Theoretical identities may not be necessary

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1. Introduction

Following insights from the New Theory of Reference, it has become widely accepted that theoretical identities like 'water = H_2O' or 'heat = mean kinetic molecular energy' are necessary. However, some have challenged this claim. I propose yet another challenge in the form of a sceptical argument, i.e., that for all we know, theoretical identities may not be necessary. The argument is based on the contention that the necessity of theoretical identities is dependent upon criteria of identity. Thus, a theoretical identity is necessary given one criterion of identity but contingent given another. Since we do not know which criteria of identity in fact obtain, it follows that, for all we know, theoretical identities may not be necessary.

2. Background

Proponents of the New Theory of Reference convincingly argue that natural kind terms, like proper names, are rigid designators. One purported result of this claim is that theoretical identifications – like 'water is H_2O', 'Gold is substance with atomic number 79' and 'heat is mean kinetic molecular energy' – turn out to be necessary.[1] So for example, it is claimed that not only is water as a matter of actual fact identical to H_2O, but that it could not possibly have been otherwise – despite some obvious pre-philosophical intuitions to the contrary. How does the necessity of theoretical identities follow from the rigidity of terms? A rigid term designates the same referent in every possible world in which that referent exists. And so, if two rigid terms designate the same referent in some world, they must also do so in all possible worlds. Similarly, if the two terms designate different referents in some world, they must also do so in all possible worlds. In particular, when an identity statement involving two rigid terms is true in the actual world, it is also true in all possible worlds, i.e., it is necessarily true. And when it is false in the actual world, it is also false in all possible worlds, i.e., it is necessarily false. It follows that *any* identity statement (theoretical or otherwise) in which the two terms flanking the identity sign are rigid is necessary. Now since, so the argument goes, theoretical identities like 'water = H_2O' etc. involve two rigid designators, such identities are necessary (Kripke 1980: 140).

Thus, the argument for the necessity of theoretical identities can be summarized as follows.

(1) Theoretical identities are typically of the form:

[Natural kind term] = [Scientific expression];

(2) Natural kind terms (like 'gold', 'water' and 'heat') are rigid;

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[1] Arguing for the necessity of theoretical identities was an important part of Kripke's agenda:

> … I hold the following about the general case. First, that characteristic theoretical identities like 'Heat is the motion of molecules', are not contingent truths but necessary truths, and here of course I don't mean just physically necessary, but necessary in the highest degree-whatever that means.' (Kripke, 1980: 99)

(3) Scientific expressions that figure in theoretical identity statements (like 'substance with atomic number 79', 'H_2O' and 'mean kinetic molecular energy') are rigid;

(4) Any identity statement in which both terms flanking the identity sign are rigid, is necessary;

Hence,

(5) Theoretical identities are necessary.

Call this argument the 'Necessity Argument'.

Though the necessity of theoretical identities has by now become widely accepted, it has also been subject to various objections over the years. Indeed, there are objections to each of the argument's premisses:

Johnston (1997) for instance argued (in the spirit of Wiggins's (1968) treatment of puzzles of material constitution) that the 'is' in scientific discoveries like 'water is H_2O' is not the 'is' of identity, but rather the 'is' of constitution. So such statements are not identity statements at all. Hence (1) is false, and the argument does not go through.

Premiss (2) is the one that expresses the main novelty proposed by the New Theory, and has naturally stirred most controversy (indeed, most of it taking place independently of the necessity of theoretical identities debate). First, many have questioned the very possibility of applying rigidity to general terms; for it is far from being clear just what it is that general terms (and specifically natural kind terms) are supposed to designate.[2] Second, even if this problem is waved, it has been argued that natural kind terms are not rigid. A well known alternative is the functionalist contention that 'heat', for example, designates, with respect to every possible world, that which occupies the *heat role* in that world.[3] Thus, 'heat' designates molecular motion in the actual world, but very different phenomena in other possible worlds, and is hence nonrigid.

