

Possible World Semantics and the Complex Mechanism of Reference Fixing

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Abstract *Possible world semantics* considers not only what an expression actually refers to but also what it might have referred to in counterfactual circumstances. This has proven exceptionally useful both inside and outside philosophy. The way this is achieved is by using *intensions*. An intension of an expression is a function that assigns to each possible world the reference of the expression in that world. However, the specific intension of terms has been subject to frequent disputes. How is one to determine the intension of a term? Carnap has shown how the intension of a term depends on the type of that term. Two-dimensional semantics has shown how intensions also depend on the actual state of affairs. I will show how, in addition, intensions are no less dependent on metaphysical *criteria of identity*. Furthermore, I will reveal how these three factors interact to fix the exact intension of a term. In other words, I propose an outline of the overall mechanism by which intensions are being fixed.

1 Introduction

The terms ‘Darwin’ and ‘the originator of evolutionary theory’ designate the same person, and yet, they might not have. For had evolutionary theory been originated by, say, Wallace, ‘the originator of evolutionary theory’ would have designated Wallace, while ‘Darwin’ would still have designated Darwin.¹ This difference in designation in counterfactual circumstances reveals a difference in meaning between the two terms. This is the type of intuition that guides *possible world semantics* (PWS). PWS has proven extremely fertile—both inside and outside philosophy. Here are some of its applications, listed by Perry.

¹Taking proper names to be rigid designators is common to most contemporary semantic theories, including many (if not most) descriptivist theories—in particular those that endorse widescopism (notably Dummett 1973 111–135) and those that analyze names as actualized descriptions (e.g., Nelson 2002).

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[PWS] has been applied to a number of intensional phenomena in addition to necessity and possibility, including conditionals, tense and temporal adverbs, obligation and reports of informational and cognitive content. PWS spurred the development of philosophical logic and led to new applications of logic in computer science and artificial intelligence. It revolutionized the study of the semantics of natural languages. PWS has inspired analyses of many concepts of philosophical importance, and the concept of a possible world has been at the heart of important philosophical systems. (2005, 965)

The central tool used by PWS is *intension*. The intension of an expression is a function that assigns to each possible world, the extension (i.e., the reference) of the term in that world. Thus, considering the example above, the intension of ‘the originator of evolutionary theory’ is a function that assigns to each possible world, the person who originated the theory in that world. Namely, it assigns Darwin to the actual world, Wallace to the possible world in which Wallace was the originator, and no one to a world where the theory came to no one’s mind. The intension of ‘Darwin,’ by contrast, is a function that assigns Darwin to every possible world (i.e., it is a constant function). So, although the two terms have the same extension in the actual world, they nonetheless have different extensions in other possible worlds, viz., they have different intensions. And this, according to PWS, accounts for their difference in meaning. Intensions thus play a key role in PWS and as such have a significant, cross-disciplinary, explanatory force.

However, determining the specific intensions of terms is far from being trivial and has been frequently disputed. Take ‘water’ for example. Consider a possible world in which the watery stuff, i.e., the drinkable colorless stuff that falls from the sky and runs in rivers etc., is constituted not by H₂O molecules but rather by some XYZ molecules.² Would ‘water’ designate that stuff? Would such stuff be included in the intension of ‘water’? Similarly, consider a possible world in which the stuff that is constituted by H₂O molecules is not watery but rather, say, pink solid.³ Would ‘water’ designate such stuff? Would it be included in the intension of ‘water’? Replies vary. In order to understand what is at stake here, it would greatly help to understand how exactly intensions are being fixed, i.e., (a) what factors are at play in fixing the intension of a term and (b) how these factors combine to do that. The aim of this paper is to answer these questions.

In the first stage, I locate the factors upon which intensions depend. This is achieved by drawing lessons about reference in possible worlds from three different debates. Specifically, “Section 2” and “Section 3” briefly illustrate the dependence of the intension of a term on the type of that term (as Carnap has shown) and on the actual state of affairs (as two-dimensionalism has shown), respectively. In “Section 4”, I argue that in addition to these two factors, intension is no less dependent on metaphysical criteria of identity. In the second stage, I move on to reveal the general mechanism, or formula, by which all three factors interact to jointly fix intension. Specifically, “Section 5” reveals this formula with relation to the term ‘water’, whereas

² Putnam (1973).

