Should We Swallow Worms or Worm Slices?

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Abstract

Are objects and people time worms or time slices? Most temporal parts theorists think we are worms. This paper argues that the two views are not as different as previously supposed. Unfortunately, the current version of Slice Theory generates incorrect truth conditions. Fortunately, a consideration of current theories of reference motivates a version that fixes the problem. Proponents of Slice Theory have conceded costs to their view since the theory seems to commit us to saying b and c are different people when intuition insists they are the same. But, like objections that opponents have raised, this too is rooted in confusion, a conflation of an everyday, temporally relative relation of sameness with a relation of absolute identity. Slice Theory, thus repaired and defended, generates the same truth conditions as Worm Theory. Quine suggests that this is a case of indeterminacy of reference. However, because both theories employ the same process of evaluating truth conditions, because this case contrasts with paradigm cases of indeterminacy, and because Quine’s argument fails for the first-person case, the evidence suggests that Worm Theory and Slice Theory are in fact merely notational equivalents. Slice Theory claims “Objects are time slices”, but this is best interpreted as meaning something different than what it seems to mean, something which does not conflict with Worm Theory or with common sense.
Should We Swallow Worms or Worm Slices?

Temporal parts theory comes in two flavors. The more popular flavor, which I’ll call Worm Theory, claims that objects are four-dimensional space-time worms.1 An alternative flavor, which I’ll call Slice Theory, claims that objects are not space-time worms but are instead momentary slices of these worms. This paper will compare Worm Theory and Slice Theory. The differences, we will discover, are not nearly as great as has been believed. We will examine various advantages which each theory is purported to have over the other, but, I will argue, such supposed asymmetries rest upon confusion. In fact, properly formulated the two theories generate exactly the same truth conditions. Does this mean that both theories are correct? That is, have we uncovered an instance of Quine's indeterminacy of reference? The question of whether objects are worms or slices can be reformulated out of the material mode as the question of whether our expressions for objects refer to worms or to slices. Perhaps, though, when one theory says we refer to worms and the other says we refer to slices, they are saying the same thing, merely meaning different things by their statements. That is, perhaps they are mere notational equivalents. This, in any case, is the possibility I will pursue.

The Basics of Worm Theory and Slice Theory

According to Worm Theory, objects have temporal parts much as objects have spatial parts. My nose is a spatial part of me, me during my first year is a temporal part of me. A temporal slice, goes the story, is a spatially maximal momentary temporal part. To understand Worm Theory better, let’s consider a suggestive fragment of a semantic theory for English using the theoretical posits of Worm Theory. Because I wish to be quite careful about the new terminology being introduced, I will distinguish English from the new language, Wormese, and

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specify truth conditional equivalences between them. Thus we have, where \( t_u \) is the time of utterance:

“Tom was tall” is true in English iff “some slice of Tom prior to \( t_u \) is tall” is true in Wormese.2

Note that English contains tensed predications while Wormese contains only tenseless predications.

Slice Theory, the other flavor of temporal parts theory, also claims that our world is populated by worms and slices, but it differs in saying that people and everyday objects are time slices rather than time worms.3 An analogy may make the issue clearer. Just as Lewis claims that people and objects are restricted to a single world, so Slice Theory claims that people and objects are restricted to a single time. According to Lewis, statements about what is possible or necessary for some object are true in virtue of modal counterpart relations which that world-bound object has to objects at other worlds. Likewise, according to Slice Theory statements about what will or did happen to some object are true in virtue of temporal counterpart relations which that time-bound object (i.e., the slice) has to objects (i.e., slices) at other times. Thus, while slices have no future or past, we can speak of the future or past of objects which are those slices, all in virtue of counterpart relations invoked by talk of objects.4

In this way, the initial appearance of the implausibility of Slice Theory can be countered. For example, one might protest that objects are quite unlike momentary temporal slices, for objects persist through time and have histories while slices do not. But if temporal properties

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2Some might insist that temporal parts talk carries with it an ontological commitment to temporal parts, a commitment which is not captured in the translation schema I have sketched. They might insist that “the slice of Tom at \( t_u \) is tall” is true in Wormese iff “Tom is tall” is true in English and there are temporal parts. Since Worm Theory and Slice theory share the same ontological commitments, this issue is independent of the comparison of the two theories.


4More properly, while the Slicese predicate “has no future or past” is true of slices, English predicates such as “will be here tomorrow” are true of slices when the context invokes an object- or person-counterpart relation.
obtain in virtue of counterpart relations, as Slice Theory claims, then we can explain the
difference in temporal properties by the difference in counterpart relations, all despite the fact
that objects are slices. “Tom” refers to a person, i.e. to a temporal slice; however, this slice has
person counterparts with past and future slices whereas it doesn’t have slice counterparts with
past or future slices. Thus, we can say that this person was tall this morning and will exist
tonight and this slice was not tall this morning and will not exist tonight, even though this person
is this slice. In this way Slice Theory hopes to do with cross-temporal counterparts what others
do with referents that span time.

Worm Theory appeals to the same relation among slices, but where Slice Theory differs
is in the way it uses them. According to Worm Theory persons are four-dimensional time worms
which are sums of temporal slices. Of course, only some slices are slices of persons, and only
some sums of person slices are persons. According to Worm Theory, the I-relation is a
genidentity relation holding between any two temporal slices of a person. Thus, a person is a
maximal sum of I-interrelated slices. Slice Theory and Worm Theory both hold that there are
person slices and both hold that there are time worms which are maximal I-related sums of these
stages. Where they differ is that Worm Theory claims objects are the worms, whereas Slice
Theory claims objects are the slices.

Sider, the leading exponent of Slice Theory, tells us that “Tom” refers to the current slice,
or, rather, since there are a huge number of current slices at any time, it refers to the current slice
of the worm somehow associated with our use of the name “Tom.” Notice that we must pick
out the appropriate worm before we can pick out which slice we want. And, one may wonder, if
one can fix upon the desired slice only by first fixing upon the correct worm, doesn’t that suggest
that we are not in fact referring to the slice but to the worm? I will address this sort of worry
shortly, but let us push on.

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5 “Survival and Identity,” p. 59.
6 “All the World’s a Stage,” p. 449.
I have described Slice Theory generally, but I would now like to characterize it by means of its semantics. In the end I will return to consider whether my characterization is a fair one. For now, however, let s be the referent of the name ‘Tom’; that is, let s be the slice, at the time of utterance, of the time worm associated with the name ‘Tom’. Distinguishing English from the technical language of Slice Theory, call it Slicese, here is a sketch of Sider’s semantics:

“Tom was tall” is true in English iff “some slice is prior to t, is I-related to s, and is tall” is true in Slicese.

Again, English contains tensed predications while Slicese contains only tenseless predications.7

Thus, both Worm Theory and Slice Theory analyze past, present, and future tensed predications not as quantifications over times, but as quantifications over temporal slices — over all of the slices that make up the subject in the case of Worm Theory and over all of the slices I-related to the subject in the case of Slice Theory. The predicate is true of the subject iff a slice at the time indicated by the tense, what I’ll call the ‘target slice’ has the corresponding property. So far I have illustrated this with a simple predicate that can be analyzed in terms of the target slice having an intrinsic property. The predicate ‘tall’ is true of the subject iff a target slice is tall, ‘bent’ is true of the subject iff a target slice is bent, etc. I will call these temporally intrinsic properties.

7 It may seem strange to some that I distinguish English from Wormese or Slicese. After all, when a Worm Theorist says that there is some slice prior to the time of utterance that is tall, isn't she just speaking English? I distinguish the different languages exactly because I believe it is the conflation of homonymous terms that has given rise to so much confusion. Worm Theorists have addressed the problem of temporary intrinsics by saying that temporally intrinsic properties such as being bent are not relations but properties, instantiated by slices of an object. This means that there are two different notions of 'bent', the more basic property instantiated by slices, and the derivative relation instantiated by worms relative to a time. Care is needed lest the two become confused. Similarly, Slice theory invokes two notions of being bent. The more basic property of being bent is instantiated by the slice that exists at the time the object is bent, while the slice being referred to is bent in the derivative sense of bearing a bentness relation to a time.

Things are difficult enough with simple properties such as being bent. I will argue, however, that whether b and c are 'the same thing' is, much like b being bent, relative to a time. Thus there is a derivative relation, what I will call 'sameness', and the more basic relation from which it derives, viz. absolute identity. These two are much more difficult to keep straight.

I distinguish Wormese and Slicese from English so that we will not confuse the everyday terms with the homonymous technical terms philosophers have introduced. Of course, once we are attuned to the differences we can, and should, simply add the new terms to English and speak a newly enriched English. And, in fact, throughout the paper I will often omit quotations and specification of languages, in effect joining English, Wormese, and Slicese. But where care is needed, I maintain the separation.
Other predicates, which I’ll call *temporally extrinsic*, are analyzed in terms of the intrinsic properties of one or more slices that include slices *other than* the target slice. For example, the predicate ‘is growing’ is to be analyzed in terms of a continuous series of slices centered about the target slice, each of which is larger than its predecessor. In the case of Slice Theory, these slices will be slices I-related to the target slice, and in the case of Worm Theory, these slices will be slices belonging to the worm centered on the target slice. Predicates such as ‘is an ex-marine’ and ‘is a descendent of’ will require similar, though increasingly complex, analyses.

**Fixing Up Slice Theory**

Opponents of Slice Theory have raised some objections which Sider has already shown to rest upon confusion. I will now present a problem for Slice Theory which I believe can *not* be resolved given Sider’s formulation, for, simply put, Sider’s version of Slice theory gets the truth conditions wrong. Consider a case of fission, a case in which Al splits like an amoeba into Cal and Hal. I will assume that a person persists through time in virtue of psychological continuity, though which theory of personal identity is correct is actually independent of the present point. Since Cal and Hal have, we will assume, identical memories up through the time of fission but gradually differing memories thereafter, we can conclude that the worm associated with the name ‘Cal’ will consist of those slices prior to the fission called ‘Al’ and those slices following the fission called ‘Cal’. Similarly, mutatis mutandis, for the name ‘Hal’.

According to Worm Theory, an utterance at t of “Cal will be tall” is true iff a slice after t of the appropriate worm, i.e. the Al/Cal worm, is tall. This sounds reasonable. (Assume the

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8 The corresponding properties I call temporally intrinsic properties. Peter Simons calls these “time-blinkered properties” (Simons, p. 229).