As per premiss (3), it too has been questioned. Steward (1990) considers the possibility of microscopic variations in H_2O molecules which give rise to salient macroscopic differences, e.g., being opaque pink solid. In such a case, says Steward,

> what seems to have been imagined is a possible world in which 'H_2O' picks out not just one but a large number of different substances, and, if such worlds as this are really possible, then 'H_2O' is not a rigid designator. (1990: 393)

Finally, the claim that any identity statement involving two rigid designators is necessary – premiss (4) – is strongly opposed by conventionalists. Notably, Gibbard (1975) holds that rigidity is merely sortal-relative. Thus, with respect to some statue made of clay, the name 'Goliath' rigidly designates this same *statue* in every possible world, whereas the name 'Lumpl' rigidly designates this same *lump of clay* in every possible world. And so, since in some possible worlds the lump does not form a statue (and vice versa), it turns out that although both names are rigid (in the sortal-relative sense), the identity 'Goliath = Lumpl' is merely contingent.

In this paper, I wish to object to the Necessity Argument in a new way. I shall develop my case by first arguing directly against the Necessity Argument's conclusion (5). More

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[2] For an elaborate discussion, see Soames (2002). Interestingly, Putnam himself had a change of heart and came to believe it was unclear whether 'water' designates certain counterfactual stuffs, thus jeopardising the very idea of rigidity of natural kind terms (1992: 443).

[3] A prominent advocate of such functionalism is of course Lewis (e.g., 1999: 44).

specifically, I shall describe circumstances under which theoretical identities are not necessary – circumstances that we cannot possibly rule out. I will then show that the flaw in the argument lies in premiss (3) (though the grounds for this are very different from Steward's).

The theoretical identity I shall focus on will be 'water = H_2O'.

3. The argument against the necessity of identity

We wish to determine whether the theoretical identity 'water = H_2O' is necessary. Recall that to claim that the identification 'water = H_2O' is necessary is to claim both that, if it is true, it is necessarily true, and if it is false, it is necessarily false. More formally,

(a) (water = H_2O) → (water = H_2O);

and,

(b) (water ≠ H_2O) → (water ≠ H_2O).

So to disprove the necessity, we have to show that either (a) or (b) is false. In order for (a) to be false, it has to be the case that 'water = H_2O' is true of the actual world but false of at least one possible world, i.e., that 'water' and 'H_2O designate the same stuff in the actual world, but different stuffs in at least one possible world. Similarly, in order for (b) to be false, 'water' and 'H_2O' have to designate different stuffs in the actual world, but the same stuff in at least one possible world.

Supplementing Putnam's (1973) twin-earth example with one extra assumption (to be presented shortly) will enable us to make such a case both against (a) and (b).

Consider the following. In the actual world, the watery stuff, i.e., the stuff which is drinkable, tasteless, odourless, etc., is composed of H_2O molecules. Now consider a (twin-earth type) counterfactual world in which the watery stuff is composed of XYZ molecules instead. Let us make no metaphysical assumptions with respect to either of these stuffs: That is, we consider two stuffs, one which has the property of being watery and the property of being composed of H_2O molecules; the other which has the property of being watery and the property of being composed of XYZ molecules. No assumption is made as to whether any of these properties – namely being watery, being composed of H_2O molecules or being composed of XYZ molecules – are essential or nonessential for either stuff.

What do 'water' and 'H_2O' designate in these two worlds?

3.1 Designation of 'water' and of 'H_2O'

Scientific expressions like 'substance with atomic number 79', 'mean kinetic molecular energy' and 'H_2O' are descriptive, i.e., they have descriptive content and hence are (normally)[4] taken to designate, with respect to every possible world, whatever fits their descriptive content in that world. In particular, the descriptive content of 'H_2O' is something like, 'stuff composed of molecules each of which contains two hydrogen atoms and one oxygen atom'. 'H_2O' thus designates, with respect to every possible world, whatever fits this description in that world. The watery-H_2O stuff in W_1 fits the description; the watery-XYZ

[4] For an alternative view and a recent discussion of other views of scientific expressions, see LaPorte (2013, Ch.6, section 2.1.2).

stuff in W_2 clearly does not. Hence, the term 'H_2O' designates the actual watery-H_2O stuff, but not the counterfactual watery-XYZ stuff:

Table 1: Designation of 'H_2O'

W_1	W_2
Watery H_2O	Watery XYZ
+	-

What about 'water'? How does it designate with respect to the two possible worlds?