³ The thought experiment is borrowed from Steward (1990), although Steward uses it to question the rigidity of ‘H₂O.’ Supervenience-based worries about the very possibility of such stuff (since a physical duplicate is presumably a duplicate in all respects) are addressed by stipulating some microscopic difference between the pink solid H₂O molecules and the watery H₂O molecules, which makes them ultimately physically distinct, thus allowing for the manifest difference.

“Section 6” generalizes from it, and shows how to use it to calculate the intensions of other terms. “Section 7” summarizes the discussion.

Using any formula for specific calculations requires plugging-in the relevant *values* of the *variables* in the formula. So using the intensions formula for the calculation of the specific intension of a term requires plugging in the values pertaining to that given term. The proposed formula can be thus viewed as a meta-semantic theory, which requires an input of *specific* values for each of its variables, in order to serve as a semantic theory that provides *specific* intensions.⁴ Sometimes, these values are easily known, and the calculation of intensions is accordingly straightforward. At other times, the values of the variables are much harder to find, thus impeding calculation. But in all cases, the meta-semantic theory provides the general principle according to which intensions are being fixed.

2 The Dependence of Intension on Semantic Rules

Here is one lesson about intensions that we learned from disputes between theories of reference.

How are referring terms related to their objects? How do they designate them? A common way of addressing such questions is by invoking thought experiments that involve counterfactual circumstances. Would a counterfactual watery XYZ stuff deserve to be called ‘water?’ And what about a counterfactual pink solid H₂O stuff?⁵

According to the descriptive theory of reference, ‘water’ has a descriptive content—presumably something like ‘the watery stuff’ (i.e., ‘the drinkable, colorless, ...’)—and it designates, with respect to each possible world *W*, that which fits this descriptive content in *W* (at least according to the so-called ‘Frege-Russell’ version of this descriptive theory).⁶ So on this view, ‘water’ designates the actual watery H₂O stuff as well as the counterfactual watery XYZ stuff, but not the counterfactual pink solid H₂O stuff (since the latter does not fit the description). Let us call terms that are governed by such a semantic rule (i.e., terms that have a descriptive content and designate, with respect to every possible world, that which fits their descriptive content) ‘descriptive.’

According to an alternative, referential view,⁷ ‘water’ picks out some stuff in the actual world,⁸ and it is then stipulated to designate, with respect to every counterfactual world *W*, just that same stuff (regardless of any description that this referent may or may not fit in *W*). This also makes ‘water’ a *rigid designator* (i.e., a term that

⁴ I use ‘value’ and ‘variable’ here similar to the way these terms are used in algebra or propositional logic and *unlike* in the way they are used in predicate logic, which involves quantification. So, no issues of domain, binding, scope, etc. apply here.

⁵ See footnote 3 above.

⁶ (Frege 1892); Russell (1905).

⁷ Notably advanced by Kripke (1980) and Putnam (1975).

⁸ Either by ostension—i.e., ‘Let *this* stuff [pointing to a sample of the watery-H₂O stuff,] be called “water,”’ or by a reference-fixing description, i.e., ‘Let the stuff, which is actually watery, be called “water.”’

designates the same referent in every possible world).^{9,10} Thus, says the referentialist, since in the actual world ‘water’ designates H₂O stuff, ‘water’ designates H₂O stuff in every possible world.¹¹ So ‘water’ designates the counterfactual pink solid H₂O stuff but not the counterfactual watery XYZ stuff.¹² Following Kripke, let us call terms that are governed by such a semantic rule (i.e., terms that are stipulated to designate, with respect to every possible world, that which they designate in the actual world) ‘*de jure* rigid.’¹³

It follows that the descriptive view and the referential view disagree on the semantic rule that governs the term ‘water’: the former takes ‘water’ to be descriptive, whereas the latter takes it to be *de jure* rigid. This disagreement can teach us something about intensions in general. We have seen that each view entails a different designation of ‘water’ with respect to the counterfactual stuffs in question, as is summarized in Table 1.

Now, recall that the intension of a term is a function that assigns to each possible world, the referent of the term in that world. So, the top row in Table 1 in fact represents the intension of ‘water’ in case the term ‘water’ is descriptive, whereas the bottom row represents the intension of ‘water’ in case ‘water’ is *de jure* rigid.