9 We cannot simply say that ‘is growing’ is true of the subject iff a series of slices that are I-related to the subject (in the case of Slice Theory) or that are slices of the subject (in the case of Worm Theory) are continuously increasing in size. As cases of fission show, the slices I-related to the subject and the slices I-related to the target slice (for Slice Theory) or the slices of the subject and the slices of the worm centered upon the target slice (for Worm Theory), are not necessarily the same. For example, if I will fuse with retired Sgt. Bilko next week, then it is true that I will be an ex-marine even though it is not true that I was, I am, or I ever will be a marine.
referent of ‘Cal’ was fixed prior to the fission by some phrase such as “the person who will leave the duplication chamber wearing Al’s coat”). According to Sider’s formulation of Slice theory, however, the utterance is true iff some slice after t is tall and is I-related to the slice at t of the appropriate worm, i.e. the Al/Cal worm. When uttered after the fission we get the desired results, but if uttered before the fission, the sentence would be true iff a slice of the Al/Cal worm or a slice of the Al/Hal worm is tall, intuitively not at all what we want. In short, for cases of fission and fusion, it appears that Sider’s semantics don’t work.

10 Sider has suggested (in correspondence) the following reply: We cannot refer, prior to the fission, to an individual Cal who is distinct from Hal. Such a reference will fail and the objection with it. I think we can refer to individuals of the future, though supporting this would take us far afield into theories of reference. Instead, though, we can consider the temporally symmetrical problem instead. That is, let’s instead consider a case of Cal and Hal fusing to form Al and consider the sentence “Cal was tall” uttered after the fusion. We then have the same sort of objection, though it is not now open to Sider’s objection.

However, one might object that in cases of fusion there is not psychological continuity since Cal’s and Hal’s memories alter drastically at the time of fusion. Since there is continuity of some memories and there are causal chains preserving these, I think cases of fusion do satisfy psychological continuity. This issue too I will not address here. Let me note, though, that the same considerations come into play with cases of objects rather than people, where spatio-temporal continuity seems to underlie so-called identity through time, and in these cases it is more difficult to maintain that the fission of an amoeba and the fusion of two amoeba are not symmetrical.  

11 One response, suggested by Cian Dorr, Tim Maudlin, and Jeremy Pierce, is that I have been presupposing there is a single I-relation for all persons, i.e. an I_{person}-relation, but what cases of fission show is that we need to have a different I-relation for each individual. Thus, we get the correct semantics if we say: “Cal will be tall” is true iff a future slice is tall and is I_{Cal}-related to the current slice of the appropriate worm.

Such an approach seems contrary to the usual counterpart-theoretic spirit, for the thought underlying counterpart theory is that the general identity conditions for being of some type T provide the necessary cross-temporal identity conditions for being a T and, hence, provide the information necessary for specifying the counterpart relations for all individuals of type T. Once one knows what it is in general to be a person, one thereby knows the counterpart relations in virtue of which we can evaluate claims about any particular person. It is easy to see how, epistemically, we can have knowledge of counterpart relations for a type, since learning what it is to be of that type is learning, inter alia, the identity conditions, and thus the counterpart relations, for being of that type. But if we are to countenance token-relative counterpart relations, how could we learn what constitutes a particular counterpart relation for a particular individual, especially an individual with which we may not yet be acquainted? Intuitively, all I need to know about Cal to fully understand the truth conditions for “Cal will be tall” is that Cal is the person who will leave the duplication center tomorrow wearing Al’s coat. How can learning this be enough to learn what the I_{Cal}-relation is?

There is a simple response to this objection, for token-relative counterpart relations are simply type-relative counterpart relations constrained in some additional way. For example, person slices x and y are I_{person}-related iff x and y are I_{Cal}-related to each other and to the slice that will leave the duplication center wearing Al’s coat. This is simply a notational variant of the modification to Sider’s theory that I will be proposing. For, notice that the explication of the I_{Cal}-relation must talk of the slice which leaves the duplication center wearing Al’s coat — this, after all, is what it is to be Cal. Thus, it seems much simpler and more natural to say that the slice to which we are referring is not the current slice but is instead the mentioned slice, i.e., the slice which will leave the duplication center wearing Al’s coat. The current slice plays no role in the semantics and incorporating it as part of the semantics only makes them more complex.
There is a related problem. How do we analyze the sentence “Socrates was wise”? There is no current slice of Socrates, so we cannot apply Sider’s usual semantics. Sider claims that all tensed sentences are ambiguous between a de re and a de dicto reading, and, to handle this as well as other problems, he appeals to this ambiguity. Roughly speaking, on the de re reading “Socrates was wise” claims of Socrates himself, i.e. of the slice to which “Socrates” refers, that he has the temporal property of having been wise, i.e. of being counterpart related to some prior slice which is (tenseless) wise. On the de dicto reading, in contrast, “Socrates was wise” asserts that “Socrates is wise” once was true; in other words, this is a claim not about Socrates himself but about what once was called Socrates, saying that at some time there was a slice called “Socrates” and that slice is (tenseless) wise. And, argues Sider, while there is no de re reading of “Socrates was wise”, there is a de dicto reading, and this reading gives us the correct truth conditions. Similarly, suggests Sider, we can employ this strategy to solve problems with fission. “Cal will be tall” doesn’t receive the desired truth conditions if interpreted de re, but does if interpreted de dicto.

Notice that if this strategy works, it appeals to an ambiguity and to two different mechanisms for evaluating tensed sentences where Worm Theory posits no ambiguity and appeals to a single mechanism. A Worm Theorist already needs the distinction between de re and de dicto, but she needn’t say that everyday past or future tense sentences are ambiguous in

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12“All the World’s a Stage,” p. 450.
13 As Derk Pereboom has pointed out to me (in conversation), it is hard to see how such an account might work, for in fact Socrates was not called ‘Socrates’.
14 Moreover, Sider asks (in correspondence), aren’t there in fact two ways we can interpret “Cal will be tall”? I would respond that the natural de re interpretation of the sentence does not make it true if either branch will be tall. There is, perhaps, a very extended sense in which the sentence can be given those truth conditions, but the explanation, I believe, is akin to the explanation of how I can truly say “This ring was once a gold nugget lying on the bottom of that river.” In both cases we are using one expression (“Cal”/“This ring”) to fix upon a different, though closely related referent (Al/this gold).
15 And, because of problems with fission cases, this ambiguity is reflected in truth conditions that vary depending upon whether the subject still exists or not. If Einstein underwent fission or fusion, the truth conditions for “Einstein invented the bomb” differ depending upon whether he is currently living. For example, if Einstein fused with Smith to become Smithstein, then, 1) if he is still alive the sentence is true iff the slices called ‘Einstein’, the slices called ‘Smithstein’, or the slices called ‘Smith’ invented the bomb; and yet 2) if he is not alive the sentence is true iff the slices called ‘Einstein’ or the slices called ‘Smithstein’ invented the bomb.
this way. Moreover, it seems that the truth conditions that we will get with the de dicto readings will be exactly the same as what Worm Theory delivers: “Socrates was wise” is true iff some slice of the Socrates worm is wise. If Worm Theory does have problems, by incorporating the Worm Theory semantics for all de dicto readings it seems that Slice Theory will have adopted all the problems of Worm Theory.

The point can be pressed further. As traditionally understood, the ambiguity between de re and de dicto readings is pre-theoretic. We can understand how “Martha believes Jose is wise” can mean two different things independently of our theoretical or ontological commitments. One reading refers to Jose himself and therefore licenses substitution and existential generalization; the other is simply characterizing a belief Martha has using the name ‘Jose’ and therefore does not license substitution or existential generalization. Yet the appreciation of Sider’s ambiguity is not open to pre-theoretic characterization; common sense finds no analogous ambiguity with “Socrates was wise.”

Worse yet, if Sider is correct, then sentences traditionally taken to have both a de re and a de dicto reading are, contrary to appearances, not ambiguous. Consider the sentence “Martha believes Socrates was wise.” Intuitively, this has both a de re and a de dicto reading. The sentence might be claiming that Martha believes of Socrates that he was wise, whether or not she has any idea what his name is; or the sentence might be claiming merely that she has the belief “Socrates was wise”, whether or not there ever was such a person as Socrates. But though this is clearly ambiguous according to the usual classification, according to Sider’s theory there can be no de re reading of the sentence since there is no current slice of Socrates to which ‘Socrates’ can refer. Something is surely amiss!

I suggest that the problem with Sider’s formulation of Slice Theory lies with his claim that we refer to the current slice. This claim may have already struck some as unmotivated. Whether my reference to Tom obtains in virtue of the descriptions I associate with the name —

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16 I owe this point to Troy Cross.
e.g. that Tom was my second grade teacher — or in virtue of *causal connections* I’ve had with Tom — e.g. either the *direct* causal connection obtaining in virtue of me seeing Tom in second grade or the *indirect* causal connection between myself and Tom’s dubbing — these are not satisfied in any direct way by the current slice. If we are to pick out a single slice of the worm to which we are referring, it seems that our theory of reference should dictate which slice it is. But if not to the current slice, to which slice do we refer?

To examine the most general case, imagine a society where everyone undergoes fission or fusion every few months. To which slice would a name, e.g. 'Sheila', refer? It seems we want the slice to occur in that worm portion which most properly *is Sheila*. If there is one segment bracketed by branch points and it was during this period that the person was called ‘Sheila’, then perhaps we want the reference slice to come from *that* segment. One idea is therefore to select the slice that was initially dubbed ‘Sheila’.

So what we can do is alter Sider’s semantics to say that names refer to the slice initially dubbed by that name. In spirit, this is a move in the right direction, for we are now choosing the referent slice using considerations that are, at heart, the same as those that have been used by theories of reference more generally, i.e. theories that are neutral with respect to the ontology underlying our talk of objects. And, it seems, the choice of a referent slice *should* be motivated by our best theory of reference. Just as Kripke sought a connection to a unique referent *object* and found a solution with the causal tie to the dubbing, so too we as Slice Theorists have found a solution with a Kripkean account of the connection to a unique *slice*.

However, I think the same considerations that weigh against Kripke’s account as a theory of reference in general, also suggest that a Kripkean account is inadequate as a theory of reference to *slices*. For one thing, it is difficult to see how to generalize Kripke’s causal theory of the reference of *names*, for presumably the correct theory of reference should generalize to pronouns, demonstratives, etc. For present purposes, I do not care which theory of reference is correct. For whichever theory is the correct one, we can simply adopt it as Slice Theorists to select the referent slice. However, while I have no desire to get sidetracked into a discussion on
the correct theory of reference, I do need to sketch some arguments for theories of reference in order to defend the claim that Slice Theory can simply adopt whichever theory is correct. So let us push beyond the Kripkean theory.

Let's return to the case of Al who splits into Cal and Hal. Suppose I met Al before the fission, though I did not learn his name. Now, after the fission I say, “Let me dub that fellow Todd.” If we’re going to follow the idea that names refer to slices, then any claim I make about Todd should, intuitively, refer to a pre-fission slice, even though the dubbing occurred after the fission. This suggests that the dubbed slice is not the slice existing at the time of the dubbing but is the slice with which the dubber is acquainted. Of course, I might have thought back to my meeting with Al and just said, “That fellow sure was friendly” without using any name, in which case it still seems that I’m referring to the slice with which I was acquainted. And, hearing my words, you might even say you’d like to meet ‘him’, referring to Al by piggybacking off my reference, suggesting that some sort of causally mediated acquaintance is also sufficient for reference.

