of its history. These actual changes in technology are sufficient, it seems to us, to support the claim that computer, telephone, and radio are functional kinds, not natural ones.[37] The modal profile of the corresponding expressions is governed by the functional property, not the underlying one. Semantically, that is, these expressions are *not* dual-property associated. They are associated with only one property: the functional one.

When it comes to expressions like 'hot', 'loud', and 'red', these are in fact clearly related to two different (kinds of) properties, manifest qualities and underlying physical realization.[38] The question nevertheless is whether this does, or does not, amount to *semantic* dual-property association. To illustrate the problem, consider an expression like 'pain'. Sensation terms like this one also are in fact related to different manifest and underlying properties, but most people, Kripke included, do not count them among the natural kind terms. Why not? In *Naming and Necessity*, Kripke uses C-fiber stimulation as the physical property underlying, or realizing, pain. And he famously argues that it is possible that pain is not C-fiber stimulation (cf. Kripke 1972, 144ff, esp. 151f). Kripke concludes that even though 'pain' is a rigid designator, it does not belong with 'water', 'tiger', 'gold', and the rest of

[36] A good candidate might be the "analytical engine", a fully programmable mechanical calculation device designed by Charles Babbage in 1837, but never built.

[37] Here, we agree with Devitt and many others; cf. Devitt 2005, 154ff.

[38] In the case of the colors, it is not so clear, however, that there is anything like a single physical property underlying the manifest; rather, given multiple realization, such a "property" might be highly disjunctive.

his examples. What makes the difference is the modal profile; according to Kripke, 'pain' is not a natural kind term precisely because its modal profile is governed by the manifest quality, *not* the underlying physical realization. Sensations are manifest kinds, not natural ones. In our terms: If Kripke is right about pain, 'pain', and other sensation terms, are not dual-property associated. *Semantically*, they are associated with only one property: the manifest one.

What about heat, loudness, and color? Kripke, for one, counts them in with the natural kinds. He does so precisely because he takes their essence to be a natural, *not* a manifest one. According to him, the modal profile of the expressions for these concepts thus is governed by the underlying, physical property. This is, of course, debatable. Intuition might tend towards the natural in the case of heat and maybe even in the case of loudness, but we are not at all sure about color. Philosophers have debated the nature of the colors and other so-called secondary qualities throughout the ages, and at least since Locke they seem forever divided between objectivist, usually physicalist, and more subjectivist positions. In the last analysis, the question here is precisely whether for instance the colors have a manifest, or a natural, underlying nature. We are not going to take a stand on these matters. What matters here is *not* what the right analysis of the concept of color, or heat, or loudness, is. What matters is *what determines whether a concept is a natural kind concept*. Similarly, it does not matter whether Kripke is right about the particular examples he considers. It does not matter whether he is right in claiming that 'red' is a natural kind term, and 'pain' is not. For all we care, the opposite might be true. What he is right about, we claim, is what determines whether these expressions are natural kind terms or predicates: This is a question of "who is master" over the modal profile – the manifest, or the underlying, physical property. In our terms: It is precisely the question whether a kind term or predicate is dual-property associated or not.

And as we stressed a moment ago, this is a purely semantic question. It depends, among other things, on ordinary speakers' intuitions regarding the truth value of modal statements involving the expressions in question. The mere semantic machinery of switcher-style dual-property association does not determine

which expressions of a natural language are dual-property associated. That is an empirical matter. There might be natural languages that do not contain dual-property associated expressions at all, and for any given language, a number of cases might be debatable, and it also might vary from speaker to speaker, or even be ultimately indeterminate, whether certain expressions are dual-property associated or not.[39] In any case, our claim is that determining which kind terms and predicates are dual-property associated amounts to determining which kind terms and predicates are *natural* kind terms and predicates. If there are any in a natural language, switcher-style dual-property association stands ready to accurately and specifically capture the peculiar semantic nature of these terms.

We conclude that whether natural kind terms are predicates or singular terms, switcher semantics can very naturally be extended to natural kind terms in a way satisfying all the desiderata on such an extension. Since there is no notion of rigidity for general terms that does equally well in this respect, we conclude that the semantic properties explaining the name-like behavior of natural kind terms are not properties of rigid designation, but properties of switcher-style dual-property association. Moreover, as we saw in the previous two sections, there is quite some evidence for the hypothesis that the extended switcher semantics provides the full matrix of semantic distinctions along the orthogonal a priori – a posteriori and necessary – contingent axes. Thus, there is good reason to expect switcher semantics to provide a full semantic explanation of the modal and epistemic phenomena involving proper names and natural kind terms. Such an explanation is, by its very nature, not to be expected from the notion of rigidity (alone).