Central to the New Theory of Reference is the claim that natural kind terms, like proper names, are rigid designators. More specifically, they are said to be *de jure* rigid, i.e., a natural kind term picks out its reference in the actual world[5] and is then *stipulated* to designate, with respect to every possible world, that which it designates in the actual world (Kripke 1980: 21, footnote 21). Natural kind terms are thus rigid *by definition*. (We shall not contest that here.) In particular, 'water', being *de jure* rigid, is stipulated to designate, with respect to every counterfactual world, the same stuff that it designates in the actual world, namely, the same stuff as the actual watery-H_2O stuff (or, described more neutrally, the same stuff as the stuff which is watery and is composed of H_2O molecules). So 'water' will designate the counterfactual watery-XYZ stuff only if it is the same as the watery-H_2O stuff. But is it?

Relative to one common view, driven by a scientific image of the world, stuff *A* and stuff *B* are the same iff *A* and *B* share the same chemical composition. In other words, the criterion of identity[6] for stuffs (i.e., the necessary and sufficient condition for being the same stuff,) is sharing their chemical composition. So in particular, under the said scientific view, the criterion for being identical to the actual watery-H_2O stuff is being composed of H_2O molecules. Hence, according to such a criterion of identity, the watery-H_2O stuff and the watery-XYZ stuff are clearly distinct. However, according to another view, which may be closer to our pre-scientific intuitions, the criterion for being identical to the watery-H_2O stuff is simply being watery (i.e., drinkable, odourless, tasteless, etc.). And generally, according to this criterion of identity, stuff *A* and stuff *B* are the same iff they share certain manifest, or macroscopic, qualities. Thus, given such a criterion, the watery-H_2O stuff and watery-XYZ stuff *are* the same.

Hence, in order to know whether the two stuffs are the same or not, we need to know which of the two criteria of identity (or some other which we have not considered) is the correct one, i.e., the one that in fact obtains. (Indeed, *pace* Gibbard, we assume that criteria of identity are objective and cannot be conventionally stipulated - i.e., that the question, what is the criterion of identity for certain stuff, admits of an objective answer. It goes without saying that the same criteria of identity obtain in all possible worlds.) But can we know which of the two criteria is the correct one?

The current prevalent assumption is that the criterion of identity that obtains is the scientific one. That this is possible, I think, can hardly be contested. But is it not also possible that this criterion is wrong; that what makes two stuffs the same, i.e., *metaphysically* the same, is

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[5] Either by ostension – i.e., 'Let *this* stuff [pointing to a sample of the watery-H_2O stuff,] be called "water"'; or by a reference-fixing description, i.e., 'Let the stuff, which is actually watery, be called "water"'.

[6] I chose to use criteria of identity rather than, the more commonly used in this context, essence, to avoid the extra 'metaphysical baggage' that I fear the latter carries.

something other than their chemical composition? Could it not be, for instance, that it is our pre-scientific intuitions, rather than scientific ones, that better match metaphysical truth, and that the criterion of identity that in fact obtains here is the manifest one? It appears that nothing in the way the world looks and behaves rules out this metaphysical possibility. (As is well known, determining the criteria of identity for even simple everyday objects, like persons, horses and ships, has been the subject of millennia-old ongoing controversies, and the criteria defended are often not scientific, or at least not the material constitution.) To be clear, by no means is it claimed here that the criterion of identity which in fact obtains is the manifest one. All that is suggested is that we *cannot rule out* either criterion.[7]

Returning to the designation of 'water', recall that 'water' is taken to be *de jure* rigid, i.e., it designates, with respect to every possible world, the same stuff that it designates in the actual world, namely the actual watery-H_2O stuff. Thus, if the criterion of identity is manifest, then the watery-XYZ stuff is the same as the watery-H_2O stuff, and hence 'water' designates both; if, however, the criterion of identity is scientific, then the two stuffs are distinct, and hence 'water' designates the watery-H_2O stuff but not the watery-XYZ stuff. This result is summarizes in Table 2.

Table 2: Designation of 'water' ('+' indicates that 'water' designates the stuff in the world above; '-' indicates that 'water' fails to designate it).

	W_1 Watery H_2O	W_2 Watery XYZ
Scientific criteria of identity	+	-
Manifest criteria of identity	+	+

3.2 Is 'water = H_2O', if true, necessarily true?

Let us focus now on the designations of 'water' and of 'H_2O' only in the case of *manifest* criteria of identity. These designations can be extracted from Tables 1 and 2 above (note that the designation of 'H_2O' – as summarized in Table 1 – is unaffected by criteria of identity). Table 3 below summarizes these designations.