Similarly, what if I met Al briefly prior to his fission, but have long forgotten that meeting and have since become close friends with Cal after the fission, never learning that Cal goes by the name ‘Cal’ and thinking of him still as ‘Al.’ If I say, “Al and I are great friends, and Al is short,” it seems what I mean is that Cal is short, not Hal. So it seems in this case we want to use a slice following the fission. Again it seems acquaintance is the key. In case it seems I’m confusing speaker meaning with linguistic meaning, we can alter the case a bit. Shortly after the fission Hal moved away and, since nobody even knew about the fission and Cal himself forgot it due to a case of amnesia, Cal still goes by his old name, viz. ‘Al.’ Nonetheless, if I meet Cal and later say, “Al is short” it seems that I’m making a statement about Cal rather than Hal; i.e., in this case we are again referring to a post-fission slice of Cal’s.
I will not take this investigation further, for objections to Kripke’s theory have already appeared in the literature on theories of reference.\textsuperscript{17} So let me shift venues to some old theories of reference, i.e. reference to objects in general rather than reference to slices.

**Evans’ Causal Theory of Reference**

According to Evans’ causal theory of reference, the object to which I refer with a name is that object causally responsible for the beliefs I associate with that name.\textsuperscript{18} Thus, if I believe Washington was the first president, had false teeth, and was named ‘Washington’, each of these beliefs can, presumably, be traced back to Washington. Washington became the first president, and that event caused various people to think he was the first president which caused . . . which caused someone to write in a book that he was the first president which caused me, upon reading that book, to believe that he was the first president. Perhaps Washington’s teeth chattered and this was in fact the cause of the \textit{false} belief that he had wooden teeth; nonetheless, since it was Washington’s teeth and not someone else’s that chattered, it is to him that I refer when I speak of Washington.

No doubt there are many cases of what has been called ‘divided reference’ if this theory is correct.\textsuperscript{19} Thus, if it was actually Franklin who had the wooden teeth and if, through some mix-up, \textit{he} was the source of my belief that Washington had wooden teeth, then in speaking of ‘Washington’ I am in some sense partially referring to Franklin. The notion of divided reference has intuitive appeal if I tell you that I admire Washington, our white-haired thirteenth president who freed the slaves, since \textit{Washington} was named ‘Washington’ and had white hair yet \textit{Lincoln}

\textsuperscript{17}See Evans’ “The Causal Theory of Names.”

\textsuperscript{18} “The Causal Theory of Names.”

\textsuperscript{19} See, e.g., Igal Kvart, “Divided Reference,” \textit{Midwest Studies in Philosophy}; Vol. XIV, 1989, pp. 140-179. The ‘alternative’ to the idea of divided reference is that the referent is that which is the \textit{dominant} source of a person’s information. This, in fact, was Evans’ original line of thought, following the lead of descriptivist theories. Given the vagueness of ‘dominant’, I prefer to see the notion of divided reference as a more precise way of spelling out just how dominant one source is over another.
was the thirteenth president who freed the slaves.\textsuperscript{20} Cases of divided reference will be important when adapting Evans’ theory to Slice Theory.

I think Evans’ theory of reference comes closer than Kripke’s, though I think the full story is yet more complicated. However, as mentioned, for my purposes it does not matter which theory is correct. I will merely presuppose Evans’ theory for now since it has some intuitive appeal and since it raises various complications which we must consider.

Alterning Sider’s Account: Changing the Referent Slice

With Evans’ causal theory roughly characterized, let’s return to our examination of the view that we refer to slices rather than to objects that span time. We can now change Sider’s semantics to say that a name does not refer to the current time slice of an object but to the time slice \textit{causally responsible for the speaker’s beliefs associated with that name}. If I know of Renata only by seeing her photo once, then when I refer to her I am referring to the time slice of Renata that was photographed. Thus, an utterance of “Renata is in New Jersey” at \( t \) is true iff a time slice in New Jersey at \( t \) is I-related to the time slice that appears in the photograph. An utterance of “Renata was in New Jersey” at \( t \) is true iff a time slice that is in New Jersey prior to \( t \) is I-related to the time slice that appears in the photograph. Demonstratives, second-person indexicals, and even first-person indexicals presumably also refer to the object which caused the speaker’s beliefs about the object.\textsuperscript{21}

\textsuperscript{20} And perhaps we should weight our different sources of beliefs differently, even across various acts of referring. (As Evans says, “the believer’s reason for being interested in the item at all will weigh.” See his “The Causal Theory of Names,” p. 303.) If I were told that it was not Washington but Lincoln who freed the slaves, I might say that in that case it was Lincoln I meant when I said how much I admire Washington. If I then say that I like Lincoln’s hair and am told that it was actually Washington who had the white hair, I might say it was Washington I meant in \textit{this} case.

\textsuperscript{21} This allows demonstrative references to things that no longer exist. If I point up to ‘that’ in the sky, perhaps the star at which I am pointing exploded long ago. And it seems that “I saw you at a party”, appearing in a letter, can be true even if the addressee died before the words were written.

As previously mentioned, I am blurring over important distinctions between the reference of names and other sorts of reference, assuming that the correct theory of reference generalizes in some way.
This change to Slice Theory overcomes the problems we found before. An utterance of “Socrates was short” at $t$ is true iff a time slice prior to $t$ both is short and is I-related to the time slice which is causally responsible for the speaker’s beliefs concerning ‘Socrates’. That is, reference to dead people is now handled in a way no different than reference to the living. There is no need for a different mechanism, and, more importantly, one need not know whether the subject is still alive to know how to evaluate the sentence.

Similarly, the problems with fission and fusion disappear. If I speak of Al, my knowledge of Al is, ex hypothesi, caused by a time slice prior to the fission. Therefore, since reference is made to the slice causally responsible for the speaker’s beliefs, the truth value of a timeless sentence does not vary with the time of utterance in the ways they did according to Sider’s semantics. “Cal will be tall two hours after the fission,” uttered an hour after the fission and “Cal will be tall two hours after the fission,” uttered before the fission, will have the same truth value in either case, as we would expect.

When I refer to most objects and persons, I have multiple sources of information about them and, hence, my reference is ‘divided’. That is, if we are referring to slices rather than worms, then I will in fact be referring ambiguously to a multitude of stages. When I speak of Mom, I am referring to that slice that I saw when I first opened my eyes, I am referring to that slice I saw a millisecond later, and so forth, including an infinitude of slices up through the slice that finished saying “Good-bye” when I was last on the phone with her. But these are 'unproblematic' cases of divided reference. Any claim I make about Mom will be equally true or false no matter which slice we take as my reference. This is guaranteed by the fact that all ‘Mom’ slices are I-related to each other.22

The only problematic cases of divided reference we could encounter would be cases of fission and fusion, i.e. cases that should be ambiguous at the level of the sentence. If I met Al

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22 Unproblematic cases of divided reference are those in which the slices causally responsible for the belief all have the same set of I-related slices. Thus, a sentence involving a term with a divided is not unproblematic merely in virtue of the truth value of the sentence being the same on either disambiguation.
before the fission, and met Cal after the fission, not knowing about the fission and thinking of
this also as ‘Al,’ then my statement “Al is tall” will be a case of problematic divided reference,
since the truth conditions are ambiguous between saying that the current slice of Cal is tall, i.e.
where I'm referring to a post-fission slice, and saying that the current slice of Cal or Hal is tall,
(i.e. where I'm referring to a pre-fission slice. This, however, just parallels the ambiguity that the
worm account will encounter, an ambiguity we expect to find.

I have used Evans’ causal theory of reference to help illustrate how we can accommodate
a theory referring to slices rather than worms. But we can also consider a descriptivist theory of
reference. There will be the usual problems of fixing upon a single referent using descriptions,
and perhaps one taking this line will take a cue from causal theories and incorporate into the
descriptivist theory some requirements for causal relations. One may think, though, that a
descriptivist reference to a slice involves additional problems over a descriptivist reference to a
worm. If I say that ‘Shorty’ will be the name, applied rigidly, for whomever is currently the
shortest spy, then assuming names refer to slices any sentence using this name will refer to the
slice of the shortest spy at the time of my dubbing. If, on the other hand, I say that ‘Shorty’ is to
name the shortest spy in 1990, then, if the shortest spy had the same height throughout the year,
there is no way to fix upon a unique referent. However, this too will simply be a case involving
an unproblematic divided reference (unless, of course, there were different shortest spies at
different times during 1990, in which case we want our theory to deliver a problematic divided
reference). Whether we are considering a causal theory or a descriptivist theory, those cases in
which an expression refers ambiguously to a multitude of slices do not necessarily bring any
ambiguity at the level of the sentence.

Problems With Sameness

Several objections to Slice Theory as well as some to Worm Theory ride on how we are
to understand predications of things being ‘the same’ and its kin. I will therefore first examine
how we should understand such predications and then introduce the various objections and show how they are resolved with the proper understanding of ‘the same’.

Some philosophers have argued that identity is contingent or even temporally relative. Such disputes presuppose that when we speak of ‘identity’ we are latching onto the identity relation, but do we have specific enough intentions to fix upon only one relation? The usual characterization of identity is that it is transitive, symmetrical, reflexive, and obeys Leibniz’s Law, which says that $x = y$ only if they have the same properties. Setting aside worries about identity appearing on the right hand side of the law, our fix upon identity depends upon our fix upon what counts as a genuine property. For example, there are two ways one might make sense of intentional properties. One might, as is standard, say that Clark Kent is identical to Superman, that Lois Lane loves this person under the Superman mode of presentation but not under the Clark Kent mode of presentation. That is, ‘loves’ picks out not a relation between two people but a relation between two people and a mode of presentation; similarly, ‘is loved by Lois Lane’ picks out not a (relational) property but a relation between a person and a mode of presentation. In contrast, one might incorporate the mode of presentation into the identity of the individual, as it were, saying that because the property of being loved by Lois Lane belongs to Superman but not to Clark Kent, they thereby are not identical. Either interpretation is consistent with the fact that “Lois Lane loves Superman” is true yet “Lois Lane loves Clark Kent” is not.