We would like to round off our considerations with a few remarks on two aspects of the present proposal that we have so far only touched upon. The first of these concerns the relation between the two properties, the manifest and the underlying, as conceived of in switcher-style dual-property association. The idea here is that, in each case, the manifest property is fully determined by the linguistic use of the relevant expression. If you like, it is part of the "lexicon" of the language

[39] Given the state of our intuitions with respect to color, color terms might be a case in point. Here, *pace* Kripke, our intuitions might very well be such that they do not clearly determine the nature of the kind we have in mind when speaking about the colors.

in question. Not so for the underlying property; this we take to be determined by the manifest property in conjunction with the way the (nearby) world is. If *semantic externalism* with respect to a kind of linguistic expression is the claim that the linguistic meaning of expressions of this kind is partly determined by the way the "external" world is, we are thus committed to a (rather non-standard) form of semantic externalism: For switcher semantics, linguistic meaning consists of pairs of possibilist and actualist intensions. If by the "external" world, we mean the *actual* external world (and relevant context), switcher semantics for dual-property associated kind terms and predicates is externalist in the sense that their actualist intensions are *defined only if* there in fact is an underlying kind determined by the relevant manifest property in cooperation with the world (and context).

Just as with other, more mainstream forms of externalism, there thus is the question what happens in those cases where the (nearby) world does not cooperate, cases where there is either no underlying property or else several underlying properties – examples would be the much-discussed case of 'jade', where there are two underlying chemical kinds fitting the manifest property, or the case of the colors, where there are many spectral reflectance profiles resulting in the same phenomenology. To simplify matters, let's call all of them cases of 'reference failure'. What should be clear from the very start, is that reference failure cases are far less drastic on the switcher semantics than on more traditional forms of semantic externalism. They never destroy the whole meaning, so to speak; the manifest element, being written into the lexicon, is always left intact. As in the case of proper names, switcher semantics thus offers the advantages of traditional descriptivism without having to relinquish any of the important Kripkean and externalist insights.[40]

It would take us too far to develop these matters in detail here, but we would

[40]Moreover, it does so without making the availability of the descriptive, manifest content contingent on actual reference failure, as those versions of mainstream externalism do, according to which terms like 'Water' have descriptive content, and refer to manifest kinds, if, and only if, there is no underlying kind in the (actual context of the) actual world. Such accounts cannot take advantage of this content in other contexts, for instance in propositional attitude contexts, since its presence depends on contingent, external facts. For versions of such disjunctive, or "a posteriori", semantics for natural kind terms, see Gallois and O'Leary-Hawthorne 1996, McLaughlin and Tye 1998, Brown 2004. For critical discussion see Häggqvist and Wikforss 2007.

like to say a little bit. One of the main ideas behind the (partial) externalism of switcher semantics for natural kind terms is the idea that a natural kind term or predicate like 'water' does not change its meaning when its scientific nature is *discovered*. Thus, the underlying property should not be part of the lexicon, while the manifest one is. This holds for both singular natural kind terms and natural kind predicates. However, as the mechanics of switcher-style dual-property association are quite different for singular terms and for predicates, so are the consequences of reference failure. Let's therefore look at singular terms and predicates in turn.

The defining trait of a natural kind *term* is that it "aims" to refer to the underlying kind. Consequently, there simply and literally is *reference failure* when there is no such kind (or too many of them). Discovery of this fact therefore either does lead to meaning change (such a term could come to refer to a manifest kind instead of a natural kind; this is one possible construal of the present use of 'jade'), or to the conclusion that there is no such kind. Alternatively, where there are too many underlying properties, one might say that the reference of the natural kind term is indeterminate. Discovery of this indeterminacy can then lead to an explicit determination of only one of these properties as the one referred to, or alternatively to a generic construal of the original term. This would be another plausible construal of the present use of 'jade': jade is the generic kind that has the natural kinds jadeite and nephrite as its subkinds.

This might not convince the arch-descriptivist, but again, the question is not so much whether this is the right diagnosis for, for instance, 'jade', as whether there are any terms (in natural English) that can plausibly be construed as dual-property associated. If there are no such terms, there is, it seems to us, a very good case to be made for the claim that there are no natural kind terms (in natural English). For in that case, the very difference distinctive of the natural kind terms *as a semantic category* would be lost; all kind terms would be (semantically) on a par. If, however, there are kind terms used to "get at", or refer to, underlying, possibly epistemically inaccessible natural kinds by means of the manifest qualities of their (presumed) instances, reference failure cannot be excluded. It simply is part and

parcel of reference to underlying kinds.[41]

Moreover, the arch-descriptivist might well be satisfied with the alleviating features of switcher externalism. For singular natural kind terms, reference failure does lead to loss of reference, but not to loss of intension, after all. Manifest intensions remain available both for "pure" semantic evaluation and for capturing the reasoning of speakers ignorant of the fact of reference failure. Thus, a natural kind term that fails to refer in the actual (context of the actual) world, will refer in non-actual world-context pairs where the relevant manifest qualities do determine an underlying kind. Since on the switcher semantics, such semantic evaluation tracks *de dicto* modality, switcher semantics thus offers an explanation for certain prevalent intuitions regarding *epistemic possibility*, for instance, the intuition that there might not have been water. This is true in the sense that there are possible worlds in which there is no natural kind underlying the manifest 'watery' qualities.[42] It should be clear, however, that in cases of reference failure, there are no true corresponding claims of *de re* modality.

