

TENSE, MODALITY, AND SEMANTIC VALUES

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Section 1: Introduction

Here is a rough sketch of what I take to be an attractive, albeit naïve, picture (its attractiveness I take to be obvious; its naïveté, though perhaps also obvious, will be discussed shortly). A primary purpose of a semantics for a natural language is to compositionally assign to sentences semantic values that determine whether the sentences are true or false. Since natural languages contain contextually sensitive expressions, semantic values must be assigned to sentences relative to contexts. These semantic values are *propositions*. Sentence types may also be associated with higher level semantic values that are or determine functions from contexts to propositions (something like what David Kaplan calls “character”).¹

Propositions are the primary bearers of truth and falsity.² Propositions are also the objects of our attitudes: they are things we doubt, believe, and think. Further, sentences that contain verbs of propositional attitude, such as

1. Julia believes that Squaw Valley is a skier’s paradise.

assert that an individual stands in a certain cognitive relation to a proposition. In addition, there are various expressions that embed sentences, which I shall call *sentence operators*, that are such that the truth values of sentences containing them (relative to a context) depend in part on the propositions expressed by the sentences they embed (relative to the context).³ I shall put this by saying that the sentence operators in question *operate* on the propositions expressed by the sentences they embed. For example, the truth-value of a sentence (relative to a context) like:

2. Necessarily, a skier is an athlete.

depends in part on the proposition expressed by the embedded sentence (relative to the context) (and not merely on the truth value of the embedded sentence (relative to the context)).

Finally, other sentence operators, most notably tenses and temporal expressions such as ‘Sometimes’ as well as location expressions such as ‘In Carnelian Bay’, also operate on propositions: again, the truth value of a whole sentence containing such an expression (relative to a context) depends in part on the proposition expressed by the embedded sentence (relative to that context).

A nice, neat story if ever there was one! Yet it involves a quite significant and not very well concealed tension. According to the story, propositions are the objects of our attitudes and verbs of propositional attitude express relations between individuals and propositions; and modal operators, tense operators, and location operators all operate on propositions. For all this to be so, (at least some) propositions must vary in truth-value across worlds, times and locations *and* be the objects of our attitudes. For if e.g. a location operator such as ‘In Carnelian Bay’ operates on propositions and is not vacuous, then the truth value of a sentence containing it (in a context) must depend on the truth value of the proposition expressed by the sentence it embeds (in that context) *at Carnelian Bay*. In particular, whether a sentence like:

3. In Carnelian Bay there is a boat launching ramp.

is true or false (relative to a context) depends on whether ‘there is a boat launching ramp’ expresses a proposition (in that context) that is true or false relative to or at Carnelian Bay. If ‘there is a boat launching ramp’ expressed a proposition (relative to that context) that didn’t vary its truth-value over locations, the location operator ‘In Carnelian Bay’ would be vacuous, and the sentence would “feel” like ‘In Carnelian Bay arithmetic is incomplete.’ But it doesn’t! In an exactly similar way, if tense and modal operators operate on propositions and are not vacuous, propositions must vary their truth values across times and worlds. And finally, again, propositions are the things we believe, doubt and so on.

But now the tension present in our neat story is all too clear.⁴ On the one hand, as we have seen, if the relevant tense, location and modal operators operate on propositions and are non-vacuous, propositions must vary in truth-value across times, locations and worlds. On the other hand, though it seems correct to hold that the things I believe, doubt, etc. can change truth value across *worlds* (i.e. some of the things I believe are true though they would have been false had the world been different), it is hard to make sense of the idea that the things I believe may change truth value across time and location. What would it be e.g. to believe that the sun is shining, where what I believe is something that varies in truth-value across times and locations in the actual world? It seems clear that when I believe that the sun is shining, I believe something about a particular time and location, so that what I believe precisely does not vary in truth value over times and locations. Further, powerful arguments have been given against the view that the objects of belief are things that change truth-value over time.⁵ So it appears that propositions must

and must not change truth-value across time and location. Something has to give.

On the basis of considerations such as these, David Lewis [1980] argues that in an important sense, propositions aren't semantic values of sentences at all, not even relative to context. Lewis agrees that for a variety of reasons, we need to assign propositions to sentences in contexts.⁶ But he claims that even if we adopt an approach to semantics that assigns semantic values to sentences relative to contexts, these can't be propositions, the things that are objects of our attitudes.⁷ They will, however, be the things that modal, tense and location operators operate on. Further, on this way of doing semantics, the assignment of these non-propositional semantic values to sentences (relative to context) is its primary task. The assignment of propositions to sentences relative to contexts is quite secondary and is not even a job for compositional semantics!

Friends of propositions will not be happy to see them demoted in this way. But if we go this far with Lewis, much more radical and unhappy conclusions threaten to follow. As indicated, on an approach to semantics on which we assign sentences semantic values relative to contexts, Lewis argues these values cannot be propositions. As the above comments suggest and as we will see below, the reason is that in many cases in which a sentence is embedded in a larger sentence, what the embedded sentence taken relative to context contributes to the semantic value of the larger sentence in that context cannot be a proposition. So assigning sentences propositions relative to contexts won't in the general case capture the contribution sentences make to the semantic values relative to contexts of larger sentences in which they occur. Thus in addition to assigning sentences propositions relative to contexts, we must assign sentences semantic values relative to those contexts that *do* capture the contributions such sentences make to the semantic values relative to the context of larger sentences in which they occur. Let us call the latter *compositional semantic values*, since they are the values that sentences contribute to the semantic values of larger sentences of which they are parts.

So according to Lewis, on the one hand, we assign to sentences relative to contexts *propositions*, which capture the beliefs sincere speakers express by means of their utterances and what it is that they assert. On the other hand, we also need to assign to sentences relative to contexts (non-propositional) *compositional semantic values*, to capture the semantic contribution sentences relative to contexts make to the semantic values relative to contexts of larger sentences in which they occur. These two kinds of semantic values appear to be close analogues of Michael Dummett's [1991] *assertoric content* and *ingredient sense*. Roughly, the former captures what is asserted by an utterance of an unembedded sentence; and the latter captures the semantic contribution embedded sentences make to the semantic values of the larger sentences of which they are parts. Though semanticists have not been quick to embrace Dummett's view that sentences have both of these two kinds of semantic values

(and that they are distinct), Lewis can be construed as providing an *argument* that this is in fact the case. Now this is where trouble begins.

Jason Stanley [1997a] precisely construes Lewis as providing an argument to the effect we need to assign to sentences both ingredient senses, Lewis's compositional semantic values, and assertoric contents, Lewis's propositions.⁸ Further, Stanley argues that once we see that what a sentence contributes to the semantic value of larger sentences containing it cannot in general be identical to what the same sentence taken unembedded asserts, the reasons for adopting a well entrenched semantic thesis are undermined. The thesis Stanley calls *the rigidity thesis (RT)*: no rigid term ever has the same content as a non-rigid term.⁹ Why believe RT? Well suppose 'Aristotle' (which I assume is rigid) and 'the greatest student of Plato' (which I assume is not rigid) have the same content. Then the sentences:

4. Aristotle is Plato's greatest student.
5. The greatest student of Plato is Plato's greatest student

also have the same content.¹⁰ But 4 and 5 can't have the same content, because they have different modal profiles. So 'Aristotle' and 'the greatest student of Plato' don't have the same content. Thus, RT. But wait, Stanley says. Lewis has shown that each of 4 and 5 needs to be assigned a semantic value that captures what it asserts unembedded (relative to a context): something like Dummett's *assertoric content*. And they need to be assigned semantic values (relative to a context) that capture what they contribute to the semantic values (relative to a context) of larger sentences in which e.g. temporal and locational operators embed them: something like Dummett's *ingredient sense*. Now when we consider the modal profile of sentences such as 4 and 5, the question is: are we considering a property of the sentences' assertoric contents or of their ingredient senses? If the latter and if we assign assertoric contents and ingredient senses to sub-sentential expressions, we can consistently hold that a rigid and non-rigid term have the same assertoric content and that so do sentences such as 4 and 5.¹¹ Thus, we can hold that 4 and 5 have different ingredient senses, and our intuitions about their modal profiles track this, while having the same assertoric contents. This contradicts RT, *if* we understand 'content' in RT to be assertoric content. But it appears proper to understand it this way, since the contents of rigid and non-rigid terms are supposed to be what they contribute to the contents of sentences containing them. And the contents of sentences are what is asserted by utterances of them.