One might respond, however, that a genuine property must be intrinsic, thereby disqualifying such perverse intentional ‘properties’ as genuine properties. This will nicely exclude these unwanted intentional properties, yet for many cases our fix upon what is intrinsic rides on our fix upon identity. If things are modally extended, existing in multiple worlds, then they have modal properties that are intrinsic to them, and thus such modal properties are genuine, and thus things differing modally will not be identical. But if things are world-bound, then their so-called modal properties are not intrinsic and thus not genuine, and therefore things appearing to differ modally can be identical. A similar problem besets those debating whether objects are temporally extended or if, as Sider insists, we are mere temporal slices.
To avoid this problem, I stipulate that by ‘absolute identity’ I mean to distinguish things by, inter alia, their temporal and modal properties; that is, I stipulate that these ‘properties’ are genuine according to my usage. Of course, there are a family of related expressions that all ride on the same underlying equivalence relation. The philosopher uses the expressions ‘the same’ and ‘identical’ interchangeably. And, if b and c ‘are identical’, then they are ‘one’ thing. If b and c are ‘not identical’, then they are ‘two’ things, 'different' things. The usage of plurals, definite and indefinite articles, and the copula likewise follow suit.

Everyday English, however, follows somewhat different rules for such expressions. Whether b and c are ‘the same’, whether b ‘is’ c, and whether there are 'one' or 'two' things often rides on an equivalence relation that does not depend upon properties extrinsic to the time and world in question. English allows that b and c were or will be different things and yet that b and c are nonetheless now ‘the same’ thing. A fortiori, English allows that b and c could have been different and yet that b and c are nonetheless actually ‘the same’ thing.

Thus, I am suggesting that there are two different relations picked out by ‘the same’, relations that philosophers have often conflated. The use of ‘the same’ I am highlighting expresses a temporally and modally relative relation I will call 'sameness'.23 Philosophers share these everyday intuitions about what is ‘the same’ in this sense, but their more explicit reasoning often invokes the relation I am calling 'absolute identity'.

As evidence for the claim that sameness is temporally and modally relative, note that non-philosophers state that the statue and the lump of clay are ‘the same’ thing, that the lump of clay ‘is’ a statue, that there is only ‘one’ thing on the mantle, all despite their just being told that the lump of clay has been sitting in the workshop for weeks and that the statue was formed from it just this morning or that the statue will be squashed tomorrow and the lump will then be sold.

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23 Our use of 'the same' does not conflict with the transitivity of identity for sameness is not absolute identity. Sameness is a transitive relation, but only relative to a time and world. If b and c are 'the same' at t at w, and c and d are 'the same' at t at w, then b and d are 'the same' at t at w, but because sameness is temporally and modally relative, b and c being 'the same' at t at w entails nothing about b and c at other times and worlds.
for its mineral value.24 Apprised of temporal or modal differences between the two, people do not hesitate in their claim that now there is only one thing, that now the statue and the lump are ‘the same’ thing. Similarly, describe Al undergoing fission, splitting to become Cal and Hal, and the non-philosopher will say that there was only a single person before the fission but he became two people, not dying at the time of fission but somehow living on as two different people. And, though the case is weaker, most would say something similar for cases of fusion, where two different people become one. Indeed this is not something merely elicited under the influence of a guiding professor, for people readily do say such things of their own accord. Science fiction has many stories of the fission of people, and Jadzia Dax, of the television series “Star Trek: Deep Space Nine”, serves as an example of a single person that is a fusion of what were two people, both of whose psychological make-up continues in a combined single individual.

The ambiguity I am highlighting is not new. According to White and Rea, Aristotle relied on a quite similar distinction.25 Wiggins, Johnston, and Thomson have distinguished the ‘is’ of identity from the temporally and modally relative ‘is’ of composition.26 It is true, they would urge, that ‘the statue is the lump of clay’, but that is because this means simply that the statue is composed of the lump of clay, i.e. is now composed of the lump of clay. Perry, Robinson, and Lewis distinguish two ways in which we count things.27 According to one way, the statue and the lump of clay are two things, for they differ modally, if not temporally. According to the other, the statue and the lump of clay are one thing, for to count in this way is to count by identity-at-t, i.e. to count in a temporally relative way.

24 Cian Dorr, describing his experience teaching undergraduates about the statue and the clay (personal correspondence), said the students “showed an unshakeable determination to say things about it that didn't make sense (stuff about how the clay 'takes on the identity of' the statue, etc. etc.).” One way to interpret these claims is as saying that the clay becomes ‘the same thing’ as the statue.
Of course, many philosophers have taken everyday claims of things being ‘the same’ to be claims of absolute identity and have denied colocation, simply by denying common sense in one or another way. By recognizing the temporal relativity of sameness, though, we can avoid these denials of common sense. We are not forced to deny what seems so obvious to so many; we can simply say that philosophers driven to such denials have conflated sameness with absolute identity.

We can now spell out the semantics for temporally relative claims of objects being ‘the same’. For Worm Theory we have:

“\(b\) and \(c\) are the same \(F\) at \(t\)” is true in English iff “the worm referred to by ‘\(b\)’ and the worm referred to by ‘\(c\)’ 1) satisfy the identity conditions for being \(F\)‘s, and 2) have identical slices at \(t\)” is true in Wormese.\(^{28}\)

And, correspondingly, for Slice Theory we have:

“\(b\) and \(c\) are the same \(F\) at \(t\)” is true in English iff “the slice referred to by ‘\(b\)’ and the slice referred to by ‘\(c\)’ 1) satisfy the identity conditions for being \(F\)‘s,\(^{29}\) and 2) are \(I_r\)-related to a single slice at \(t\)” is true in Slicese.

According to both theories, saying that \(b\) and \(c\) are the same \(F\) is to say two things. First, it says that both \(b\) and \(c\) are \(F\)‘s. Second, it says that \(b\) and \(c\) are the same, but for Worm Theory this is a sort-independent relation of sameness (at \(t\)) whereas for Slice Theory this is a sort-relative sameness (at \(t\)) relation.

So far I have suggested that the relation often picked out by everyday uses of ‘the same’ holds relative to a time. That is, I have suggested that \(b\) and \(c\) are often said to be ‘the same’ relative to one particular time. Notice, though, that with this sense of ‘the same’ we cannot say

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\(^{28}\) I speak of the two worms having identical slices. More generally I should say they have slices that are identical in all non-modal properties, for we might want to leave open as a possible form of Worm Theory, at least at this point, a theory which says that multiple slices can occupy the same spatio-temporal region yet differ modally. I will omit such niceties, though, since the main advocates of Slice and Worm Theory deny such coincidence.

\(^{29}\) To say that a slice \(s\) satisfies the identity conditions for being a \(F\) is to say that \(s\) is a \(F\) slice (i.e. satisfies the spatial requirements for being a \(F\)) and is \(I_r\)-related to a series of \(F\) slices that span an interval such that those \(F\) slices together satisfy the persistence conditions for \(s\) being a \(F\).
that \( b \) at \( t_1 \) is the same as \( c \) at \( t_2 \). That is, there doesn’t seem to be any means of having a cross-temporal relation whereby \( b \) and \( c \) are related by sameness. And, some may insist, English clearly allows such talk: “I am the same person who waved to you yesterday.” Likewise, “Cal, who is standing here now, and Hal, the person who will marry Sheila next year, are the very same person.” We might simply say that such cross-temporal claims of things being ‘the same’ are invoking absolute identity. But I think we can also accommodate such sentences with a relation that only relates things at a single time.

We can simply say that while the relation invoked by ‘the same’ does not span times, the things related, or at least their counterparts, commonly do, and thus these things can be identified by properties they, or their counterparts, have at other times. The sentence “I am the same person who waved to you yesterday” claims that sameness obtains now between the referent of ‘I’ and the referent of ‘the person who waved to you yesterday’, though these things now related by sameness also have features obtaining at other times, e.g. the latter’s waving to you yesterday. Of course, I and the person who waved to you yesterday are absolutely identical, so they are also related by sameness at all times at which they exist, but, say I, we can interpret the sentence as only asserting sameness at a time, something weaker than absolute identity. In contrast, while Cal and Hal are now ‘the same,’ next year, when Hal marries, they will not be. Hal persists through time: next year he will marry, but now he is ‘the same’ as Cal. Thus, a statement claiming that two things ‘are’ the same can be understood as predicating sameness now even if it identifies the relata in terms of properties they have at past or future times.\(^{30}\)

From the perspective of Worm Theory, sameness at t is the relation of sharing a slice at t. Thus, if two worms overlap for some interval and that interval includes the time t, then the two worms are 'the same' at t. Of course, a common case in which \( b \) and \( c \) are said to be 'the same' is when they are absolutely identical, in which case they will be the same at all times at which they

\(^{30}\) And, likewise, statements can predicate sameness at past or future times even if they identify the relata in terms of properties they have at other times: “My uncle, who is now in Chicago, was the same person who you talked to yesterday.”
exist. From the perspective of Slice Theory, b and c being 'the same' at t is the relation of b being I-related to some slice at t to which c is I-related. Again we can picture this by thinking of the worm consisting of all slices I-related to b (what Worm Theory says is the referent of 'b') and the worm consisting of all slices I-related to c (what Worm Theory says is the referent of 'c'); b and c are then 'the same' at t iff these worms overlap at t.

**Addressing Objections Based on Sameness**

With the temporal relativity of ‘the same’ clear, let’s now look at some objections which it dissolves. Sider concedes that Slice Theory “has costs”, for, he says, the

> concern is this: the fact that I was once a child and will one day be an old man is, according to the stage view, really a fact about two different objects, a stage that is a child and a stage that is an old man.31

Similarly, Sider admits that “When I look back on my childhood, and say ‘I am that irritating young boy’, the stage view pronounces my utterance false.”32 Notice, however, that though the slice that is a child and the slice that is an old man are different slices, they are the same person, as the semantics for the English expression ‘the same’ shows. Likewise, the slice that is the irritating boy and the slice that is Sider are the same person. According to the semantics of sameness that we have sketched, since these slices are I-related to a single slice at the time indicated by the tense, they are therefore to be considered the same person. Thus, Sider's concession is not necessary.33

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31 “All the World’s a Stage,” p. 447.
32 “All the World’s a Stage,” p. 446.
33 Could the ‘cost’ of Slice Theory that Sider concedes instead be a conflict with our intuition in Slicese that these are the same people? The difficulty with this proposal is that our intuitions are in English. Any Slicese intuitions that we have must be derivative intuitions; we must understand a Slicese statement by understanding its English translation, not by taking it to mean what the homonymous English claim means. Because Slice Theory analyzes tensed predications in terms of counterpart relations to other slices, and since Slice Theory takes the referent slice to be that slice causally responsible for the speaker’s beliefs, a Slicese claim that x is Φ must be understood in English as the claim that x was, is, or will be Φ at the time of its causing the speaker to have her beliefs about x. To say in Slicese that Tom is tall is to say in English that Tom was tall at the time that he caused my beliefs about him. The Slicese claim that the woman in the photograph does not persist must be understood as meaning, roughly, that the woman in the photograph did not, at the moment of being photographed, have a property intrinsic to that moment of time of existing throughout an interval of time, something that is trivially true. Finally, to say in Slicese that the woman in the photograph and the woman I met yesterday are different people is to be understood, roughly, as saying that the woman in the photograph was, at the time of the photograph, not instantiating any temporally intrinsic property in virtue of which she was identical with the woman I met yesterday, again considered only
Considering a similar objection to Slice Theory, Sider sees himself as forced to make ‘a partial retreat’.