The first lesson we can draw then is that the intension of at least some terms depends on the semantic rule that governs these term (e.g., on whether these terms are descriptive of referential).

3 The Dependence of Intension on the Actual Referent of a Term

We can also learn something about intensions from disputes about what the actual state of affairs is like.

Take the famous Newton-Leibniz dispute over the origination of the calculus. Let the term, ‘the *actual* originator of the calculus’ designate, with respect to each possible world *W*, the person who originated the calculus *in the actual world* (i.e., regardless of whether or not that person originated the calculus *in W*).¹⁴ What particular person would this term designate in different possible worlds?

Surely, that would depend solely on who originated the calculus *in the actual world*. Specifically, if the actual originator of the calculus was Newton, then the term ‘the actual originator of the calculus’ designates Newton in the actual world and then goes on to

⁹ As in the case of proper names (noted earlier, in footnote 1), some versions of ‘descriptivism’ endorse the rigidity of natural kind terms too; this is done by rigidifying the relevant descriptions (notably by means of actualizing them, or by applying a wide-scope reading). However, under the present definition of ‘*de jure* rigid’ and ‘descriptive,’ such views will be considered *de jure* rigid.

¹⁰ Admittedly, the rigidity of natural kind terms like ‘water’ or ‘gold’ has been the subject of much debate (see Soames 2002 and LaPorte 2013, for elaborate discussions).

¹¹ Referentialists disagree on whether such terms are *obstinately* or *persistently* rigid (i.e., on whether they designate their actual referent in every possible world or only in those worlds in which that referent exists). The argument advanced in this paper by no mean depends on the answer to this question.

¹² Kripke (1980 128-9).

¹³ Kripke (1980 21, footnote 21). *De jure* rigid terms are contrasted with *de facto* rigid terms. The latter are *descriptive* terms that simply *happen* to be rigid, e.g., ‘the successor of 3’ designates the number 4 in every possible world. *De jure* rigid terms, by contrast, are *stipulated* to be rigid; e.g., the term ‘the *actual* originator of evolutionary theory’ designates Darwin in the actual world and is then *stipulated* to designate that same person in each counterfactual world *W* (regardless of who originated the theory in *W*).

¹⁴ Davies and Humberstone (1980). Note that thus defined, ‘the *actual* originator of the calculus’ is explicitly a *de jure* rigid term (see footnote 13 above).

Table 1 The possible intensions of ‘water’ relative to different semantic rules that may govern the term

	W_1	W_2	W_3
	Watery H ₂ O	Watery XYZ	Pink solid H ₂ O
‘Water’ is descriptive	+	+	–
‘Water’ is <i>de jure</i> rigid	+	–	+

designate Newton in all possible worlds, including in those worlds where Leibniz was the originator, as well as in those where neither of them was. If, on the other hand, the actual originator was in fact Leibniz, then ‘the actual originator of the calculus’ designates Leibniz in the actual world and then goes on to designate Leibniz in every possible world, including in those worlds where Newton was the originator, as well as in those where neither of them was.

Again, we wish to see what we can learn about intensions from this dispute. We can see that ‘the actual originator of the calculus’ will have different designations with respect to different possible worlds, depending on who originated the calculus in the *actual* world. Table 2 summarizes these differences.

So the intension of the term ‘the actual originator of the calculus’ depends on whether the actual originator was Newton or Leibniz. Our second lesson is thus that the intension of at least some terms depends on the actual state of affairs.¹⁵

Note that this does not apply to simple (non-actualized) *definite descriptions*, e.g., ‘the originator of the calculus.’ This term simply designates, with respect to every possible world W , the person who originated the calculus in W , i.e., regardless of the state of the actual world, and in particular, of who originated the calculus in the actual world.

4 The Dependence of Intension on Criteria of Identity

Finally, we can also learn something about intensions from metaphysical disputes about identity.

Which of an object’s properties are essential to it and which are not? A common way of addressing this issue is by invoking counterfactual circumstances that involve changes to the object’s properties. Consider a clay statue of David, or, put more neutrally, an object that is made of clay and has the shape of David. Call it, ‘David.’¹⁶ What if we were to smash David into a ball? Would that object be David still? Would it deserve to continue to be called ‘David?’ Alternatively, what if we were to gradually replace all of David’s parts, bit by bit, until it was entirely made of, say, bronze? Would that object be David? Would it deserve to keep its name?¹⁷

According to a materialist view, an object remains the same iff it keeps its material constitution.¹⁸ So according to this view, David would survive being smashed into a ball

¹⁵ This type of dependence is highlighted in the two-dimensional semantics literature. Philosophers who are associated with this approach are notably Chalmers (e.g., Chalmers 2006), Jackson (e.g., Jackson 2004), Kaplan (1989), and Stalnaker (e.g., Stalnaker 2004).