Table 3 – Designation of 'water' and of 'H_2O' in case of <u>manifest</u> criteria of identity

	W_1 Watery H_2O	W_2 Watery XYZ
'water'	+	+
'H_2O'	+	-

We can see that in the case of manifest criteria of identity, 'water' designates the watery-XYZ stuff in world W_2 (upper right cell) whereas 'H_2O' does not (bottom right cell). In other words, the terms 'water' and 'H_2O' do not designate the same stuff in W_2, and hence the

[7] It is worth pointing out here that the dependence on criteria of identity stands independently of our epistemic state of ignorance with respect to such criteria. In other words, even if it were known without failing that the criterion of identity is, say, scientific, and hence that the two stuffs are distinct, it would still be true that *had* the criterion been manifest, the two stuffs *would* have been identical. (Indeed, by this I acknowledge two notions of possibility (cf. Chalmers, 2006).) Consequently, one can accept the first claim without accepting the second. Having said that, the dependence on criteria of identity is of course of more interest when there is a genuine epistemic uncertainty about which criterion in fact obtains.

theoretical identity 'water =H_2O' is false in W_2. However, relative to the same criteria of identity, both terms designate the watery-H_2O stuff in W_1 (upper and bottom left cells), i.e., the theoretical identity 'water =H_2O' is true in the actual world W_1. Thus, in case the criteria of identity are manifest, the theoretical identity 'water =H_2O' although actually true, is not necessarily true.

In other words, given manifest criteria of identity, 'water = H_2O', if *true*, is only contingently true, i.e., the first part of the necessity of identity claim,

(a) (water = H_2O) → (water = H_2O),

is false.

And since, for all we know, criteria of identity may indeed be manifest, it follows that (a) may be false.

This by itself suffices to establish that, for all we know, the theoretical identity 'water = H_2O' may not be necessary, i.e., that (5) may be false.

However, it is interesting to further examine whether, given such manifest criteria of identity, the other part of the necessity claim, namely,

(b) (water ≠ H_2O) → (water ≠ H_2O)

is false as well. This is what we do next.

3.3 Is 'Water = H_2O', if false, necessarily false?

Suppose it turns out that the actual watery stuff is *in fact* not composed of H_2O molecules, as we think, but rather of XYZ molecules; i.e., suppose that the *actual* world is not W_1 but rather W_2. In such a case, 'water =H_2O' is actually false; but is it also *necessarily* false? In other words, is claim (b) true?

As in the case of (a), I shall argue against (b) that relative to manifest criteria of identity, (b) is false.

Recall that for (b) to be false, it has to be the case that 'water' and 'H_2O' designate different stuffs in the actual world, but the same stuff in at least one possible world. Thus, again, we need to determine the designation of 'water' and of 'H_2O' with respect to W_1 and W_2 – only that this time under the assumption that W_2 is actual and W_1 is counterfactual.

We start with 'water'. To repeat, 'water' is a natural kind term and as such is *de jure* rigid. Thus, the term 'water' is stipulated to designate, with respect to every possible world, the same stuff that it designates in the actual world. In the present scenario, the actual world is W_2, i.e., the watery-XYZ world. So in this scenario, 'water' designates the watery-XYZ stuff in W_2.[8] Consequently, the term 'water' designates, with respect to every possible world, the stuff which is the same as this watery-XYZ stuff. In the case of manifest criteria of identity, being the same as the watery-XYZ stuff amounts to being watery; in which case 'water' designates the watery-H_2O stuff in W_1 as well.[9]

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[8] Either by ostension – i.e., 'Let *this* stuff [pointing to a sample of the watery-XYZ stuff], be called "water"'; or by a reference-fixing description, i.e., 'Let the stuff, which is actually watery, be called "water."' (Cf. footnote 5 above).

[9] Of course, relative to *scientific* criteria of identity, being the same as the watery XYZ amounts to being composed of XYZ molecules, and hence, relative to such criteria, 'water' will fail to designate the watery H_2O in W_1 (presently considered counterfactual).

What about 'H_2O'? Here things are much simpler. As a descriptive term, 'H_2O' simply designates whatever fits the description 'stuff composed of H_2O molecules'. Thus, 'H_2O' does not designate the watery-XYZ stuff in W_2 (currently considered actual) yet it does designate the watery-H_2O stuff in W_1 (currently considered counterfactual).

Table 4 summarizes these results.