If we take the ‘timeless perspective’ and ask how many people there ever will be, or how many people have been (say) sitting in my office during the last hour, the stage view seems not to have an easy answer. But this too is now easy to answer, as long as we don’t confuse English and Slicese. There were an infinitude of slices that sat in my office during the last hour, but according to our semantics for English claims of sameness these are all the same person.

Actually, we have only looked at the semantics for tensed English claims and Sider asks us to take the ‘timeless perspective’, so we need to determine how a tenseless predication of being ‘the same’ applies to the various slices that sat in my office this morning. I have advocated a temporally relative notion of sameness, but isn’t there also an absolute notion as well? The sentence “There are five people who have climbed Mt. Fuji” can be true even if the five people lived at distinct periods of history. In fact, for those that deny English has a temporally relative sameness relation I believe we can also answer the objections to Slice Theory using an absolute relation.

So what does it mean for x and y to be ‘the same’ in a tenseless way? One natural thought is simply that they must be the same at all times. A similar thought is that we should invoke Leibniz’s Law and say x and y are the same only if they have identical properties, including temporal and modal properties. And, since Slice Theory understands predications of

insofar as she existed at that moment I met her. We have incorporated into Slice Theory the assumption that objects persist in virtue of some relation extrinsic to a time, viz. being I-related, so this claim too will be trivially true, assuming the woman was photographed at a different time than when I met her. The point of Slice Theory is to analyze our statements using temporal counterpart relations. Slicese, the language that results after applying counterpart relations to English will, and should, therefore sound quite strange to the ear trained in English. Thus, we have no intuitions in Slicese. Cf. Hazen, “Counterpart-Theoretic Semantics for Modal Logic”, pp. 320-324.

34 “All the World’s a Stage,” p. 448.

35 One might object that temporal and modal ‘properties’ are not genuine properties, for they are extrinsic to the subject, i.e. to the referent slice. As a statement of Slicese, it is no doubt true that whether slice s is I-related to some other slice that is tall is a matter extrinsic to s and therefore the height of the other slice should not count as a genuine property of s for purposes of Leibniz’s Law. However, as a statement of English and, moreover, a statement about a person, the future height of Tom concerns Tom and only Tom. The strength of Slice Theory lies in its ability to deliver intuitively correct judgments of the truth of predications extrinsic to the time in question using counterpart theory. “Tom is growing” is thus not to be understood as saying that the slice is growing, but
temporal and modal properties using counterpart relations, this means x and y are (tenselessly) the same F iff x and y are I-F-related to all of the same slices. The key idea in Slice Theory is the use of temporal counterparts to trade talk of objects having temporally relative properties for talk of slices bearing counterpart relations to slices with corresponding temporally intrinsic properties. A Slice Theory analysis of English tenseless claims can likewise be understood as applying the same sort of counterpart analysis as for tensed claims. Thus, even understood as a tenseless claim, b being ‘the same F’ as c will still be spelled out in terms not of b and c being identical slices but of b and c bearing the appropriate I-relations, and, given this understanding, only a single person sat at my desk this morning, viz. me. Again, the conflict with intuition has disappeared.

The next objection is that according to the Slice theory, objects do not persist through time. Sider answers this as follows:

If by ‘Ted persists through time’ we mean ‘Ted exists at more than one time’, then the stage view does indeed have this consequence. But in another sense of ‘persists through time’, the stage view does not rule out persistence through time, for in virtue of its account of temporal predication, the stage view allows that I both exist now and previously existed in the past. Given that the stage view allows the latter kind of persistence, I think that the denial of the former sort is no great cost.36

In fact I think that Sider has again not gone far enough. What does it mean to say ‘Al exists at more than one time’? Presumably we are to think of Al as a person rather than a slice. It is also clear that ‘exists’ is not a present tense claim indicating that right now Al exists at more than one time. Instead this is some sort of tenseless claim, perhaps a 'historical present'. However we are to analyze this tenseless claim, it seems it must mean that Al did, does, or will exist at more than one time. But this too is easily accommodated by Slice theory, as Sider notes. It seems that any analysis of tenseless English statements that follows the same approach, i.e. applying temporal counterparts, will give us the desired truth conditions for sentences such as ‘Al exists at more than one time’. The objection rides on reading the sentence as bypassing the application of these

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36“All the World’s a Stage,” p. 446.
counterpart relations, i.e. as being a claim of Slicese rather than a claim of English. In short, it seems that the objection only carries through if we confuse the two languages, if we think that the Slicese statement that “Al exists at only one time” commits us to the English statement that “Al exists at only one time.”

Other similar objections also dissolve given the temporal relativity of everyday claims of sameness. For example, one might complain that you and I are referring to different people when we talk about Bob, since different slices are responsible for your and my beliefs about Bob. But even if it is true to say in Slicese that we are referring to different slices, we nonetheless are referring to what is the same person, understood as a claim of English. Or, as another example, one might question my attempt to explain away potential problems with ambiguous references as ‘unproblematic ambiguity’. For, consider the phrase ‘the shortest spy of 1990’. A Russellian analysis of ‘the’ requires a unique referent, and yet according to Slice Theory there may be no such unique referent since the shortest spy may have had the same height at different times in 1990. But, again, there is a single person, at least as we individuate people in English; it is only as a claim of Slicese that we can say there are multiple referents, for ‘multiple’ in Slicese when talking of slices does not entail ‘multiple’ in English when talking of people or objects.

Finally, we can dissolve a supposed advantage of Slice Theory. According to Sider, Worm Theory has costs because “the idea that in fission cases there would be two persons in a single place at one time is preposterous.” But we can defend Worm Theory using the same understanding of ‘the same’ we have been using to defend Slice Theory. Individuating things by their temporally intrinsic properties, i.e. counting by identity-at-t, there is only one person at a place. Both Worm Theory and Slice Theory agree on this, for counting people individuated by their temporally intrinsic properties just is counting slices. Thus, Worm Theory is not committed to the English claim that there are multiple colocated people. On the other hand, individuating

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37“All the World’s a Stage,” p. 439.
things by their temporally extrinsic properties, there are, prior to the fission, two worms in a single place. But again, both Worm Theory and Slice Theory agree on this, for on either theory, worms are the result of individuating people by their temporally extrinsic properties. In other words, if we are counting objects by absolute identity, i.e. individuating objects by their temporally extrinsic properties, then Slice Theorists must also agree that Cal was present before the fission, Hal was present at the same place and time, Cal was sitting down one hour after the fission and Hal was not sitting down one hour after the fission, and therefore there were in this sense 'two people' in a single place prior to the fission.

**How Similar are Worm Theory and Slice Theory?**

With some of the purported differences between Worm Theory and Slice Theory dismissed, we begin to see that in fact the semantics of Slice Theory are surprisingly similar to the semantics of Worm Theory! Let’s compare the two. Recall that with Worm Theory we have:

“Tom was tall” is true in English iff “a slice 1) belongs to the worm referred to by ‘Tom’, 2) exists before the time of utterance, and 3) is tall” is true in Wormese.

Correspondingly, with Slice Theory we have:

“Tom was tall” is true in English iff “a slice 1) is I-related to the slice referred to by ‘Tom’, 2) exists before the time of utterance, and 3) is tall” is true in Slicese.

Both say that some slice is tall. Both require that slice to precede the time of utterance. We are left with the single difference between the two accounts: Slice Theory requires that the slice be I-related to the referent slice, while Worm Theory requires that the slice be a slice of the referent worm.

However, even this difference dissolves upon closer inspection, for being a slice I-related to what Slice Theory calls ‘the referent slice’ just is being a slice of what Worm Theory calls ‘the referent worm’. Whether the correct theory of reference relies upon causal connections or descriptions, the same underlying mechanism can be adopted equally well by an account that
says that our expressions refer to slices or by an account that says that our expressions refer to worms. The theory of reference that says that my utterance of ‘Tom’ refers to a slice (or, ambiguously, to some slices) will pick out that slice (or those slices) that satisfies my beliefs about Tom or that caused me to have my beliefs about him. The theory of reference that says that my utterance of ‘Tom’ refers to a worm will pick out that worm that satisfies my concept of Tom or that caused me to have my beliefs about him. Remember, though, that according to Worm Theory the worm that satisfies some predicate (e.g., being bent) does so derivatively in virtue of being a sum of I-related slices, one or more of which satisfies the predicate in a more basic way. So the worm that satisfies my concept of Tom or that caused me to have my beliefs about him will simply be the sum of all slices I-related to the slice that satisfies my concept or that caused me to have my beliefs about him. Thus, Slice Theory and Worm Theory give different accounts of reference and different truth theories in terms of these referents, but the one difference compensates for the other. The net result is that, once we cash out all talk of ‘the referent’ in more basic terms, the two accounts generate exactly the same truth theorems!

**Understanding Claims that Identity is Relative**

The framework we have been developing for understanding Worm and Slice Theory gives us a perspective well suited for viewing various claims that identity is relative. Arguments that identity is temporally and/or modally relative originate in intuitions riding on the everyday sense in which the statue and the lump are 'the same thing'. Their mistake is in confusing this relation, what I'm calling 'sameness', with absolute identity, drawing conclusions about the nature of 'the' identity relation.

And how are we to understand claims that identity is sort-relative? Again, we can see such claims as confusing absolute identity with the everyday relation of sameness; if there is

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38Applying this to Gibbard, we might say that Gibbard is confusing absolute identity not with sameness, a temporally and modally relative equivalence relation, but with something between the two, a modally relative equivalence relation. See Gibbard’s “Contingent Identity”: “Meaningful cross-world identities of such things as statues, it begins to seem, must be identities *qua* something: *qua* statue or *qua* lump” (p. 100).
something correct about such theories, it is with the claim that *sameness* is relative to a sort. Worm Theory and Slice Theory disagree about whether sameness is relative to a sort, but, as before, this is a difference compensated by a disagreement over whether the determination of reference is relative to a sort.

According to Slice Theory, the claim that sameness is relative to a sort is fully on the mark. Whether b and c are ‘the same’ at t is not determined solely by the referents nor even by the state of the universe at t but also by the *sort-relative* counterpart relations invoked by talk of ‘b’ and ‘c’, for these counterpart relations determine whether the referent of ‘b’ and the referent of ‘c’ are counterpart related to a single slice at t. If I speak of ‘Goliath’, the context invokes, let us assume, a *statue* counterpart relation, a different counterpart relation than that invoked by talk of ‘Lumpl’, a lump of clay, even though ‘Lumpl’ and ‘Goliath’ might refer to the same slice. Thus, the English sentence “Lumpl and the lump of clay my sister gave me are the same thing” might be true while “Goliath and the lump of clay she gave me are the same thing” is false, if, for example, the clay making up the statue was replaced with lead earlier today, for then the current statue counterpart might be on the mantle while the current lump counterpart is in the garbage. Of course, according to Slice Theory the sort relativity of sameness is of a piece with the sort relativity of any temporally intrinsic predicate. Whether Lewis was bent yesterday depends not just upon the referent, a slice perhaps existing now, but also upon the sort-relative I-relation which connects the referent to the appropriate slices existing yesterday, the sort being something we associate with the name ‘Lewis’.