¹⁶ Note that unlike Gibbard’s (1975) ‘Goliath,’ which names only the statue (whereas ‘Lumpl’ names only the lump of clay) ‘David’ here names, neutrally, that thing, whatever it is, that is made of clay and has a shape of David.

¹⁷ This second scenario is based on the famous puzzle of the ship of Theseus (Plutarch, *Life of Theseus*, XXIII 1859).

¹⁸ For example, Noonan (1993). This view is sometimes referred to as ‘mereological constancy’ (Wasserman 2013).

Table 2 The possible intensions of ‘the actual originator of the calculus’ relative to different actual referents that this term may have

	W_1	W_2	W_3
	The originator of the calculus is Newton	The originator of the calculus is Leibniz	The originator of the calculus is neither
The actual referent is Newton	Newton	Newton	Newton
The actual referent is Leibniz	Leibniz	Leibniz	Leibniz

(as such a manipulation would involve no change to its material constitution; both the clay statue and the clay ball are made of the very same lump of clay). However, David would not survive a complete part replacement (as this *would* involve a complete change of its material constitution, namely, from clay to bronze). Hence, on this view, the term ‘David’ would continue to designate the counterfactual clay ball but not the counterfactual bronze statue. Let us call such criteria of identity over time, ‘material.’

According to an alternative view, an object remains the same iff it keeps some of its manifest properties.¹⁹ So according to this view, David would survive a complete part replacement (as such a manipulation would involve no change to its manifest form; the clay statue continues to have the exact same form, namely of a statue, throughout the process of turning into a bronze statue). However, David would not survive being smashed into a ball (as this *would* involve a complete change of its manifest form, namely, from a statue to a ball). Hence, according to this view, the term ‘David’ would continue to designate the counterfactual bronze statue but not the counterfactual clay ball. Let us call such criteria of identity over time, ‘manifest.’²⁰

Note that both views assume that criteria of identity are *an objective feature of reality* and cannot be stipulated at will. In particular, it is assumed that the question of whether a certain object is identical to David admits of an objective answer, regardless of what the speaker that uses the term ‘David’ may believe.

The two views disagree on the criteria of identity over time that apply to David: The former takes these criteria to be material, whereas the latter takes them to be manifest. Of course, there are other views on offer regarding criteria of identity over time.²¹ Yet, it is enough to consider these two views to realize that this metaphysical debate can also teach us something about intensions. For we can see that each view

¹⁹ For an interesting defense of such a view, see Burke (1994). He says, ‘of the sortals satisfied by an object, the one that tells the object’s sort is the one whose satisfaction entails possession of the widest range of properties’ (p. 252). Based on this criterion, Burke selects, for example, ‘tree’ over ‘hunk of cells’ and ‘statue’ over a ‘piece of copper’ as determining the object’s sort (p. 253).

²⁰ Some may suspect that this latter view conflicts with the supervenience of the non-material on the material and hence question this view’s legitimacy. Yet, there appears to be no such conflict. For it seems perfectly consistent to assume that the world is populated by, e.g., animals, that can survive gradual replacement of cells, and yet, also that these animals supervene, at each given moment t , upon the cells from which they are composed at t .

²¹ For example, that there are two objects—a statue *and* a lump of clay—in the same place at the same time (e.g., Wiggins 2001); or, that what David is, is relative to the way it is described/intended/thought of (e.g., Quine 1960: 199; Geach 1967); or, that David is a temporal part of a four-dimensionally extended object, shared by two different collections of such temporal parts—a statue collection and a lump collection (e.g., Sider 2001).

entails a different designation of ‘David’ with respect to the counterfactual objects in question, as is described in Table 3.

So, the intension of the term ‘David’ depends on whether the criteria of identity that in fact obtain in the world are material or manifest. Thus, the lesson we can draw from this debate is that the intension of at least some terms depends on criteria of identity.