Now Stanley wouldn't actually want to rest his case against RT on an example like 4 and 5. For the claim that 4 and 5 have the same assertoric content and so "assert the same thing" (when uttered in the same context) doesn't look very plausible. Stanley would prefer to consider a case like:

6. The actual President of the US came by.

7. The President of the US came by.

in which it is at least somewhat plausible to hold that utterances of the sentences in the same context “assert the same thing”. Or consider a case in which a name is introduced by a reference fixing description thus: let ‘Julius’ denote the inventor of the zipper. Further suppose that competence with the name requires knowing this. Then again it is not implausible to hold that the following sentences have the same assertoric content, so that utterances of them “assert the same thing”:

8. Julius was born in New York.

9. The inventor of the zipper was born in New York.

If any such pair of sentences can be held to have the same assertoric content, RT is refuted.

One way of summarizing Stanley’s point here is this. If, as Lewis argues, in addition to assigning to sentences (relative to contexts) elements that capture what they assert when unembedded (“assertoric contents”), we need to assign to sentences (relative to contexts) elements for tense and locational operators to operate on (“ingredient senses”), why think that modal operators don’t operate on these latter as well, and that these ingredient senses are the things with modal profiles?¹² If that were the case, then sentences (relative to context) that have different modal profiles may nevertheless have the same assertoric contents and so assert the same thing. If we identify a sentence’s content (relative to a context) with what an utterance of it is used to assert (in that context), then sentences with differing modal profiles may have the same content, and sub-sentential expressions with different modal properties (rigid vs. nonrigid) may have the same content, contrary to RT.

Even while seeing the abstract possibility here, some readers may wonder how “what is asserted” by a sentence in fact can fail to be what modal operators operate on. We are so used to thinking of “what is asserted” as being what modal operators operate on that this may sound almost incoherent to some. Here it is worth noting that *one* way of developing a “two dimensional semantics” would be to hold that often what is asserted by a sentence in a context is the *diagonal proposition* expressed by the sentence in that context; but it is the *horizontal proposition* expressed by the sentence in the context that is operated on by modal operators. On such a view, “what is asserted” by an utterance of a sentence is one thing and what modal operators operate on is another.

And indeed, having raised the spectre of two dimensionalism, I should say that Stanley is properly construed as arguing that there is a very direct route to a version of a two dimensionalist semantics that is based straightforwardly on purely semantic considerations. For I think he should be understood as claiming that Lewis has shown that given the proper semantics for tense, modal and

location operators, we are forced to posit two sorts of content, or two “semantic dimensions” for sentences: one that captures what a sentence asserts and one that captures what a sentence contributes to a larger sentence of which it is a part when it is embedded under operators. I believe that Stanley took this argument in favor of a sort of two dimensionalist view to be particularly hard for philosophers of language to resist, since it is based only on considerations having to do with the proper semantics for modal, tense and location expressions, and e.g. doesn’t make assumptions, which are controversial to many, about capturing epistemic properties by semantic means.¹³ In this, I think Stanley is right: if considerations having to do with the semantics of modal, tense and location expressions drive us to a two dimensional semantics, then we philosophers of language are stuck with two dimensionalism.¹⁴

Now recall that Stanley’s attack on RT and defense of a version of two dimensionalism was predicated on Lewis having provided an argument to the effect that we need to assign to sentences both propositions/assertoric contents and compositional semantic values/ingredient senses. Further, the demotion of propositions to objects of secondary importance in semantics and the correlative enshrinement of non-propositional compositional semantic values as objects of primary importance was similarly predicated. The point of the present work is to show that friends of RT and of the semantic primacy of propositions and opponents of the sort of two dimensionalism defended by Stanley need not worry on this account. Contrary to what Lewis claims, we need not assign to sentences relative to contexts both propositions *and* compositional semantic values. Propositions can be compositionally assigned to sentences relative to contexts, and no second semantic value of the sort countenanced by Lewis is needed.

The plan of the paper is as follows. In Section 2, I present Lewis’s argument that the compositional semantic values assigned to sentences relative to contexts cannot be propositions. I end by emphasizing two important claims Lewis makes in his discussion. In Section 3 I discuss the views of Mark Richard and Nathan Salmon on the issues Lewis raises. I make some criticisms of Richard and Salmon in this section (there are other criticisms as well however—see below). But the material in Section 3 is independent of the main argument of the present paper, as I discuss in the beginning of that section. In Section 4, I provide a response to Lewis. In so doing, I reject the two important claims Lewis makes that I highlight in Section 2. Since, as I mention in Section 3, Richard and Salmon concede these claims of Lewis’s, my rejection of these claims constitutes a criticism of Richard and Salmon. In Appendix 1 I discuss possible responses to Lewis other than the one I give. Appendix 2 discusses data on tense that will be mentioned in Section 4. I have organized the paper in such a way that the reader who wants a bear bones view of the main argument of the paper, or the reader who wishes to make the minimal initial investment, may read only Sections 1, 2 and 4 (though I recommend reading the first three paragraphs of Section 3 as well).

Section 2: Lewis's Argument

Lewis's argument that propositions cannot be compositional semantic values comes in the context of a discussion of more general issues. To avoid distorting Lewis, I think it wise to sketch the issues Lewis is addressing. So let us begin with this task.

Lewis claims, and I agree, that it is the (or at least, *a*) job of a syntax and semantics for English (roughly what Lewis calls *grammar*) to deliver a characterization of truth-in-English. Lewis notes that whether truth-in-English is achieved by the utterance of a sentence depends not just on the sentence uttered and what the facts are, but also on various features of the context of the utterance of the sentence, such as who is speaking, who is being addressed, what time it is, and so on. Since English sentences are contextually sensitive in all sorts of ways, in order to characterize truth-in-English, we *at the very least* need a characterization of what it is for a sentence to be *true relative to a context*.

But Lewis argues that a characterization of truth in a context for sentences, or making the truth of sentences context dependent, is not enough. The problem is that often, whether a sentence is true in a context depends upon whether some other sentence is true relative to the result of shifting just one feature of the context. That is, languages contain "feature shifting" sentence operators. For example, whether 'It is possible that the Earth is flat' is true relative to my present context depends on whether 'the Earth is flat' is true relative to some result of shifting only the world feature of my present context. But now what sort of thing *is* a result of shifting only the world feature of my present context? Lewis thinks that this thing is not itself a context. According to Lewis, a context is a space-time location in a possible world. But the result of shifting just one feature of a context will not be a space-time location in a possible world and hence won't be a context. Indeed, Lewis claims that the result of shifting just one feature of a context is *never* a context.¹⁵ I am unsure whether this conclusion depends on idiosyncrasies of Lewis's views, for example his modal realism and accompanying counterpart theory. But it is at any rate clear that *sometimes* the result of shifting just one feature of a context is not a space-time location in a possible world and hence not a Lewis context. For example, consider a context containing a speaker and addressee, and shift the world feature of this context to a world where people don't, never have, and never will exist. Then the result of this shift can't be a space-time location in a possible world, since it would consist of a speaker and an addressee and a world in which no one ever exists.

Further, even if we don't take contexts to be space-time locations in possible worlds, there still is reason to think that the result of shifting just one feature of a context is at least sometimes not a context. As David Kaplan pointed out, if we want sentences like 'I am here now' (or insert your favorite example) to be true in all contexts, contexts must be *proper*: the speaker of the context must be at the location of the context at the time of the context in the

world of the context. But the result of shifting just one feature of a context may result in something improper: as in the case described above, the speaker of the context may not exist in the world that results from shifting only the world feature of the context. Thus, I think we should at least agree with Lewis that the result of shifting one feature of a context *may* not itself be a context.