According to Worm Theory, in contrast, sameness is *not* sort relative, for sameness is determined by the two referents and the time at which they are supposed to be ‘the same’. And, likewise, other temporally intrinsic predicates are also not sort relative; whether the predicate ‘was bent’ is true of Lewis depends solely upon matters intrinsic to the referent of ‘Lewis’.

However, the germ of truth underlying the claim of sort relativity is that without a contextually salient sort we cannot say whether this at t is ‘the same’ as that at t*. According to Worm Theory, we are unable to identify the intended referents in the first place without their
sorts being identified, either explicitly through mention of the sort or implicitly through the context. This, though, does not mean that whether $x$ and $y$ are ‘the same’ is relative to a sort. Worm Theory says that I am unable to say whether ‘this on the mantle’ was on the workbench, was worth much money, or was the same as ‘that in the garbage’ last week because such expressions do not allow me to determinately fix upon a single referent. It is only in virtue of knowing the intended sort that I can fix upon the referent. But while we are unable to fix upon a referent without understanding its sort, whether one referent in fact is ‘the same’ as another is determined solely by matters intrinsic to the referents.\(^{39}\)

According to Slice Theory, in contrast, the determination of the referent is not a sort-relative affair. If I pick up what sits upon the mantle and talk about ‘this’, it is clear to which slice I am referring since there is only one slice in my hands, whether we describe it as a slice of a statue or a slice of a lump of clay.\(^{40}\)

Thus, according to Worm Theory, relativity to a sort enters into the picture in the determination of the referent, whereas according to Slice Theory it enters into the picture in the determination of whether a predicate is true of the referent. Notice, though, that \textit{these are compensating differences}. If we consider the sentence, “This will still be on the mantle next week,” both theories use the contextually invoked sort in order to pick out the worm comprising the slices over which the truth conditions quantify.

\begin{flushleft}
Was This Ring Once a Nugget?
\end{flushleft}

It seems reasonable to say, e.g., “This ring I am wearing was once a solid nugget lying on the bottom of the American River.” Yet, according to Worm Theory, when I speak of ‘this ring’ I am picking out a time worm that came into existence only when the gold was hammered into

\(^{39}\) Cf. Wiggins’ Thesis of the Sortal Dependency of Individuation. (See \textit{Sameness and Substance}, esp. ch. 2.)

\(^{40}\) I am discussing only how the sort relativity of persistence conditions or \textit{diachronic} identity conditions is handled by Worm and Slice Theory. Both theories will say that the determination of the referent is sort relative insofar as they are to handle \textit{synchronic} identity conditions. Point Theory, soon to be discussed, will take things one step further and say that neither synchronic nor diachronic identity conditions require the referent to be determined by the sort, though both require the evaluation of predicates to involve sort relativity.
the shape of a ring. The Worm Theorists cannot say that the ring preceded this time if she is to maintain the difference between the statue and the lump of clay which is key to her explanation of colocation and, more generally, of material constitution. It seems that, according to Worm Theory, the sentence should be not merely false but jarring since a ring could not have been a solid nugget. So why does saying “This potato was once a president” sound impossible while saying “This ring was once a nugget” does not? Is this evidence in favor of Slice Theory over Worm Theory or, worse, evidence in favor of the view that all that exists are quantities of stuff?

The Worm Theorist will have to say either that the statement is false, though by way of pragmatics it conveys something true about the quantity of gold of which the ring is made, or that the statement is true because ‘this ring’ somehow combines with intentions or context to refer to the quantity of gold rather than to the ring. If these are unacceptable positions then perhaps Worm Theory, or at least a Worm Theory of the sort we have been considering, should be rejected. I believe these positions can be defended, but my concern here is not with the defense of temporal parts theory in general but with the parallel between Worm Theory and Slice Theory.

And, as we see, Slice Theory faces a parallel dilemma. Because the sentence talks of ‘the ring’, the natural assumption is that the temporal predication invokes a ring counterpart relation. Thus, Slice Theory must say either that the statement is false, though by way of pragmatics it conveys something true using a counterpart relation for a quantity of gold, or that the statement is true because in the context 'this ring' somehow combines with intentions or context to invoke a counterpart relation for a quantity of gold.

Both theories invoke a sort-relative relation which defines the range of slices in virtue of which temporally extrinsic predications are evaluated. Whether Worm and Slice Theory can meet objections such as that being considered depends upon which I-relation is invoked in which circumstances. Worm Theory includes the I-relation as part of the theory of reference, while Slice Theory includes it in the application of the predicate to the subject, but the net effect on the
truth conditions is the same. Thus, the possible moves open to the Worm Theory exactly parallel those open to the Slice Theorist.

A single moral keeps appearing. The two theories give us the same truth theorems and thus, assuming truth conditions determine meaning, the two theories agree on the meanings of all sentences. Where they disagree, however, is over the meaning or reference of the words. Perhaps, then, we have stumbled upon an example of indeterminate reference. Since the truth conditions are the same, it may seem that there is no fact of the matter about which theory is correct. Perhaps, that is, both theories are correct and it is indeterminate whether Tom is a worm or a slice. In fact, the idea that our names refer to time slices did not originate with Sider in 1996 nor even with Perry in 1972 but with Quine’s *Word and Object* in 1960, which used time slices and undetached parts to illustrate referential indeterminacy. But before we explore whether this is indeed a case of indeterminacy of reference, let me take a detour to extend the parallel between Worm and Slice Theory to yet other theories.

**As with Time, so with Space and Worlds**

Sider has taken counterpart theory to heart. Lewis says that we don’t refer to individuals that span worlds, that talk of S’s being possibly φ is true in virtue of S, an individual who exists entirely at one world, bearing a counterpart relation to someone at another world who is φ. Sider makes the parallel move, saying that we don’t refer to individuals that span times, that talk of S’s having been φ or going to be φ is true in virtue of S, an individual who exists entirely at one time, bearing a counterpart relation to someone at another time who is φ.

And, it seems, we can take this one step further. We can say that we don’t refer to individuals that span space, that talk of S’s being φ at different locations is true in virtue of S, an individual who exists entirely at one point in space, bearing a counterpart relation to other people at other points who are φ. Thus, when I speak of Mom, I’m not referring to a persisting thing nor even to a thing that, though limited to a time, is spread out in space. Rather, I am referring to a single point in space-time. Which point? That point that is causally responsible for my beliefs
about Mom. In fact there is no single point that is causally responsible for my beliefs about
Mom, but this just shows that we have a case of unproblematic divided reference.

As always, we must be careful not to confuse languages. Some might object that an
object is not simply a point or collection of points which caused my beliefs about it. Surely,
goes the objection, Mom consists of something more than skin deep! But this is little different
than the objection to Slice Theory that Mom existed even while I was off at camp. According to
Slice Theory, Mom has the temporally extrinsic property of having existed while I was off at
camp in virtue of bearing the correct temporal counterpart relation to slices that existed while I
was off at camp. Similarly, according to Point Theory, Mom has the spatially extrinsic property
of existing at points I've never seen in virtue of bearing the correct spatial counterpart relation to
those points. All common sense claims come out true on the theory that we are referring to a
point, just as they do on the theory that we are referring to a stage.

Of course, we can make the same move in the reverse direction. We can say that Mom
spans not only space and time but also possibilities. That is, we can say that ‘Mom’ refers to a
trans-world individual, and any claim about what Mom could have done is true iff there is some
world-slice of Mom that did it.

We appear to have four different conflicting theories. The theories deliver the same truth
conditions, but according to one ‘Mom’ refers to a trans-world individual, what I will call a
hydra, according to another ‘Mom’ refers to a persisting but world-bound individual, according
to a third “Mom” refers to a time slice, and according to a fourth “Mom” refers to a space-time
point, or, perhaps more accurately, it refers ambiguously to a multitude of space-time points.

41 The requisite causal relation highlights a potential asymmetry between the different theories. Point Theory
assumes that it makes sense to speak of causal relations between space-time points. One with micro-reductionist
views would likely think this to be reasonable. The brick’s breaking the window consists in, one might think, the
many causal relations among subatomic parts. However, if this assumption is incorrect, then ipso facto a Point
Theory that identifies the referent as that point causally responsible for the speaker’s beliefs is incorrect. Similarly,
if it makes no sense to speak of a slice causally responsible for some belief, then ipso fact a Slice Theory that says
that the referent is the slice causally responsible for the speaker’s beliefs is incorrect.
There is a parallel between these four accounts, though, and to make this clearer let me sketch corresponding theorems from each of the truth theories.

S’s utterance of “Tom was tall” at t (where ‘Tom’ is understood to refer to a person) is true in English iff:

in Hydraese: 1) ‘Tom’ refers to a person time-world hydra, h; 2) there is some world-bound worm, a part of h existing at the speaker’s world, which has a time slice prior to t that is tall (h is the person hydra that was causally responsible for S’s beliefs about ‘Tom’).

in Wormese: ‘Tom’ refers to a person time worm, w, which is R-related to time worms which sum to hydra h; 2) there is some world slice of h existing at the speaker’s world which has a time slice prior to t that is tall (w is the person worm that was causally responsible for S’s beliefs about ‘Tom’).

in Slices: ‘Tom’ refers to a person time slice, s, which is R'-related to time slices which sum to worm w, which is R-related to time worms which sum to hydra h; 2) there is some world-bound worm, a part of h existing at the speaker’s world, which has a time slice prior to t that is tall (s is the person slice that was causally responsible for S’s beliefs about ‘Tom’).

in Pointese: ‘Tom’ refers to a space-time point, p, which is R''-related to space-time points which sum to slice s, which is R'-related to time slices which sum to worm w, which is R-related to time worms which sum to hydra h; 2) there is some world-bound worm, a part of h existing at the speaker’s world, which has a time slice prior to t that is tall (p is the space-time point that was causally responsible for S’s beliefs about ‘Tom’).

According to each of these theories, there is a point p (or collection of points) causally responsible for my knowledge of Tom, the points R’’-related to p compose a slice s, the slices R’-related to s compose a worm w, and the worms R-related to w compose h. In all cases, a statement about ‘Tom’ is true iff the slice with the appropriate relation to p satisfies the predicate. The theories do not differ one jot regarding what the appropriate relation to p is.
The theories only differ regarding what they identify as ‘the referent’ of the name ‘Tom’. According to Pointese p is ‘the referent’, according to Slicese s is ‘the referent’, according to Wormese w is ‘the referent’, and according to Hydraese h is ‘the referent’.