Overall then, we have reached three conclusions: (a) the intension of at least some terms depends on the semantic rule that governs these terms (e.g., on whether a term is descriptive or referential), (b) the intension of at least some terms depends on the actual state of affairs (e.g., on whether the actual inventor of the calculus is Newton or Leibniz), and (c) the intension of at least some terms depends on the criteria of identity that in fact obtain in the world (e.g., on whether the relevant criteria are material or manifest).

Of the various versions of possible world semantics, standard possible world semantics (also known as ‘one-dimensional semantics’) only incorporates the first conclusion; whereas, the more elaborate, two-dimensional semantics also incorporates the second conclusion (i.e., in the sense that different actual states of affairs will yield different intensions).²² However, all versions of possible world semantics have thus far failed to acknowledge the third conclusion, namely, the dependence of intension on criteria of identity. So, this conclusion would be our first contribution to possible world semantics.²³

In what comes next, we shall proceed to see how the intension of a term, in this case ‘water’, in fact depends on *all* three factors. Moreover, in the course of discussion, we shall also reveal the mechanism by which these three factors interact to jointly determine the intension of ‘water.’ This mechanism will be then generalized and will make the final contribution of the present discussion.

5 How the Three Factors Interact to Jointly Determine Intension

Consider ‘water’ again. In “Section 2”, we have seen that the intension of ‘water’ depended on the semantic rule that governs this term. Specifically, if ‘water’ is descriptive, then ‘water’ is associated with some description (‘watery stuff’) and designates, with respect to every possible world *W*, that which fits the description in *W*. Consequently, in such a case, ‘water’ designates the watery XYZ stuff but not the pink solid H₂O stuff (row 1 in Table 4 below). If, by contrast, the term ‘water’ is *de jure* rigid, then ‘water’ rigidly designates, with respect to every possible world, the same stuff that it designates in the actual world, namely, the same stuff as the watery H₂O stuff. But what would that stuff be? Is the counterfactual watery XYZ stuff the same stuff as the actual watery H₂O stuff? And what about the counterfactual pink solid H₂O stuff?

In our initial presentation of the water case, we simply *assumed* that being the same as the watery H₂O stuff amounted to being H₂O. However, following the discussion of the case of David above, we now know better. We know that being the *same*

²² According to standard possible world semantics, the semantic value of an expression is a function from counterfactual worlds to extensions (viz., the expression’s intension); according to two-dimensional semantics, the semantic value of an expression is a function from worlds considered as actual to intensions (viz., the expression’s two-dimensional intension). (Schroeter 2012, section 1.1.1.)

²³ I have recently indicated the implications of this dependence of intension on criteria of identity in Pelman (2014) and Pelman (2015).

Table 3 The possible intensions of ‘David’ relative to different criteria of identity that may in fact obtain in the world

	W_1	W_2	W_3
	Clay statue	Clay ball	Bronze statue
Material criteria of identity	+	+	–
Manifest criteria of identity	+	–	+

depends on criteria of identity. Specifically, if the criteria of identity that obtain in the world are material, then being the same as the watery H_2O stuff indeed amounts to being composed of H_2O molecules. Consequently, a *de jure* rigid ‘water’ would designate the counterfactual pink solid H_2O stuff but not the watery XYZ stuff (row 2 in Table 4 below). However, should the criteria of identity that in fact obtain not be material, but rather manifest, then being the same as the watery H_2O stuff simply amounts to being watery. After all, nothing in the way the world looks and behaves can rule out, in principle, the mere possibility that the true criterion of identity for stuffs *is* indeed manifest, rather than material. Just as, for all we know, being David may not consist in having the same material parts but rather in a continuity of form, so, for all we know, being the same stuff *may* not consist in sharing the same chemical composition but rather in sharing some non-material qualities. And relative to such manifest criteria of identity, a *de jure* rigid ‘water’ would designate the counterfactual watery XYZ stuff but not the counterfactual pink solid H_2O stuff (row 3 in Table 4).

It thus turns out that the intension of ‘water’ depends not only on the semantic rule that governs the term but also on criteria of identity.