But then since, as pointed out above, the truth of a sentence in a context often depends on the truth of a different sentence in the result of shifting one feature of the context, in the general case, the truth of a sentence in a context often depends on the truth of another sentence in something that isn't a context. Thus it appears that our characterization of truth must be a characterization not simply of a sentence being true in a context, but of a sentence being true in a context with respect to these things that result from shifting only one feature of a context. Following Lewis, let's call these latter things *indices*. Then we need to characterize a sentence being *true in a context with respect to an index*.

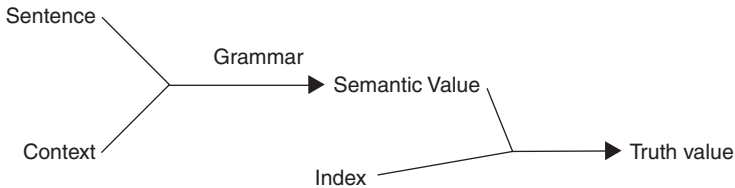
Of course, as I hinted above, there is other pressure to have this double dependence of truth on context and index. On the one hand, we need contexts to provide the semantic values (in that context) of contextually sensitive expressions. On the other hand, we need indices so that the sentence operators in our language have something to shift. And so in languages, such as English, containing contextually sensitive expressions that designate and sentence operators that shift *the same kind of thing* (in the way 'actual' and 'It is possible that' do), we need context to be *unshiftable* and to provide the semantic values to contextually sensitive expressions (even if they occur deeply embedded with respect to various operators) and we need indices whose features are shifted by our operators. So again, in such languages, we need truth to depend on both context and index. So whether or not I agree with the details of Lewis' argument that we need to characterize the notion of a sentence being true with respect to a context and index, I do agree that we need to characterize this notion and that this is one of the primary tasks for semantics.

We should remind ourselves at this point that what *features* or *coordinates* indices must have will be determined by the sorts of sentence operators that are present in the language. For indices are the things whose features are shifted by operators, and thus whether an index must have a given feature depends on whether there are operators in the language that shift that feature.¹⁶ Thus, if, as Lewis believes, the language contains temporal, modal, location and standard of precision sentence operators, an index must have as coordinates times, worlds, locations and standards of precision. This point will be important later.

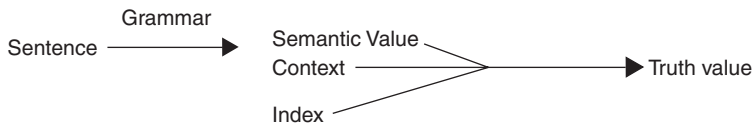
So, we wish to assign semantic values to sentences in a compositional way, so that the semantic value of a sentence is a function of the semantic values of its parts and how they are put together, and in so doing characterize a sentence's being true with respect to a context and index.

Now, Lewis asks, given this, what sorts of semantic values should we assign to sentences? There appear, he says, to be two options. Our syntax and

semantics could assign semantic values to sentences relative to contexts, so that what semantic value a sentence has varies with context. This semantic value would then be, or determine, a function from indices to truth-values. Following Lewis, call these *variable but simple semantic values*. Lewis provides the following picture:



The other option is to have our syntax and semantics assign to a sentence a semantic value once and for all, and let this semantic value be, or determine, a function from indices *and* contexts to truth-values. Following Lewis, call these *constant but complicated semantic values*. Again, Lewis provides a picture:



It should be clear that the assignment of either sort of semantic value allows us to characterize the notion of sentence being true with respect to a context and index. And Lewis notes that given either sort of semantic value, it is easy to define the other in terms of it. Thus, one can easily convert the one sort of semantic approach into the other.¹⁷ Lewis writes:

Given the ease of conversion, how could anything of importance possibly turn on the choice between our two options?... How could the choice between the options possibly be a serious issue?¹⁸

Lewis then notes that both Stalnaker and Kaplan have defended the first option on which semantic values are variable but simple. Lewis goes on to argue that neither Kaplan nor Stalnaker succeeds in showing that this option is preferable. Because I want to defend something like Stalnaker's view against Lewis, I shall only discuss Stalnaker's defense of variable but simple semantic values and Lewis' response to it.

On Stalnaker's [1970] view, syntax and semantics "determine an interpreted sentence", which, together with a context, determine a proposition. A proposition together with a possible world determines a truth-value. Thus, we can see that Stalnaker's account is a version of the variable but simple semantic value option, with propositions as semantic values. We can make this clear by

annotating Lewis's picture of variable but simple semantic values with labels indicating what Stalnaker takes semantic values and indices to be:



Stalnaker defends this account against an account that merges context and index, and assigns to sentences a semantic value that is, or determines, a function that maps these merged contexts/indices to truth-values. This would be a version of the constant but complicated semantic value option (actually, not quite—see note 19).

Stalnaker's argument in favor of variable but simple semantic values is extremely straightforward. On this view, there is an "extra step on the road from sentences to truth values". That is, (on Stalnaker's version of this view) we map a sentence and a context to a proposition, which is something that maps a world to a truth-value. On the opposing view, we map a sentence from a merged context/index straight to a truth-value. So, Stalnaker says, the former approach, which involves the "extra step", is only justified if what the extra step delivers, namely, propositions, are of some "independent interest". And obviously Stalnaker thinks they are: they are objects of the attitudes and the bearers of modal properties. On the constant but complicated semantic value option, there are no entities that could plausibly be held to be the objects of the attitudes. The semantic values on this option are functions from context-index pairs to truth-values. Clearly such functions from speakers, addressees, times, locations, worlds, etc. to truth values are not the sorts of things that we believe, doubt and so on.¹⁹

Lewis' argument against Stalnaker is also extremely simple. Variable but simple semantic values of sentences cannot be identified with propositions, as they are on Stalnaker's view. For as mentioned earlier, what coordinates an index has is determined by what sorts of sentence operators are present in the language, since these work semantically by shifting coordinates of indices. And Lewis claims that there are tense operators ('It has been that'), location operators ('Somewhere'), modal operators and standard of precision operators ('Strictly speaking'). But then indices must have at least time, location, world and standard of precision coordinates. This means that variable but simple semantic values of at least some sentences, those embedded with respect to such operators, are, or determine, functions from an n-tuple of at least a time, location, world and standard of precision to a truth-value. But such things, which change truth value across times, locations, etc. are not *propositions* and do not seem to be the right sorts of things to be the object of the attitudes; and any way, Stalnaker is clear that propositions *are* functions from (only) possible worlds to truth values. So at least some sentences must be assigned variable

but simple semantic values that are not propositions. Of course, one could assign to sentences that are *not* embedded with respect to operators (i.e. either they contain no operators, or they do but are not themselves embedded with respect to any operators) propositions as variable but simple semantic values. But then the assignment of variable but simple semantic values would be noncompositional: the semantic value of an unembedded sentence containing operators in a context (i.e. the proposition it expresses in that context) would be a function in part of some *non*-propositional semantic value (in that context) of a constituent sentence (i.e. would be a function in part of something that is, or determines, a function from worlds, times, locations and standards of precision to truth values).

Thus, at least some sentences cannot have propositions as their variable but simple semantic values; and the price of assigning to the others propositions as variable but simple semantic values is a noncompositional assignment of semantic values. It is worth emphasizing that what bars the identification of Lewis's variable but simple semantic values with Stalnaker's propositions is the presence in the language of e.g. time and location operators, which bring with them the requirement that indices contain times and locations (in addition to worlds).

So Stalnaker's propositions cannot be Lewis' variable but simple semantic values. But then the need for or interest in propositions cannot constitute an argument for the variable but simple semantic value option over the constant but complicated semantic value option. And so Stalnaker has given no reason for favoring variable but simple semantic values over constant but complicated semantic values.