Even more importantly, on the switcher semantics reference failure for a singular natural kind *term t* does *not* automatically mean that the extension of the corresponding natural kind *predicate F* is empty. We fully agree with the descriptivist who urges that it would be highly counterintuitive to have to say that there is no water (around here) – just because it had turned out that there are two different, or even a whole motley of, underlying kinds for water. Fortunately, switcher semantics does not commit us to any such consequences. For what happens to a natural kind predicate F in cases where reference fails for the corresponding term t is the following: While no u-intension is defined for F, the m-intension remains

[41] In other words: What the traditional descriptivist has to dispute is the (empirical) claim that natural language natural kind terms are dual-property associated, and, thus, form a semantic category of their own. Descriptivists such as Wikforss and Häggqvist are willing to bite this bullet. However, in contrast to the direct reference theorist construing all simple kind terms as forming a semantic category (such as Marti, Salmon, and, recently, Soames), the traditional descriptivist cannot even draw any semantic distinction between kind terms and corresponding explicit definite descriptions, thus having to deny, or 'explain away', the initial modal intuitions that motivated Kripke. To us, this quite clearly seems to be a bigger bullet than to admit the possibility of reference failure for singular natural kind terms.

[42] Switcher semantics offers analogous explanations for the treatment of empty proper names. For more on this, see Author 2009.

totally defined.[43] A sentence of the form $F(u)$ will be true or false at any world-context pair (**w**, **c**). And the extension of F is non-empty at (**w**, **c**) as long as the manifest property is instantiated. That is, even though water would not be a natural kind under such circumstances, there would still be water – as long as the manifest property is instantiated.[44] This result, it seems to us, is entirely desirable and in line with intuition.

We would like to conclude by adding a few reflections on analyticity and a priority. Throughout this paper, we have tentatively endorsed the hypothesis that switcher semantics offers a semantic explanation not only of the modal status of identity statements and theoretical identifications, but also of their epistemic (and analyticity) status. In particular, we have suggested that the peculiar pattern of necessity and truth of necessitation induced by the switcher semantics, and spelled out at the end of section 4, indicates both epistemic and modal status.

We therefore must issue a disclaimer before we conclude: In talking of analytic necessities here, we do not mean to suggest that semantics, be it switcher-style or not, offers a solution to what we would like to call 'Quine's problem'. It does not, and, as far as we can tell, it cannot. Quine's problem concerns the notion of *truth in virtue of meaning*. According to this notion, a statement, or interpreted sentence, is analytic iff it is true in virtue of meanings and independently of matters of fact (cf. Quine 1951, 20). In Quine 1954, Quine formulates what we call Quine's problem: We have no basis for applying the concept of truth in virtue of meaning in the crucial cases, for we don't know how to tell whether a sentence is true in virtue of meaning alone, or in virtue of very general facts. For every truth that is even a candidate for analyticity, there would seem to be a corresponding general fact. With this problem, we clearly do not get any help from looking at a semantic theory (cf. Glüer and Pagin 2007, 7ff). Personally, we do not think there is any solution to Quine's problem.

Nevertheless, intuitively, there is a distinction, and clearly an important and interesting distinction, between necessary truths such as logical truths (and an-

[43] Again, the m-intension can be used to explain intuitions about epistemic possibility.

[44] This does not hold for scientific natural kind terms. These are associated only with one (underlying) property, and in a case such as 'phlogiston' where the kind term does not refer, the corresponding predicate automatically has an empty extension. This is as it should be; there is no phlogiston.

alyticities) and other necessities when it comes to their dependence on general metaphysical fact. The distinction we have in mind is not an on/off distinction, but can be characterized in terms of *degrees of dependence* on metaphysical facts: Logical truths only minimally depend on general metaphysical facts, but other necessities do so to a much higher degree.[45] One intuitive desideratum on a notion of analyticity would thus be that it accommodates this distinction. That is, amongst the necessities, it should distinguish the minimally metaphysical ones, among them the logical truths, from the (more) metaphysical necessities. For the purposes of this paper, we take for granted that this notion of the analytic coincides with that of the a priori. And while the matter clearly requires a much more thorough investigation, we hypothesize that switcher semantics does provide a semantic explanation, or account, of the epistemic and the modal status of the sentences in the fragment it is defined for. But again, it remains for a more thorough future investigation to arrive at a deeper understanding of what is going on here, and especially a deeper understanding of the relation between the NN-pattern of necessity and necessitation and the intuitive notions of more or less metaphysical necessity. Since we here were principally concerned to argue that switcher-style dual-property association is the semantic property really explaining those phenomena rigidity for general terms was supposed to explain, we shall not pursue that investigation any further here.

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[45] Cf. Pagin 2001, Pagin 2003.

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