But now, (in light of our discussion of the originator of the calculus,) suppose that the *actual* watery stuff—i.e., the stuff that we have been calling ‘water’ all along—turns out not to be composed of H_2O molecules but rather of XYZ molecules. Suppose, that is, that our current chemistry got it wrong, and that the true chemical composition of the *actual* watery stuff is different from what the theory says. (After all, most past scientific theories have been disproved and replaced, so why assume our current chemistry will fare any better?) In such a case, a *de jure* rigid ‘water’ would designate, with respect to every counterfactual world, that which is the same as *that* stuff, namely, as the *actual* watery XYZ stuff (rather than the watery H_2O stuff).

It follows that, in case the term ‘water’ is *de jure* rigid, the intension of ‘water’ depends not only on the semantic rule that governs the term and on criteria of identity but also on the actual state of affairs.

And what would the exact intension of ‘water’ be in such a case (i.e., when ‘water’ is *de jure* rigid and its *actual* referent is watery XYZ stuff)? Would ‘water’ designate the counterfactual pink solid H_2O stuff? And what about the (now) counterfactual watery H_2O stuff? Again, (just like in the case when the actual referent was watery H_2O .) this would depend on criteria of identity. Specifically, if the criteria that in fact obtain in the world are material, then being the same stuff as the (now) actual watery XYZ stuff would amount to being composed of XYZ molecules, and hence, a *de jure* rigid ‘water’ would designate neither the pink solid H_2O stuff nor the watery H_2O stuff—for neither is composed of XYZ

Table 4 The possible intensions of ‘water’ relative to: (a) different semantic rules that may govern the term ‘water’, (b) different stuffs that may be the actual referent of ‘water’, and (c) different criteria of identity that may in fact obtain in the world

	Semantic rule	The actual referent	Criteria of identity	W_1	W_2	W_3
				Watery H ₂ O	Watery XYZ	Pink solid H ₂ O
1	Descriptive	(<i>Whatever</i>)	(<i>Whatever</i>)	+	+	–
2	<i>De jure</i> rigid	Watery H ₂ O	Material	+	–	+
3			Manifest	+	+	–
4		Watery XYZ	Material	–	+	–
5			Manifest	+	+	–

molecules (row 4 in Table 4). If, by contrast, the criteria of identity that obtain in the world are in fact manifest, then being the same as the watery XYZ stuff amounts to being watery, in which case a *de jure* rigid ‘water’ would designate the watery H₂O stuff, but not the pink solid H₂O stuff—for the former, but not the latter, is watery (row 5 in Table 4). Table 4 below summarizes all of these options

Table 4 clearly indicates that the intension of ‘water’ depends on all of the following three factors: (a) the semantic rule that governs ‘water’, (b) the actual referent of ‘water’, and (c) the criteria for being identical to this actual referent. Moreover, Table 4 specifies how exactly variations in each of these three factors change the intension of ‘water.’

In fact, in the course of discussion, we have also uncovered the mechanism by which the intension of ‘water’ is fixed. This mechanism can be viewed as a three-stage process. We begin with the semantic rule that governs the term ‘water.’ If ‘water’ is descriptive, then ‘water’ designates, with respect to every possible world W , that which fits the description (‘watery stuff’) in W . If, by contrast, ‘water’ is *de jure* rigid, then, in the next stage, the actual referent has to be fixed.²⁴ Once the actual referent is fixed, then, in the last stage, criteria for being identical to that actual referent determine the referents of ‘water’ in other counterfactual worlds, thereby determining the intension of ‘water.’

Finally, we can now proceed to our main goal: outlining the general mechanism by which the three factors jointly determine intensions. This can be achieved by generalizing from the case of ‘water.’

6 Generalization

Let P_1 and M_1 be properties of some stuff in the actual world and let T be the term that designates that $P_1 + M_1$ stuff in the actual world. Let $P_2 + M_1$ be a counterfactual stuff (i.e., stuff that has the same M -property as the actual stuff but a different P -property) and let $P_1 + M_2$ be another counterfactual stuff (i.e., stuff that has the same P -property as the actual stuff but a different M -property). Using the case of ‘water’ above as a model, we can apply the same principles to this general case. The result will be the possible intensions of T relative to: (a) the different semantic rules that may govern T , (b) the different referents

²⁴ To remind, a *de jure* rigid term is fixed either by ostension or by a reference fixing description. See footnote 8.

that may be the actual referent of T, and (c) the different criteria of identity that may in fact pertain to the actual referent of T. Table 5 below specifies these intensions.