As I remarked in the previous section, Lewis [1980] endorses the view that we need propositions. He just doesn't think they can be identified with variable but simple semantic values for the reasons given. As we have indicated, using either variable but simple *or* constant but complicated semantic values we can define the relation *sentence S is true with respect to context c and index i*. Given this relation, Lewis' idea is that we can associate a proposition, construed as a set of possible worlds, with a sentence as follows: the proposition expressed by S in c is the set of worlds that contains w iff S is true with respect to c and i_c^w , where i_c^w is the result of taking the index whose coordinates are the time, location, world and standards of precision of the context c, and shifting the index's world component to w. So either variable but simple semantic values or constant but complicated semantic values can be used to assign propositions, understood as sets of possible worlds, to sentences in contexts.²⁰ But propositions cannot be *identified* with variable but simple semantic values (nor constant but complicated semantic values) for the reasons given. So again, that we need propositions or that they are independently interesting gives us no reason to favor variable but simple semantic values over constant but complicated semantic values. We need one or another of these types of semantic values, and Lewis is indifferent as to which, *in addition to* the assignment of propositions to sentences in contexts.

Put in the most general terms, the issue Lewis has raised is how to assign propositions to sentences relative to contexts, when your language contains tense, location and standard of precision operators. As we have seen, Lewis makes essentially two points. First, if the semantic values you assign to sentences relative to contexts are propositions, the assignment will have to be noncompositional. For the proposition assigned to a sentence like ‘Sometimes, Doug is happy’ relative to a context cannot be determined in part by the *proposition* assigned to ‘Doug is happy’ relative to the context. The latter cannot vary in truth-value over time, whereas the “tense operator” ‘Sometimes’ must operate on something that varies its truth-value over time. The proposition assigned to the whole sentence relative to a context is partly determined by this thing that varies over time and is associated with ‘Doug is happy’ relative to the context, and not the *proposition* expressed by ‘Doug is happy’ relative to the context. So the proposition assigned to the whole is not a function of the proposition assigned to the embedded part. That is non-compositional. Second, as this suggests, some other sort of semantic value needs to be assigned to sentences relative to contexts, and this value needs to vary in truth value over times, locations, etc. There is no barrier to this assignment being compositional, which is why these things are the “real” semantic values, propositions being derivative and secondary.²¹

As I indicated at the outset, I intend to argue against Lewis (and so to some extent in defense of Stalnaker) that neither of the above two points is correct: sentences *can* be assigned semantic values relative to contexts in such a way that propositions are compositionally assigned to sentences relative to context and are the semantic values relative to those contexts of the sentences in question. And we need not assign sentences any second sort of semantic value. Thus the independent interest in propositions noted by Stalnaker *does* provide an argument in favor of variable but simple semantic values as opposed to constant but complicated semantic values. Before turning to my response to Lewis, let me consider some recent work that is relevant to the issues Lewis raises. As indicated above, readers not interested in this recent work can go straight to my response to Lewis (Section 4).

Section 3: Mark Richard and Nathan Salmon on Tense and Propositions

As we saw in the previous two sections, Lewis’s argument that we need to assign non-propositional semantic values to sentences relative to contexts in addition to assigning them propositions relative to contexts and so Stanley’s argument against RT and for a version of two dimensionalism (since it assumes Lewis’s argument) grow out of the simple observation that if our language contains tense, modal and location shifting operators, these cannot operate on propositions, the things that are the objects of our attitudes. This was precisely the thinly veiled tension present in the neat, naïve story I began with. As I suggested in a note above (note 4), this tension was first made clear to many of

us in Kaplan [1989], though Kaplan concentrated primarily on tense and modal operators (not saying much about location operators).

Kaplan's remarks on the topic gave rise to a debate in the 1980's involving Mark Richard and Nathan Salmon as to how the tension was to be resolved. It was taken as clear that tense and modal operators could not operate on the things that are the objects of our attitudes. So what to do? Richard [1982] in effect argued that tense and modal operators operate on the same things, but these are not propositions, the objects of our attitudes. Salmon [1986], by contrast, in effect has modal operators operating on the things that are the objects of our attitudes (information *values*) and has tense operators operating on something else (information value *bases*). Either of these strategies resolves the tension present in having modal and tense operators operating on the things that are the objects of our attitudes (in Salmon's case, the point is that the objects of our attitudes do vary in truth value across worlds, and so modal operators may operate on them).²²

Though Salmon and Richard both defend accounts that resolve the tension at the root of Lewis's argument, I think both of their accounts are wrong headed. The reasons are that both Richard's account and Salmon's accounts (we will see he has two) retain the view, held by Lewis as well as we have seen, that tenses are sentence operators. That, as I shall argue in Section 4, is a mistake. Second, Richard's account and Salmon's accounts concede to Lewis the two important claims mentioned at the end of section 2. That, as I shall argue in Section 4, is also a mistake. Thus, if the reader is willing to believe that Salmon's and Richard's accounts have the features mentioned and isn't interested in slogging through the details of their accounts, he/she can skip from here to Section 4. In the rest of this section, I describe the accounts of Richard and Salmon, and particularly in the case of Salmon, offer additional, more theory internal, criticisms.

Let's look at Richard's view first. Richard [1981] defends the view that propositions, the objects of belief, do not change their truth-values over time.²³ Richard calls this view *eternalism*. As we saw above, Lewis is himself an eternalist, since he takes propositions to be sets of worlds. Richard [1982] takes up the question of how an eternalist ought to treat tense. Obviously, this is intimately related to the issues addressed by Lewis. Richard assumes a Priorian sentence operator approach to tenses, and recognizes that such operators can't operate on eternalist propositions. Because Richard accepts the view that there is a "syntactic and semantic parallel" between sentences containing tenses and sentences containing modal operators, he takes modal and tense operators to operate on the same thing. Richard formulates a semantics on which tense and modal operators operate on a character level semantic value, which Richard calls *sentence meaning*; that is, a function from contexts to propositions.²⁴ The result of this, of course, is that Richard's assignment of propositions to sentences relative to contexts is non-compositional: the *proposition* expressed relative to a context by a sentence e.g. fronted by a past tense

operator is determined by the *meaning* of the sentence it embeds and not the proposition expressed by this sentence relative to the context.²⁵ Thus, Richard concedes the first of Lewis's points mentioned above. In a sense, Richard also concedes the second: some other, non-propositional semantic value must be assigned to sentences for tense operators to operate on. However, it is a virtue of Richard's account that the semantic value he assigns to sentences for tense operators to operate on is one that is independently needed to handle contextually sensitive expressions.

One problem with Richard's account is that since tense and modal operators operate on the same thing, since these are not propositions and since propositions are the objects of the attitudes, for Richard the objects of the attitudes and the things modal operators operate on are not the same. But that means that on Richard's view, the following inference should not be valid:

Shannon believes that God exists.
It is possible that God exists.
Therefore, Shannon believes something that is possibly true.

But this inference certainly does seem valid. Perhaps Richard would have some response to this point. In any case, my main objections to Richard's view, which will emerge in Section 4, are that, as I indicated above, he should not concede the two point of Lewis's previously mentioned, *and* that he is wrong to think tenses are operators of any sort.