Table 4 – Designation of 'water' and of 'H_2O' in case of manifest criteria of identity (under the assumption that W_2 is actual and W_1 is counterfactual)

	W_2 Watery XYZ	W_1 Watery H_2O
'H_2O'	-	+
'water'	+	+

But these are just the designations that were required to refute (b): 'Water' designates the watery-XYZ stuff in world W_2 (now considered actual) whereas 'H_2O' does not, i.e., the terms 'water' and 'H_2O' do not designate the same stuff in W_2. Hence the theoretical identity 'water =H_2O' is false in W_2, i.e., it is actually false. However, relative to the same criteria of identity, both terms designate the watery-H_2O stuff in W_1 (now considered counterfactual), i.e., the theoretical identity 'water =H_2O' is true in world W_1. Thus, in case the criteria of identity are manifest, the theoretical identity 'water =H_2O' although actually false, is not necessarily false.

3.4 The modal status of 'water =H_2O'

Overall then, given manifest criteria of identity, the theoretical identity 'water =H_2O', if true, is not necessarily true, and if false, is not necessarily false, i.e., both (a) and (b) are false. Hence, given manifest criteria of identity, 'water =H_2O' is not necessary. Now since, for all we know, criteria of identity may indeed be manifest, it follows that, for all we know, the theoretical identity 'water =H_2O' may not be necessary.

The same line of reasoning can be applied to other theoretical identities, like 'gold = substance with atomic number 79', 'heat = mean molecular kinetic energy', etc.

We may conclude therefore that for all we know, theoretical identities may not be necessary.

4. The Necessity Argument revisited

We have shown that the conclusion

(5) Theoretical identities are necessary

of the Necessity Argument may be false. If our reasoning is right, then there must be something wrong with the Necessity Argument. Showing where exactly the problem lies will thus reinforce our main claim against (5).

I shall now show that the problematic premiss of the Necessity Argument is

(3) Scientific expressions that figure in theoretical identity statements (like 'H_2O', 'substance with atomic number 79', and 'mean kinetic molecular energy') are rigid.

A rigid designator is a term that designates the same object in all possible worlds in which that object exists. Hence, if a term designates an object in one world but fails to designate

that same object in another, the term is nonrigid. As mentioned earlier, 'H_2O' is descriptive and thus designates whatever fits its description, 'stuff composed of H_2O molecules'. In particular, 'H_2O' designates the watery-H_2O stuff in W_1, but not the watery-XYZ stuff in W_2 (as indicated in Table 1). Now given manifest criteria of identity, these two stuffs are the same (for they are both watery). And yet, as we have just seen, 'H_2O' designates the one but not the other. It thus turns out that, given manifest criteria of identity, 'H_2O' is nonrigid.[10]

Now since, for all we know, criteria of identity may in fact be manifest, it follows that, for all we know, the scientific expression 'H_2O' may be nonrigid. Consequently, for all we know, premiss (3) may be false, and as a result, the conclusion (5) may also be false.

5. Conclusion

It is widely agreed that theoretical identities are necessary. In this paper, I have argued that, for all we know, theoretical identities may not be necessary. My argument has been based on the contention that the necessity of theoretical identities is dependent upon criteria of identity. I have shown that given manifest criteria of identity, if 'water = H_2O' is actually true, it is nevertheless false in another possible world, and hence it is *not necessarily* true. (And that the same holds for 'water ≠ H_2O'.) Since, for all we know, criteria of identity may in fact be manifest, it follows that for all we know, 'water =H_2O' may not be necessary, and therefore, the claim that such theoretical identities are necessary is unwarranted.

The necessity of theoretical identities is the conclusion (5) of the Necessity Argument. The question arises; where exactly is the problem in this argument? I have proposed that the problem lies with premiss (3), according to which scientific expressions figuring in theoretical identities are rigid. I have shown that, given manifest criteria of identity, 'H_2O' is nonrigid. And since the obtaining of such manifest criteria cannot be ruled out, it follows that for all we know, premiss (3) may be false, and that would explain why the conclusion (5) may be false as well.[11]

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[10] Note that, as stated in Section §2, my proposed reason for the possible nonrigidity of H_2O is crucially different from that of Steward; while my argument rests on the possibility that criteria of identity are not scientific, Steward does not question that. Like the New Theorists, she assumes that what determines whether two instances of H_2O are identical is their chemical composition, only that two such instances may differ in this respect due to some microscopic variation, and so be ultimately distinct, while still deserving to be called 'H_2O'.

[11] I thank David Widerker, Ira Schnall and an anonymous referee for helpful remarks.

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