Furthermore, $P_1 + M_1$ may, alternatively, stand not for some stuff, but rather for some *object*. For example, $P_1 + M_1$ may stand for the clay statue David, where P_1 is David's material constitution and M_1 is its shape.²⁵ Likewise, $P_1 + M_1$ may stand for Newton, where P_1 is Newton's body and M_1 is his mind.²⁶ Accordingly, $P_2 + M_1$ would stand for a counterfactual *object* that has the properties P_2 and M_1 , whereas $P_1 + M_2$ would stand for another counterfactual object that has the properties P_1 and M_2 . Now, if T is the *singular term* that designates the actual object $P_1 + M_1$, then Table 5 above simply specifies the possible intensions of that singular term, T.²⁷

Table 5 can thus serve as an outline for a general formula of intension. The intension of a specific term—be it 'water,' 'David,' or 'the actual originator of the calculus'—is calculated by interpreting the relevant 'P's and 'M's as appropriate and by plugging in the specific values of the three variables that pertain to the term in question (viz., choosing the specific row in the table that represents these values).²⁸

True, the challenge of knowing the correct values of the three variables may vary considerably depending on the terms in question. For example, the value of the variable *the semantic rule that governs the term* is very easy to tell when the term is 'the actual originator of the calculus'; it is clearly *de jure* rigid, i.e., this term designates, with respect to every counterfactual world, the same person that it designates in the actual world. However, the correct value of the same variable is much less clear in the case of 'water.' By contrast, the value of the variable 'the actual referent of the term' is fairly easy to tell with respect to 'water'; it is extremely likely to be watery H₂O stuff, yet it is much harder to be certain about in the case of 'the actual originator of the calculus.'

7 Summary

Possible world semantics offers a powerful tool that has been extensively used in many realms of inquiry. The key player in possible world semantics is intension, i.e., a function from worlds to referents. As is well known, intensions are dependent on the semantic rule that governs the term and also on the actual referent of the term. It has been shown that in addition to these two variables, intension is also dependent on metaphysical criteria of identity—a fact that has thus far managed to escape possible

²⁵ Note that if M-properties are the *shape* of objects, then the relevant criterion of identity is not likely to be based on simply *sharing* the same M-property, but rather on *keeping* that property. For otherwise, different statues with a shape of David, for example, will all be identical to David, which is untenable.

²⁶ The criteria of personal identity in such a case will likely be, respectively, bodily—i.e., x and y are the same person iff x and y share the same body (e.g., Thomson 1997; for a closely related, animalist version, see Snowdon 2014)—or, by contrast, psychological—i.e., x and y are the same person iff they share the same mind (e.g., Unger 2000 and Shoemaker 1999).

²⁷ Needless to say, Table 5 can be extended to include more values for each variable, namely, more possible semantic rules, more possible actual referents of the term, and more possible criteria of identity (see footnote 21 above). However, the principles of determining the intension in each of these extended cases should be fairly clear by now.

²⁸ To remind, 'value' and 'variable' are used here similar to the way they are used in algebra or in propositional logic and not in the way they are used in predicate logic, i.e., no quantification etc. is involved (see footnote 4).

Table 5 The possible intensions of some term T relative to: (a) different semantic rules that may govern T, (b) different referents that may be the actual referent of T, and (c) different criteria of identity that may in fact pertain to the actual referent of T

Semantic rule	The actual referent	Criteria of identity	W_1	W_2	W_3
			$P_1 + M_1$	$P_2 + M_1$	$P_1 + M_2$
1 Descriptive (expressing M_1)	(<i>Whatever</i>)	(<i>Whatever</i>)	+	+	–
2 <i>De jure</i> rigid	$P_1 + M_1$	X and Y are the same iff they share their P-property	+	–	+
3		X and Y are the same iff they share their M-property	+	+	–
4	$P_2 + M_1$	X and Y are the same iff they share their P-property	–	+	–
5		X and Y are the same iff they share their M-property	+	+	–

world semantic theories. Furthermore, I have revealed the general complex mechanism by which all three factors interact to jointly determine intensions, which provided a type of formula for the calculation of intensions. In other words, the view put forward here provides the general principles by which intensions are being fixed.²⁹