Nathan Salmon [1986, 1989] has produced an elaborate and sophisticated semantic theory that assigns propositions to sentences relative to contexts, and Salmon's semantics contains one "temporal operator" ('Sometimes'—Salmon's semantics contain no location operators). Salmon (1986, 1989) actually formulates two theories of the semantics of tense. The first account, formulated in Salmon (1986) and repeated in Salmon (1989), I shall call 86. The second theory, formulated in Salmon (1989) I shall call 89. Let's consider 86 first. According to 86, a sentence such as

10. Frege is happy

taken relative to a time and a context expresses a proposition, which Salmon calls *the information value of a sentence relative to a time t and context c*. This information value/proposition doesn't change truth-value over time and so includes reference to the time t. Hence the information value with respect to t and c of 10 is the proposition that Frege is happy at t.²⁶ Now generally, the information value of a sentence relative to a time t and context c is made up of, and hence a function of, the information values relative to t and c of its parts. However, as already indicated, the information value of a sentence (relative to a time and context) doesn't change truth-value over time. Hence, Salmon's temporal operator 'sometimes' cannot operate on the information values (relative to

contexts and times) of the sentences it embeds on pain of being vacuous. It must operate on temporally neutral entities that can change truth-value over time. Salmon calls these entities *the information value bases of sentences relative to contexts*. Salmon represents the information value base with respect to a context c of 10 as the ordered pair of Frege and the property of being happy, and he supposes that this entity takes a truth-value relative to a time and world. Of course, it will often have different truth-values at different times in the same world. These information value bases determine functions from times to functions from worlds to truth-values, (that is, functions from times to intensions). For example, the information value base of 10 relative to c determines a function that maps a time t to a function that maps a world w to true iff Frege is happy in w at t . Such functions from times to intensions Salmon calls *superintensions*. Now Salmon takes temporal operators to operate on information value bases relative to contexts of the sentences they embed, or the superintensions determined by those information value bases (Salmon moves indifferently back and forth between these formulations). Thus, the “operator” ‘Sometimes’ looks at the superintension of the sentence it embeds (relative to a context) and the entire sentence is true at a world w iff there is some time t such that the superintension of the embedded sentence (relative to the context) maps t to a function that maps w to true. Other temporal operators, including “tense operators”, function analogously. Thus Salmon writes:

In general, temporal operators—such as ‘sometimes’, tense operators (including complex ones such as present perfect and future perfect), indexical temporal operators (e.g. ‘present’), and even nonindexical specific time indicators (e.g. ‘on December 24, 1996’ + future tense or ‘when Frege wrote “Thoughts”’ + past tense)—may all be seen as superintensional operators.²⁷

The first point to note here is that, as Salmon himself notes, 86 is not compositional. The information *value* relative to t and c of a sentence such as ‘Sometimes, Frege is happy’ is a function of the information *value base* relative to c (and *not* the information *value* relative to t and c) of ‘Frege is happy’. Thus, the assignment of information values (Salmon’s propositions) to sentences is not compositional. Hence Salmon concedes the first of Lewis’s points, that the assignment of propositions to sentences relative to contexts will be noncompositional. Salmon also concedes the second of Lewis’s points: some other sort of semantic value needs to be assigned to sentences relative to contexts, this value needs to vary in truth value over times, locations, etc. and this value *can* be compositionally assigned to sentences. For as we have seen, Salmon assigns to sentences information value bases relative to contexts, and this assignment is compositional.

I have already indicated that I shall subsequently argue that these points should not be conceded to Lewis. That aside, 86 has other problems. Specifically, 86 requires what appear to me to be ad hoc semantic clauses. As we have

seen, ‘Sometimes’ operates on the information *value base* relative to a context of the sentence it embeds. On the other hand, a belief ascription asserts that an individual stands in a relation to the information *value* relative to a context and time of its embedded sentence. But then what happens when we combine the two as follows:

11. Sometimes, John believes Frege is happy.

‘Sometimes’ must operate on the information value base with respect to the context *c* of ‘John believes Frege is happy’.²⁸ The information value base with respect to *c* of this sentence includes only the information value base with respect to *c* of ‘Frege is happy’.²⁹ And this, of course, is an entity that changes truth-value over time at a given world. But then unless something is done, 11 will assert that sometimes John stands in the belief relation to an entity that changes truth-value over time (the information value *base* with respect to the context of ‘Frege is happy’), and Salmon denies that the things believed change truth-value over time. Salmon avoids this consequence by introducing the *eternalization with respect to a time of a value (content) base*.³⁰ He then has to add two special semantic clauses that use the notion of an eternalization to specifically handle a content consisting of an individual (or the contribution of a definite description), the believing relation and an information value (content) *base*, (rather than an information *value*).³¹ The upshot is that because for Salmon the thing that ‘Sometimes’ operates on is different from the object of the believing relation, the semantics of sentences like 11 require special definitions and semantic clauses not required for other belief ascriptions or for other cases in which ‘Sometimes’ embeds another sentence. That 11 requires such things appears to me ad hoc. It seems to me that on a proper theory, the right truth conditions for 11 should fall out of the semantics for ‘Sometimes’, ‘believes’ and the tenses.

It is worth noting that if Salmon added location operators to his semantics more ad hoc definitions and clauses of a similar sort would be required. To handle a sentence like:

12. Back in California, Doug believes the sun is shining.

Salmon would have to introduce the notion of a *locationization of a value base with respect to a location*, on analogy with the notion of an eternalization that had to be introduced, to insure that 12 asserts that Doug stands in the belief relation to something that doesn’t change truth value across locations. He would then have to add more special semantic clauses that use the notion of a locationization (or add something to the existing clauses involving eternalization) to specifically handle a content consisting of an individual, the believing relation and an (“locationally neutral”) information value (content) *base*, (rather than an information *value*).

Finally, the truth conditions Salmon gets for 11 (relative to a context, time and world w) are that there is a time t such that John believes at t in w that Frege is happy at t in w . Perhaps the sentence has this reading, but it also seems to have another. Consider

13. Sometimes John believes Frege is happy but sometimes he doesn't believe Frege is happy.

Salmon's account claims this is true iff there is a time t such that John believes at t Frege is happy at t and there is a t' such that John doesn't believe at t' that Frege is happy at t' . That is, the time of believing has to be the same as the time that the belief is about. So on this alleged reading, 13 would be true if what John believes and doesn't believe at t and t' (respectively) are different (he believes at t that Frege is happy at t and doesn't believe at t' that Frege is happy at t')! Again, perhaps 13 has such a reading, but one tends to hear it another way. 13 seems to claim that there is some one thing that John believes at some times and not at others. If 13 has this reading, Salmon's view doesn't capture it. And if we move away from examples in which both 'believes' and the embedded sentence are in the present tense it becomes very clear that such sentences do not require the time of believing to be the same as the time the belief is about; indeed, some sentences require that this not be so. A sentence such as 'Sometimes, John believes that Frege was unhappy' requires the time of believing to be after the time the belief is about. As formulated, 86 does not have the resources to capture the proper readings of such sentences.

Salmon will have similar problems with 12 above if he introduces location operators and they work on analogy with temporal operators. On that way of doing things, 12 must report that the place of believing is the same as the place the belief is about. But as with the temporal case, this seems incorrect. 12 could be used to assert that Doug is back in California believing there that the sun is shining in Cambridge. (Imagine 12 uttered by us in Cambridge after Doug just left for California. It was snowing before Doug left and has continued to snow since. Not wanting Doug to think that he was going to a better climate, one of us e-mailed him saying that the sun is out in Cambridge. We utter 12 to report the belief induced by the e-mail.)

In sum, then, 86 requires ad hoc definitions and special semantic clauses to handle the interaction of temporal expressions and verbs of propositional attitude. Such problems would only be exacerbated by the introduction of location operators. Further, it makes a variety of predictions that appear incorrect. Finally, in Appendix 2, I show that as formulated it cannot handle complex data involving tense that motivates current research in that area, and that straightforward extensions of it won't handle such data either.