**Notational Variation?**

As we have seen, both Worm Theory and Slice Theory go through the same steps to determine whether a sentence is true. Under both theories, to determine if "Tom was tall" is true, you find a slice s causally responsible for the speaker's beliefs (or that fits the speaker's concept), you find a worm w consisting of all of the slices I-related to s, and the sentence is true iff a slice of w prior to the time of utterance is tall. According to both theories, the slice s and the worm w are used in exactly the same way. Slice Theory says, "both s and w are important: s is the slice causally responsible for the speaker's beliefs, viz. the referent, and w is the sum of all slices in virtue of which temporally extrinsic predicates about the person are evaluated, what we might call the referent (I_person-) expanded." Worm Theory says, "both s and w are important: s is the slice causally responsible for the speaker's beliefs, what we might call the referent determiner, and w is the sum of all slices in virtue of which temporally extrinsic predicates are evaluated, viz. the referent." Since s and w have the same role on both theories, we might wonder on what basis one theory calls s 'the referent' and the other calls w 'the referent'. On the face of things, theorists of the two camps are arguing past one another: what Slice Theory means by 'the referent' is what Worm Theory means by 'the referent determiner' and what Worm Theory means by 'the referent' is what Slice Theory means by 'the referent expanded'.

Pressing the point, we can imagine an artificially intelligent robot that goes through the steps mentioned above, retrieving a descriptor for the slice that it saw in the photograph, generating a descriptor for the worm constructed from this slice, and finally asserting "Tom was tall" in order to convey the information that some slice of that worm prior to the time of utterance is tall. Which of Slice Theory or Worm Theory better captures the robot’s semantics? It seems there is nothing about the robot, nor any other fact about the world, that determines this.
For that matter, what fact can we even imagine that could differentiate the two views? And, more to the point, it is hard to see how human cognitive processes could differ from the robot’s such that one theory correctly captures our semantics and the other does not. Again, it seems that the two theories do not differ in substance, that they differ only in that the ‘different’ theories use different expressions to pick out the same relation.

Both Worm Theory and Slice Theory can account for the same puzzles since they generate identical truth conditions. No ontological considerations have been offered — and it is hard to see how there could be — which distinguish them, for both endorse the existence of the same slices and worms. It thus seems that the two theories are in fact the same theory under different guises. This may strike some as utterly fantastic. After all, doesn’t Worm Theory claim that objects are temporally extended worms and doesn’t Slice Theory claim that objects are momentary slices of these worms? Not necessarily.

Worm Theory and Slice Theory can be characterized in two contrasting ways. According to one way, Worm Theory claims, e.g., that ‘Tom’ refers to a worm while Slice Theory claims, e.g., that ‘Tom’ refers to a slice. But I have presented Worm Theory and Slice Theory in a somewhat unusual way, saying instead that Worm Theory makes the Wormese claim “‘Tom’ refers to a worm” and that Slice Theory makes the Slicese claim “‘Tom’ refers to a slice”. That is, since Wormese and Slicese are not English, my characterization of the theories does not specify whether or not the Worm Theorist and the Slice Theorist are using the term ‘refers’ for reference or for some other, perhaps closely related relation. My presentation has been somewhat duplicitous, for I have, through my silence, undoubtedly fostered the view that the Wormese claim means what it seems to mean, viz., that ‘Tom’ refers to a worm, and the Slicese claim means what it seems to mean, viz., that ‘Tom’ refers to a slice. Anticipating a bit, however, I think Slice Theory avoids contradiction only if interpreted as not claiming that our

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42 The advocates of Slice and Worm Theory claim there is no ontological difference between the views. However, as David Christensen has pointed out to me (in conversation), if one could provide some sort of argument that worms exist but not slices, the more parsimonious Worm Theory would then have an advantage over the competing Slice Theory.
names refer to slices. The Slice Theorist, I hold, is following a well-worn Quinean path of confusing reference with closely related relations.

I have established a parallel between the truth conditions of the two theories. Yet this parallel is, presumably, a thoroughgoing parallel, extending to claims about persistence and reference as well. Thus, both theories say that the English sentence “Tom persists” is true, and both say that the English sentence “‘Tom’ refers to a persisting thing” is true. And, disquoting, according to both theories, Tom persists and ‘Tom’ refers to a persisting thing. It may be true that the Wormese sentence “Tom persists” is true while the Slicese sentence “Tom persists” is false, but these are not English, so this should concern us no more than if, in uttering “Empedocles leaped”, you utter something true in English but false in German. And, in fact, we know that the English sentence “Tom persists” means something different than the corresponding Slicese sentence since the former is true while the latter is false. Our debate is over. Objects persist.

An advocate of Slice Theory will likely protest, and rightly so, for I have constructed Slice Theory not around the claims that objects don’t persist or that names of objects refer to slices, but instead around the words “Objects don’t persist” and “Names of objects refer to slices”, words of a foreign language which don’t mean what the homonymous words of English mean. The Slice Theorist can therefore object that I have misrepresented the underlying spirit of Slice Theory, that in fact Slice Theory subscribes to the English claim “Tom persists” and the English claim “‘Tom’ refers to a momentary thing”. But is there any reasonable way for Slice Theory to maintain these claims? I don’t see how.

Let us first consider the Slice Theorist who claims that objects do not persist. I will assume that our Slice Theorist will still try to maintain the truth of most sentences by explaining tensed predications in terms of extrinsic relations to other slices; without this basic story, all true everyday tensed predications would be deemed false. So the Slice Theory we are considering now would say that “Tom was born sixty years ago”, “Tom rode horses when he was young”, and the like are true. But this means that all of the normal entailments deriving from the
meaning of ‘persists’ must now be denied. Slice Theory would be claiming that Tom was born sixty years ago but would be denying that Tom persists. Slice Theory would systematically contradict common sense both regarding the vast majority of entailments of statements about persistence and regarding the truth of the vast majority of statements about what persists. In short, it looks like we have every reason to believe that the Slice Theorist we are considering means something else by ‘persistence’ than we mean. Thus, denying that objects persist while maintaining their other intuitive temporal properties is not a realistic option. Of course, we might have wondered from the start why some temporally extrinsic properties, such as having been born sixty years ago or having ridden horses, are analyzed in Slice Theory in terms of extrinsic relations to other slices while another extrinsic property, viz. persisting, is not to be analyzed in a corresponding fashion.

Central to Slice Theory is the project of analyzing predications of properties extrinsic to the moment at which the referent exists by using counterpart relations to slices at other times. If only some predicates are handled in this way, the inevitable outcome are glaring conflicts with common sense, both as far as which claims are true and as far as the entailments that one expects to hold between predicates which are given a counterpart analysis and predicates that are not. But why not, then, analyze all predications of properties extrinsic to the moment at which the referent exists in the same counterpart-theoretic manner? It may seem that we need two sorts of analyses to allow us to 1) agree with common sense that Tom persists, and yet also 2) claim that ‘Tom’ refers to something that does not persist. But remember that the counterpart analysis is relative to a sort. Hence, we can easily talk about persons and say that Tom persists and yet later talk about slices and say that ‘Tom’ refers to a slice that does not persist, for the referent of ‘Tom’ is person-related to slices that exist at other times while the referent of ‘Tom’ is not slice-related to a slice that exists at another time. In short, it seems that we will face no problems if we give the same counterpart analysis, albeit a sort-relative one, to all temporal predications.

The problem, however, is that the counterpart analysis analyzes some temporal predicates in terms of others, and thus we can’t understand all temporal predications via a counterpart
analysis. The only grip we have on what the counterpart analysis is claiming is in virtue of the
grip we already have on the analysans, i.e., more basic claims of things ‘existing at times’ which
ipso facto must taken as everyday English. Similarly, the theory presupposes a grip on the
distinction between a slice, i.e., something that exists only at a moment, and a worm, i.e.,
something that exists at multiple times. If one thinks worms are things that exist at multiple
times, one is not understanding what it is to be a worm in terms of its extrinsic properties nor in
terms of its sort-relative properties — otherwise we would be unable to distinguish worms from
slices! Thus, if the Slice Theorist claims that she is analyzing the English predicate ‘exists at t’
using counterpart theory, either she will give an analysis in terms of some foreign sense of
‘exists’ or her analysis will be viciously circular as well as being unable to capture the sense in
which a worm exists at multiple times, what presumably is a more basic notion than the sense in
which a slice might be said to exist at multiple times.

The parallel between the truth conditions for Worm Theory and Slice Theory that we
have discovered is the secret to Slice Theory’s success, for only so can it save common sense as
well as Worm Theory. But this parallel is also its undoing, for it guarantees that the only claims
it makes that sound controversial are claims in Slicese, claims which mean something different
than what their homonymous translations mean and therefore claims we shouldn’t care about in
the first place.

Indeterminacy of Reference?

If the two theories are using the term ‘refers’ differently, then either a) one of the theories
is using ‘refers’ incorrectly, the position I have been urging, or b) both are equally correct in their
use of the term since the English term ‘refers’ is indeterminate. The latter alternative leads us
back to indeterminacy of reference — i.e., if ‘refers’ is indeterminate in meaning between a
relation between the name ‘Tom’ and a worm on the one hand and between the name ‘Tom’ and
a slice on the other, then what ‘Tom’ refers to is indeterminate. The indeterminacy of ‘refers’
does not require that the two senses of ‘refers’ be compatible, and in fact they are not, for Worm
Theory says “‘Tom’ refers to a worm and not a slice” while Slice Theory says “‘Tom’ refers to a slice and not a worm”. For those not convinced by my argument that Slice Theory uses “refers” to mean something other than reference, I’d like to show exactly why this is not a case of indeterminacy.

We can compare this case with a clearer case of indeterminacy of reference. Field has argued that the term ‘mass’ was once indeterminate.43

Before relativity theory was discovered . . . the word 'mass' was referentially indeterminate: it did not lack denotation, in any straightforward sense; on the contrary there are two physical quantities that each satisfy the normal criteria for being the denotation of the term.44

Special relativity distinguishes two similar but incompatible notions, 'relativistic mass', i.e. energy/c², and 'proper mass', i.e. nonkinetic energy/c². But, Field argues, there was nothing prior to the discovery of relativity that would establish that people meant one rather than the other. If we interpret them as meaning relativistic mass, then one of the central tenets of Newtonian theory would be wrong. If we interpret them as meaning proper mass, then another of the central tenets is wrong. Relativity theory shows that the conjunction of the tenets is wrong, but it doesn't dictate how to interpret the Newtonian term 'mass' and so it doesn't dictate which of the tenets is wrong.