References

- Burke, M. (1994). Preserving the principle of one object to a place: a novel account of the relations among objects, sorts, sortals and persistence conditions. *Philosophy and Phenomenological Research*, 54, 591–624.
- Davies, M., & Humberstone, I. L. (1980). Two notions of necessity. *Philosophical Studies*, 38, 1–30.
- Dummett, M. (1973). *Frege: philosophy of language*. New York: Harper and Row.
- Chalmers, D. (2006). Two-dimensional semantics. In E. Lepore & B. Smith (Eds.), *Oxford handbook of philosophy of language* (pp. 575–606). Oxford: Oxford University Press.
- Frege, G. (1892). On sense and reference, in P. Geach and M. Black, (eds.), (1952), *Translations from the philosophical writings of Gottlob Frege*, Oxford: Blackwell.
- Geach, P. (1967). Identity. *Review of Metaphysics*, 21, 3–12.
- Jackson, F. (2004). Why we need A-intensions. *Philosophical Studies*, 118, 257–277.
- Kaplan, D. (1989). *Demonstratives, in Themes from Kaplan* (pp. 481–563). Oxford: Oxford University Press.
- Kripke, S. (1980). *Naming and necessity*. Cambridge, MA: Harvard University Press.
- LaPorte, J. (2013). *Rigid designation and theoretical identities*, Oxford University Press.
- Nelson, M. (2002). Descriptivism defended. *Noûs*, 36(3), 408–435.
- Noonan, H. (1993). Constitution is identity. *Mind*, 102, 133–146.
- Pelman, A. (2014). Theoretical identities may not be necessary. *Analysis* 74(3), 412–422.
- Pelman, A. (2015). Metaphysics of pain; semantics of ‘pain’. *Ratio* 28(3), 302–317.
- Perry, J. (2005). Semantics, possible worlds. In E. Craig (Ed.), *The shorter Routledge encyclopedia of philosophy* (pp. 955–956). Oxon: Routledge.
- Plutarch, Life of Theseus, in Clough, A.H. (trans.). (1859). *Plutarch's lives*. Boston: Little, Brown and Company.
- Putnam, H. (1973). Meaning and reference. *Journal of Philosophy*, 70, 699–711.
- Putnam, H. (1975). *Mind, language, and reality: philosophical papers* (Vol. 2). Cambridge: Cambridge University Press.
- Quine, W. V. O. (1960). *Word and object*. Cambridge, MA: MIT Press.

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- Russell, B. (1905). On denoting, mind, 14: 479–493. Reprinted in Russell, B. *Essays in Analysis*, London: Allen and Unwin, 1973: 103–119.
- Schroeter, L. (2012). Two-dimensional semantics, *The Stanford Encyclopedia of Philosophy* (Winter 2012 Edition), Edward N. Zalta (ed.), URL = <<http://plato.stanford.edu/archives/win2012/entries/two-dimensional-semantics/>>.
- Shoemaker, S. (1999). Self, body, and coincidence. *Proceedings of the Aristotelian Society*, 73, 287–306.
- Sider, T. (2001). *Four-dimensionalism*. Oxford: Oxford University Press.
- Snowdon, P. F. (2014). *Persons, animals and ourselves*. New York: Oxford University Press.
- Soames, S. (2002). *Beyond rigidity*. New York: Oxford University Press.
- Stalnaker, R. (2004). Assertion revisited: on the interpretation of two-dimensional modal semantics. *Philosophical Studies*, 118, 299–322.
- Steward, H. (1990). Identity statements and the necessary a posteriori. *The Journal of Philosophy*, 87, 385–398.
- Thomson, J. J. (1997). People and their bodies. In J. Dancy (Ed.), *Reading Parfit*. Oxford: Blackwell.
- Wasserman, R. (2013). Material constitution, *The Stanford Encyclopedia of Philosophy* (Spring 2015 Edition), Edward N. Zalta (ed.), URL = <<http://plato.stanford.edu/archives/spr2015/entries/material-constitution/>>.
- Unger, P. (2000). The survival of the sentient. In J. Tomberlin (Ed.), *Philosophical perspectives II*. Malden, MA: Blackwell.
- Wiggins, D. (2001). *Sameness and substance renewed*. Cambridge: Cambridge University Press.
- Pelman, A. (2015). Metaphysics of pain; semantics of ‘pain’. *Ratio*, 28(3), 302–317.
- Pelman, A. (2014). Theoretical identities may not be necessary. *Analysis*, 74(3), 412–422.