I turn now to Salmon's other account of tense: 89, (formulated in section X of Salmon (1989)). Let me say at the outset that 89 is much harder to assess than 86, since Salmon formulates no explicit semantics for it. At any rate, Salmon

distinguishes between *quantificational temporal operators* (e.g. ‘sometimes’, ‘always’), *specific temporal operators* (e.g. ‘on December 24, 1989’, ‘when Frege wrote “Thoughts”’) and *pure tense operators* (e.g. past, present, future). Quantificational temporal operators are just quantifiers over times. Thus, the information value (with respect to a context and time) of e.g. ‘sometimes’ is the property of being a non-empty class of times and its extension (relative to a context, world and time) is the class of nonempty classes of times.³² By contrast, specific temporal operators have as their extensions (relative to a context, world and time) the indicated times (the extension of ‘December 24, 1989’ is December 24, 1989); and Salmon suggests that even the information values of some specific temporal operators (with respect to a time and context—e.g. ‘at 3:00 P.M. on 4 December, 1983’, ‘now’) are the indicated times.³³ In effect, then, 89 treats quantificational temporal operators as quantifiers over times and certain specific temporal operators as names of times.³⁴ As to the pure tenses, these convert information value bases of sentences (with respect to contexts) into properties of times.³⁵ So consider the information value base of e.g. ‘Frege is busy’ (relative to context c). This is essentially the pair of Frege and the property of being busy. Now applying the past tense to this sentence, which we represent as:

14. Past Tense(Busy(f))

we get as the information value of the result (with respect to a context c and time t) the property of being a time prior to t when Frege is busy. So the extension of the sentence relative to a context c time t and world w is not a truth-value but the set of times t' prior to t such that Frege was busy in w at t'. The point to notice immediately is that once again the assignment of information values (with respect to a context and time) is not compositional. The information *value* (with respect to a context and a time) of 14 is a function of the information value *base* (relative to a context) of the embedded expression ‘Busy(f)’. Since the information value (with respect to a context and a time) of a complete sentence³⁶ (i.e. one with a pure tense and a specific or quantificational temporal operator) is a proposition, this means that the assignment of propositions to sentences is also non-compositional on 89.³⁷ So once again, Salmon concedes to Lewis the first of his points. On 89 Salmon again concedes the second of Lewis’s points as well: some other sort of semantic value needs to be assigned to sentences relative to contexts, this value needs to vary in truth value over times, locations, etc. and this value *can* be compositionally assigned to sentences. For here again, Salmon assigns to sentences information value bases relative to contexts, and this assignment is compositional.³⁸ As in the case of 86, however, I think 89 has other problems.

Suppose we put a specific temporal operator in front of 14:

14a. At 3:00 P.M. on December 4 1983(Past Tense(Busy(f)))

This is true relative to a world w context c and time t iff the time designated by ‘At 3 P.M. on December 4, 1983’ (relative to w,t,c) is in the class of times that is the extension of 14 (relative to w,t,c). By contrast, suppose we put a quantificational temporal operator in front of 14:

14b. Sometimes(Past tense(Busy(f)))

This is true relative to w,t,c iff the set of times that is the extension of 14 relative to w,t,c is in the class of classes of times that is the extension of ‘Sometimes’ relative to w,t,c . So 14 has as its information value (relative to a context and time) a property of times, the outermost operator in 14a is like the name of a time and the outmost operator in 14b is a quantifier over times. In this way, 14, 14a and 14b are quite analogous to:

15. is happy

15a. Leroy is happy

15b. Someone is happy.

except that 14 is a predicate of times rather than individuals, 14b quantifies over times instead of individuals, etc. An obvious problem with this approach, recognized by Salmon, is that we normally take tensed sentences without specific or quantificational operators such as the following to express propositions (when uttered relative to a context and time) and have truth-values:

16. Leroy is happy.

16a. Doug was busy.

But for Salmon, these express (have as information values relative to a time and context) properties of times, and so have as extensions (with respect to a time, context and world) sets of times. Hence they are neither true nor false (relative to a world, context and time)! But then how can Salmon explain why we take them to have truth-values? Here Salmon claims that the sentences “involve” “implicit” demonstratives or indexical temporal operators.³⁹ Thus, 16 has an “implicit” ‘now’ and 16a an implicit ‘then’ (or ‘at that time’):

16'. Now (Present tense(Happy(l)))

16a'. Then (Past tense (Busy (d)))

(Salmon sometimes puts the point in terms of 16 and 16a being “elliptical” for 16' and 16a'.) These ‘now’ and ‘then’ operators, which obviously aren’t contributed by anything in the syntax of the sentence, come and go at all the right times to get things to come out right. So though in 16a we have an implicit ‘then’, we don’t in

17. Sometimes, Doug was busy.

on pain of ‘sometimes’ being vacuous. But we need one again in

18. Sometimes, Doug knew that he was busy.

so that what Doug knows can be a proposition (and not a property of times—see Salmon’s note 31). Positing these implicit operators that aren’t expressed by anything in the syntax and that come and go in 16–18 just so that things work out right seems very *ad hoc*.⁴⁰ Further, and perhaps even worse, note that stand-alone tensed sentences *never* get used to express what are in fact their information values (properties of times). Thus, Salmon is committed to a sort of error theory according to which such sentences are *never* used to convey what are in fact their information values (relative to a time and context). It seems to me that semantic theories that assign sentences information contents that they are never used to convey should not be tolerated. For the primary evidence for or against a semantic theory is that speaker intuitions about what sentences mean are captured or not captured by the semantic values the theory assigns to sentences. If we employ a methodology that allows a semantics to assign to sentences information contents those sentences are never used to convey, we undercut our primary evidence for or against the theory.⁴¹

Two final points: first, for all Salmon has said, 89 also shares the problem with 86 discussed above with respect to 13 above. Second, as with 86, in Appendix 2 I show that 89 as formulated cannot handle complex data involving tense that motivates current research in that area; and that straightforward extensions of it won’t handle such data either. However, let me again stress that my main criticisms of Richard and Salmon are that they concede to Lewis the two points mentioned at the end of Section 2 and in this section; and that they, like Lewis, treat tenses as operators. In the next section, I argue that these are both mistakes.

Section 4: Response to Lewis

Like Stalnaker’s argument in favor of variable but simple semantic values and Lewis’s response to that argument, my response to Lewis is very simple. In effect, Lewis argues that variable but simple semantic values can’t be propositions, because in the general case such semantic values must be or determine functions from indices to truth-values. Since indices must include times, locations, worlds, and standards of precision, variable but simple semantic values of at least some sentences must be functions from times, locations, worlds and standards of precision to truth values. But then if we identify propositions with such functions (or with things that determine such functions), we must say that propositions can change truth value over times, locations, worlds, and standards of precision. But things of that sort don’t seem the right sorts of things to be the

objects of the attitudes. And Stalnaker's argument for variable but simple semantic values was that they are things that are suitable objects of the attitudes. Thus, to repeat, Lewis claims that Stalnaker has given no reason for preferring variable but simple semantic values to constant but complicated semantic values.

By contrast, I shall argue that temporal expressions (including tenses) and location expressions are not best understood as sentence operators that shift features of the index of evaluation. If this is correct, then indices do not need to contain times or locations for such purported operators to shift. But then there is no reason to have times and locations as coordinates of indices. This leaves only worlds and standards of precision as coordinates of indices. And this, in turn, leaves us with the view that variable but simple semantic values of sentences are, or determine, functions from worlds and standards of precision to truth-values. But such entities *are* appropriate objects of the attitudes, and possessors of modal properties. So given that we need entities that are objects of the attitudes and possessors of modal properties, this gives us reason to prefer variable but simple semantic values to constant but complicated semantic values. Thus, the need for these propositional middlemen does, as Stalnaker claimed, provide a reason for preferring variable but simple semantic values.

Before turning to the argument that temporal expressions and location expressions are not to be understood as features of index shifting sentence operators, a few qualifications are in order.

First, I will confine my discussion here to simple tenses (present, past and future), and temporal adverbs such as 'yesterday', 'in a week', etc. I shall not, for example, consider aspect here. As far as I can see, limiting my discussion in this way has no effect on my argument. Second, I assume that we are working in a syntactic and semantic framework in which there are both index shifting sentence operators (whose semantic clauses are spelled out in terms of quantification over coordinates of indices in the metalanguage) and object language quantifiers. Certainly most current semantic and syntactic theorizing takes place within such a framework. More importantly for present concerns, the disputants involved all make use of such frameworks: Lewis, Kaplan and Stalnaker all theorize within frameworks in which one has both feature-of-index-shifting operators (e.g. modal operators) and object language quantifiers (e.g. over individuals—e.g. 'every pig'). Thus, in making this assumption, I beg no questions against Lewis.