Assuming Field has located a case of referential indeterminacy, how does this apply to the possibility that our terms are indeterminate between referring to worms and referring to slices? The answer is that we see a stark contrast when we compare Field’s case with ours. With 'mass' we have a choice of two different interpretations, both of which seem to fit the data equally well. If relativity theory were explained in full to nineteenth century scientists, they would be unable to say whether their word 'mass' means proper mass or relativistic mass. In contrast, with the debate between those saying objects persist and those denying this, we see no parallel parity. Asked if Tom is someone who exists for only a single moment or instead persists

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43 “Theory Change and Indeterminacy of Reference”.
44 “Theory Change and Indeterminacy of Reference,” p. 466.
through time, the answer is univocal. The voice of common sense sides firmly with the view that Tom persists, that 'Tom' refers to something that exists at multiple times.

The Quinean Argument

Quine has famously argued for the indeterminacy of translation using just the sort of compensating differences we have found. This, then, may be seen as another source of support for the view that Worm Theory and Slice Theory are both correct, even if interpreted as saying that names refer to worms and names refer to slices. Quine’s theses of indeterminacy of translation and indeterminacy of reference have seen much dissent, especially insofar as Quine limits the grounds upon which we can judge the acceptability of translations so severely, but even accepting his behaviorist grounds I think we can say something to justify the common hesitation in endorsing his conclusions. Surely I know what I’m talking about when I use the name ‘Peter’, and I’m certain it is not a mere part or stage of a rabbit. So goes the intuition. In what follows I wish to place a limitation on Quine’s thesis that may perhaps justify our common sense objection.

Quine argues that, because no behavioral evidence will determine whether the native’s word ‘gavagai’ is true of rabbits, of undetached rabbit parts, or of rabbit stages, there is no fact of the matter about what the true extension is. Things become more interesting, of course, when I apply these same ideas to my neighbor who appears to speak the same language as I, for, Quine argues, the same consequences follow. There is no independent fact of the matter about what my neighbor refers to when she speaks of ‘Peter’, he insists. We can either interpret ‘Peter’ as referring to a particular rabbit and ‘\( \phi \) was tall’ as meaning that the referent of ‘\( \phi \)’ has a slice prior to \( t_u \) that is tall.\(^{45}\) Or we can interpret ‘Peter’ as referring to a particular rabbit slice and ‘\( \phi \) was tall’ as meaning that the referent of ‘\( \phi \)’ is I-related to a slice prior to \( t_u \) that is tall. Both theories

\(^{45}\) Of course, Quine’s argument did not speak of time worms which are sums of temporal slices, but the Quinean compensating changes apply here very clearly. In fact, this is what makes possible the debate between Worm Theory and Slice Theory.
give us correct truth conditions, and both theories give us behaviorally kosher referents, and therefore, Quine tells us, both theories pick out correct referents.

There is a simple objection that is important to understand, though it fails. Even if the basis for a correct theory is behavioral, one might wonder, what about my neighbor’s disposition to utter, “‘Peter’ refers to a rabbit”? However, such dispositions do not count against Quine’s thesis, for the same Quinean ‘compensating adjustments’ will make this statement come out true on either translation. Thus, we can interpret her utterances either by saying that ‘Peter’ names a rabbit and ‘rabbit’ is true of rabbits, or by saying that ‘Peter’ names a rabbit stage and ‘rabbit’ is true of rabbit stages. Because the metalanguage, my own language, and the object language, my neighbor’s language, can differ in meaning, I can freely posit compensating changes wherever I wish throughout. Thus, even considering my neighbor’s use of ‘rabbit’, we can still pursue Quine’s thesis.

Quine, however, wants to go further yet. He claims that “the inscrutability of reference can be brought even closer to home than the neighbor’s case; we can apply it to ourselves.” But applying this to ourselves makes no sense. If my interpretation of my language speaks about my own words, then I am using my own language as both object language and metalanguage; thus, the meaning of ‘rabbit’ cannot shift in going from the object language expressions which I mention to the metalanguage expressions which I use. My neighbor is disposed to assent to the statement “‘Rabbit’ does not refer to rabbit stages”; this is behavioral evidence I try to accommodate. When considering my neighbor, I can both endorse her statement, “‘Rabbit’ does not refer to rabbit stages”, and yet claim that her term ‘rabbit’ does refer to rabbit stages, since her term ‘rabbit’ which I mention and my term ‘rabbit’ which I use can, ex hypothesi, mean different things. On the other hand, I too, as a subject of interpretation, am disposed to assent to the claim “‘Rabbit’ does not refer to rabbit stages”. But in this case I, as interpreter, cannot claim that my term ‘rabbit’ does refer to rabbit stages since the subject’s expression ‘rabbits’ as

46“Ontological Relativity,” p. 47.
it is mentioned in this claim must have the same meaning as the expression ‘rabbits’ as it is used by the interpreter. The Quinean compensating changes which come between subject and interpreter are precluded once we say that the subject is the interpreter. In short, I cannot coherently consider the possibility that my term ‘rabbit’ doesn’t refer to rabbits without flying in the face of the evidence that Quine himself considers paramount, viz. my behavioral dispositions.

One of Quine’s larger points is that the proper unit of meaning is larger than the single word. The point I have been stressing, that for me the reference of my words are determinate, does not conflict with this, for when I pick out a single word of my language and speak of its meaning, I am not isolating a word from the larger theory in which it is embedded. I cannot pick out the word ‘gavagai’, perhaps, and determinately say what it means because I will be trying to identify the meaning of a single word of the native’s language. Likewise, I cannot pick out the word ‘rabbit’ from my neighbor's idiolect and determinately say what it means. But when I pick out a word of my own language and say what it means, I am embedding the mention of that word in sentences of the same language as that word. The isolated expression ‘rabbit’ may be indeterminate in meaning, but when this expression is embedded in a sentence of what is, ex hypothesi, the same language, it regains its determinacy. That is, my expression ‘rabbit’ may be meaningless if we are looking for a meaning independent of its role in a larger theory, but once I consider its meaning and therefore embed it in sentences of the same language, then I am evaluating its meaning relative to a background theory.

Other people can interpret my language and say of my term “‘Rabbit’ can refer to rabbit stages”. But this does not conflict with anything I have said, for I can make sense of this as a true statement referring to my word ‘rabbit’ by interpreting their word ‘refer’ as meaning something different than my word ‘refer’ means. Thus, if my concern is with my own language, I can only see my words as having their intended referents. Quine has at most established only the indeterminacy of the reference of words taken in isolation, i.e. words being considered by one who does not speak the language in which they occur.
Some may think that I have conflated indeterminacy of translation with indeterminacy (or ‘inscrutability’) of reference. My focus on truth theories, one might complain, has steered me away from talk of the referents and toward a consideration of the translation scheme I can use for my own language; and thus it is hardly surprising that I can only translate ‘rabbit’ as ‘rabbit’ when translating from my idiolect to my idiolect. But, the objection continues, this point about translation still leaves open the semantic question of what my utterance of ‘rabbit’ refers to in the world, whether to rabbits or rabbit slices.

This objection assumes indeterminacy of translation and indeterminacy of reference can be separated, yet this is what I am resisting. Anyone discussing a possible reference relation, such as ‘rabbit’ being true of rabbits, will be using some language and thereby implicitly presupposing some language-world connection between the words she uses and the referent to which she is referring. If I say that my term ‘rabbit’ cannot refer to anything other than rabbits, as I use the language, she may reply that all I am really saying is that my term ‘rabbit’ cannot refer to anything other than what my term ‘rabbit’ refers to, a banal point. With this, I agree. And if she tries to go ‘further’ and say that she instead wants to discuss what it is in the world to which my term refers, then she can only succeed insofar as she presupposes word-world connections that come with her own language, a language which possibly differs from mine. However, if I try to go further and consider what it is in the world to which my terms refer, then, I think, the project collapses. For how can I consider the world but through my language, bringing back the problem of saying that my term ‘rabbit’ refers to something different than that to which my term ‘rabbit’ refers?47

47 Of course, there is the possibility that I have two languages. Perhaps I actually speak two languages. Or perhaps I speak only a single language but I think in another language or in some other way independent of my spoken language. In such a case, it seems I can coherently question in one language what the referents of the terms of the other language are. Does my use of ‘Kaninchen’ refer to rabbits? Even here, though, it is difficult to see how there can be indeterminacy. I certainly think that ‘Kaninchen’ refers to rabbits. Thus, I am disposed to asssent to the claim “‘Kaninchen’ refers to rabbits”, making any truth theory of mine incoherent which says otherwise. Similarly, if I can think about rabbits without using language, perhaps using some non-linguistic demonstration to latch onto rabbithood, then I can entertain the thought that ‘rabbit’ refers to the stages of those things. But again I am disposed to think that ‘rabbit’ refers to those things, not to their stages. Only if my use of one language is entirely independent of my use of the other could I coherently question whether, e.g., ‘Kaninchen’ refers to rabbits. But in
Actually, Quine’s argument reveals a possible limitation to the argument I have been presenting. I have assumed throughout that we all speak the same language, that we all mean the same thing by our homonymous terms. But I have not supported this. So we might say, more carefully, that I cannot say of my term ‘Tom’ that it refers to a momentary object, leaving open the possibility that you may speak a different idiolect and hence, as far as I can know, that perhaps your term ‘Tom’ does refer to a momentary object. Certainly this epistemic possibility is left open, and I have nothing to add to arguments against the stronger Quinean thesis that there is no fact of the matter.

**Conclusion**

I began by arguing that Slice Theory should be modified to bring it in line with our theories of reference. This fixes some problems with Slice Theory and, modified in this way, Slice Theory then matches Worm Theory truth condition for truth condition. This may seem to be a paradigm case of indeterminacy of reference, as Quine suggests. But several points argue against this view. First, the process of evaluating truth conditions is identical for Worm Theory and Slice Theory; the opposing theorists merely call different objects along this process ‘the referent’, suggesting that the theories disagree in name only, meaning different things by the term ‘refers’. Second, the method of evaluating temporal predications which is central to Slice Theory suggests that the English sentence “‘Tom’ refers to a momentary object” is determinately false; hence, it appears that the Slicese claim that “‘Tom’ refers to a momentary object” is merely a claim of a foreign language and means something different than what it means in English. Finally, Quine’s use of compensating changes, which is the major support given for the claim of indeterminacy, fails when applied to one’s own language. It therefore seems that the counterpart theory adopted by Slice Theory gives us an alternative to Worm Theory in name.

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this case it seems that ‘I’ have two cogitos, that I am in some sense two people, such that it would be unsurprising for me-the-speaker-of-English to wonder whether the term ‘Kaninchen’ as used by me-the-speaker-of-German refers to rabbits or not.
only, that Slice Theory and Worm Theory are not, as originally thought, contrasting metaphysical theses but are simply notational variants.
Cited Works