With these qualifications in mind, let us turn to tenses and temporal expressions. It is important to be clear at the outset that the claim that tenses are operators that shift features of the index of evaluation is an empirical claim about natural language. It is a claim to the effect that in the best syntax and semantics for natural language, tenses will be treated syntactically and semantically as such operators. I shall argue that given the available evidence, this is an implausible empirical claim.

Let us begin by noting various ways in which tenses don't behave as do the standard operators of standard tense logic. Standard treatments of operators of

tense logic go something like the following. Taking the operator ‘P’ for a past tense sentence operator as an example, the relevant clause runs as follows:

(Past) ‘P(ϕ)’ (where ‘ ϕ ’ is a formula) is true at time t iff for some $t' < t$, ‘ ϕ ’ is true at t' .

Thus, ‘P’ is understood as effecting existential quantification over times in the metalanguage. But as Partee (1973) observed, the English past tense doesn’t seem to work this way. A sentence like:

19. John turned off the stove.

uttered in a particular context (at a particular time t) will be interpreted to mean not that for some time t' prior to t , John turned off the stove at t' , but rather that at some particular contextually determined time t' prior to t , John turned off the stove at t' . Thus, it looks as though here the tense in some way picks out a particular contextually determined past time (or interval of time). But in so doing, it is hardly behaving like a standard past tense operator.

Second, and related to the first point, tenses and temporal adverbs interact in ways that make little sense on standard operator conceptions of tense. As Dowty (1982) observes, if we treat temporal adverbs like ‘yesterday’ and past tense morphemes as standard operators, we get incorrect predictions. Thus consider what might seem the natural operator clause for the operator ‘Y’ (for ‘yesterday’):

(Yesterday) ‘Y(ϕ)’ is true at t iff ‘ ϕ ’ is true at some t' such that t' is within the day preceding the day that includes t .

Now consider a sentence like:

20. Yesterday, John turned off the stove.

We have a past tense and ‘yesterday’, so combining (Past) and (Yesterday), we get two possibilities for readings for 20, depending on which operator takes widest scope:

20a. Y (P (John turns off the stove))

20b. P (Y (John turns off the stove))

Supposing 20 uttered at a certain time t on day d , the reading corresponding to 20a would be true in a situation in which at *any* time prior to a time included in the day before d , John turned off the stove. 20 certainly does not seem to have this reading. 20b would be true in a situation in which there is some past time t' (any past time t' !) such that John turned off the stove on the day d' that precedes the day that includes t' . Again, 20 has no such reading. So given the

natural operator treatments of ‘Yesterday’ and past tense, we can’t correctly predict their interaction in simple sentences like 20. And indeed, the prediction that 20 has two readings corresponding to 20a and 20b, whatever those readings are, is itself incorrect: 20 isn’t ambiguous!⁴²

Thinking about the natural interpretation of 19, and now looking at 20, intuitively what seems to be going on is that ‘Yesterday’ in some sense picks out an interval of time, as does the past tense of 19 (both considered alone and as embedded in 20). The truth of 20 requires the interval picked out by the past tense to fall within the interval picked out by ‘Yesterday’. But obviously, to understand the past tense and ‘Yesterday’ as working in this sort of way is not to understand them as anything like standard tense operators.

Third, and related to the first two points, consider examples such as:

21. Yesterday John gave a party. Annie got drunk.

As we have already seen, it would seem intuitively that in the first sentence (when it is uttered in a context), ‘Yesterday’ picks out a day and the past tense picks out an interval that is required to fall within that day. But further, as Partee [1973] noted, it seems that the second sentence has a reading (its most natural reading) on which the past tense in it picks out the same interval that is picked out by the past tense in the first sentence (or a closely related interval). So here, there seems to be a sort of anaphoric phenomenon: the second sentence past tense takes on the same value as its “antecedent” past tense in the first sentence. Again, no account of the tenses as standard operators gives us any insight into this behavior.

Thus far, I have discussed three respects in which tenses don’t appear to behave like operators. I am not claiming that data of the sort discussed could not be handled by some modification of the operator approach to tense, and I will discuss this point below. But since data of this sort shows that tense in natural language does not work the way tense operators in standard tense logic work, researchers began to question whether viewing tenses as operators of any sort was illuminating.

Recent work on tense in philosophy and linguistics has concentrated on so-called “sequence of tense” and related phenomena. The data of concern here involve sentences with verbs that take sentential complements, such as ‘believe’, ‘say’ etc., and sentences with noun phrases that have relative clauses. In both cases, we have tenses embedded with respect to other tenses and the interaction between these tenses is fairly complex. I have mercifully confined my review of some of the data in this area that a theory of tense needs to capture to Appendix 2. The crucial point about such complex data is this. Virtually every recent theory of tense that attempts to treat this data fails to view tenses as index shifting operators. Let’s consider a few examples.

Enc [1987] explicitly opposes an operator account of tense and holds that tenses are devices that refer to time intervals. Her view is that tenses can be anaphoric

on or “bound” by other tenses, in which case they refer to what their antecedents refer to.⁴³ Obviously, then, tenses are not index shifting operators on her view.

Abusch [1997] holds a complex theory on which some tenses are interpreted “de re” (as she puts it). Abstracting from certain complexities of her framework, in such cases tenses are rather like anaphoric pronouns on E-type theories of anaphora: they are in effect interpreted as definite descriptions denoting time intervals, where the descriptive material in the description is determined by context, including elements of the discourse/sentence the tense occurs in.⁴⁴ Other tenses express complex relations between the time interval designated by the tense and a local evaluation time, which will be utterance time for the highest tense, but may change as one goes down a syntactic tree.⁴⁵ So for Abusch as for Enc, tenses are not operators.

In perhaps the most extensive recent work on tense and sequence of tense, Ogihara [1996] adopts a formalism for representing natural language tense that uses explicit quantification over time in the object language, where tenses express relations between times. Thus, for a sentence like

22. A man died.

(when uttered at *i*)

we get the following representation in Ogihara’s intensional logic IL:

22a. $\exists t \exists x[\text{man}'(t,x) \ \& \ t < s^* \ \& \ \text{die}'(t,x)]$

where ‘*t*’ is a time variable, and ‘*s**’ is an indexical constant denoting the time of speech.⁴⁶ It is true that in discussing why he adopts this formalism with explicit object language quantification over time to represent natural language, he gives practical reasons, saying the formalism is “more flexible” than others he considers and can “readily accommodate the complex temporal facts in natural language”.⁴⁷ He concludes

This choice of logical language should not be taken as an important theoretical decision...The only important issue is whether the language has enough tools to describe the target constructions in natural language, and the reader will find that our notational system is indeed powerful enough for our purposes.⁴⁸

Despite Ogihara’s pragmatic, almost instrumentalist, attitude I am inclined to view things rather differently. If the complex temporal facts present in natural language are most readily and easily represented by viewing tenses as involving explicit quantification over time and as expressing relations between times, that is a good reason for thinking that tenses really work this way.⁴⁹ But in any case, Ogihara certainly doesn’t treat tenses as index shifting operators.

Finally, consider the proposal regarding sequence of tense due to Higginbotham [2002], who, like Enc, explicitly opposes an index shifting operator treatment of tense.⁵⁰ Higginbotham works in a neo-Davidsonian framework in which natural language sentences quantify over events (or events and states). Higginbotham assumes that every predicate contains an event argument place, which gets existentially quantified. Tenses are understood as expressing relations between events. In the simplest case, a tense expresses a relation between the event of uttering the very sentence it is in (which, of course, occurs at speech time or the time of the context of utterance) and some event or other (i.e. an event satisfying the existential quantification over events in the sentence). So an utterance of a simple past tense sentence asserts that some event prior to the event of uttering this very sentence is thus and so. Thus, it is very clear that on Higginbotham's proposal, tenses are not operators and so there is no need for temporal coordinates of indices.

Indeed, it is worth mentioning more generally that within such neo-Davidsonian frameworks in which English sentences involve existential quantification over events, it is virtually inevitable to treat tenses as in some way expressing temporal information about events, and so as in some broad sense expressing properties of or relations between events. Hence in such frameworks tenses are predicates of times or events. Thus, in Parson's [1990] extensive event-based semantics for English, tenses constrain or restrict the quantification over time that is claimed to be present in an English sentence (see p. 209), and thereby locate the event in time. So that tenses are not index shifting operators is all but inevitable in such frameworks.

To sum up the discussion of tenses and temporal expressions to this point, we have seen that there is data (1–3 above) that shows that tenses and temporal expressions do not work like the standard operators of tense logic. Second, and related to this, we have seen that virtually all recent attempts to handle complex data involving tenses of the sort exhibited in Appendix 2 have rejected the view that tenses are sentence operators.⁵¹ I think that this is enough to show that tenses are not operators, or at least that that is the most reasonable position to hold, based on current theorizing. But it is important to be clear on why these points show this.

First, the issue is not one of expressive power. That is, I am not claiming that *no* version of the view that tenses and temporal expression are sentence operators could be formulated that would assign the right truth conditions to the data we have discussed. Indeed, I think that is false. Through the late 60's and 70's, there was a debate about whether all readings of English sentences with temporal elements (including tenses, expressions such as 'now', etc.) could be expressed by a language containing only tense operators, or whether e.g. one needed a language in which one explicitly quantified over time. We can put this by saying that the question was whether English temporal expressions could be understood as operators, or whether, because there were readings of English sentences that could not be expressed only with tense operators, we had to understand English as containing explicit quantifiers over time. The outcome of this debate was that relative expressive power alone does not seem to tell us

whether tenses can be treated as operators, or e.g. must understood as object language quantifiers over time. For, first, even relatively simple (single index) operators have surprisingly strong expressive powers. Hans Kamp [1968] showed that (if time is modeled as the real numbers) any operator definable in a language with explicit quantification over times, a two place “earlier than” predicate of times, and one-place predicates of times can be expressed in a language without quantification over or variables for times that contains only his two-place sentence operators ‘S’ (“since”) and ‘U’ (“until”). Second, each time someone has come up with an English sentence whose truth conditions aren’t given by any formula of some language containing only tense operators (and no explicit quantification over time), new operators are introduced yielding a language that has a formula with the truth conditions in question. For example, Kamp [1971] showed that sentences such as ‘A child is born which will be king’ have truth conditions that are not expressible in a tensed predicate logic containing standard Priorian tense operators. The introduction of the doubly time indexed ‘Now’ operator allows for the expression of such truth conditions. Vlach [1973] claims that the intuitive truth conditions of sentences like ‘One day, all persons alive then would be dead’ cannot be expressed in Kamp’s ‘Now’ enhanced language. But he introduces another doubly time indexed operator (‘K’—“then”) that allows for the expression of such truth conditions. This dynamic has continued with the introduction of ever more operators with ever more indices.

Now Quine [1960] had already shown how to formulate a language with the expressive power of first order predicate logic, using only predicate operators, and no variables or quantifiers. Thus, it seems clear that by introducing temporal operators mimicking Quine’s, one could achieve the expressive power of a first order predicate logic quantifying over times in a language with only operators, and no variables or quantifiers for times. And indeed, various theorists during the 1970s working in the operator tense logic framework had begun to introduce operators that were analogues of Quine’s operators (e.g. permuting indices, and substituting one index for another rather as Quine’s ‘Inv’ and ‘Ref’ operators permuted predicate argument places, and identified them, respectively). van Bentham [1977] is a nice summary of these developments up to 1977. Discussing the tendency of those working in the “operator tense logic” tradition to keep adding more points of time as coordinates of their indices, and adding more complex operators to manipulate these complex indices, van Bentham [1977] writes:

...the tendency exists to add ever more points in time at the *index* (of evaluation), which are then *manipulated* by operators without moment variables in the object language. The alternative, which should have been kept in mind throughout the discussion, is the use of predicate-logical formulas containing moment variables and overtly displaying these *manipulations*. Clearly, if one is willing to increase the complexity of the index to any extent (while adding enough operators to take profit of it), there is no need to ever resort to predicate logic *technically*, but in our opinion it is a Pyrrhic victory.⁵²

What is important here for our purposes is van Benthem's point that, given the willingness to use indices with more and more times, and operators to exploit them, the expressive powers of the two sorts of languages inevitably will converge. And indeed, Cresswell (1990) formulates a language whose sentences are evaluated at infinite sequences of times (or worlds) and that contains no time (or world) variables or quantifiers over times (or worlds), but that for each n , contains an operator that can in effect substitute the n th element of a given sequence for the 0th and an operator that can substitute the 0th element for the n th. He shows that such a language has the expressive power of a language that has explicit quantifiers over times (or worlds).⁵³

Thus my claim that English tenses cannot be viewed as operators cannot be based on the claim that to treat them in this way would be to not capture the expressive power of English (since I would not claim that treating them as quantifiers over times would have this result).

Rather, the claim is that treating tenses as e.g. involving quantification over times (and expressing relations between times) rather than index shifting sentence operators (i) allows for a simpler, more elegant, less ad hoc treatment of tenses and temporal expressions than does an operator treatment; and (ii) allows for a more plausible account of the relation between the surface structures of English sentences and the syntactic representations of those sentences at the level of syntax that is the input to semantics (which I shall call *LF*). This, in turn, explains the fact mentioned above: that virtually all current researchers trying to give a treatment of the complex temporal data in natural languages eschew an operator approach to tenses in favor of treating tenses as something like quantifying over, referring to and/or expressing relations between times. Let me briefly illustrate points (i) and (ii) by means of a couple examples.

First, point (i). For the sake of definiteness, let me suppose that a tense quantifies over times, while putting a restriction on that quantification, and that predicates have argument places for times. So, for example, at the relevant level of syntactic representation, the following sentences will look like the following sentences:

- 23a. Maggie is happy.
- 24a. Maggie was happy.
- 25a. Maggie will be happy.
- 23b. $\exists t (t = t^* \ \& \ \text{Maggie be happy}(t))$
- 24b. $\exists t (t < t^* \ \& \ \text{Maggie be happy}(t))$ ⁵⁴
- 25b. $\exists t (t^* < t \ \& \ \text{Maggie be happy}(t))$

(where 't*' is a term that gets assigned the time of speech)

Now note how easily temporal adverbs of the sort discussed above (so-called "frame" adverbials like 'yesterday', 'in 2004', etc.) are accommodated in such a representation. Such adverbials can be treated as denoting e.g. intervals of time (or maybe properties of such intervals). Thus, letting ' \leq ' be

an expression expressing the *part of* relation (between times) and supposing that ‘yesterday’ in the context of utterance picks out the day before the day including the time designated by ‘t*’, the following sentence:

26a. Maggie was happy yesterday.

can be rendered as

26b. $\exists t (t < t^* \ \& \ t \leq \text{yesterday} \ \& \ \text{Maggie be happy } (t))$

Thus, frame adverbials effectively function as predicates of times, and are readily and smoothly added to the present framework. As suggested above, it is, by contrast, much less clear how to treat such adverbs if one is treating tenses as operators. At any rate, the treatment is sure to be much more complex.

Turning now to point (ii) above, consider a pair of sentences of the sort that were much discussed in the 1970s after Hans Kamp had argued that the presence of the temporal indexical ‘now’ in English, together with (alleged!) index shifting tense operators required double temporal indexing (one index to be shifted by operators, and another to be unshiftable, so that an embedded ‘now’ could pick it up):

27. One day, all persons alive now will be dead.

28. Once all persons alive then would be dead.

Using operators of the sort pioneered by Kamp and Vlach [1973], these sentences are represented as follows:⁵⁵

27a. $F (\text{All persons } x: (N(Ax) \rightarrow Dx))$

28a. $P \ K \ F (\text{All persons } x: (N(Ax) \rightarrow Dx))$

where ‘P’ and ‘F’ are (standard) past and future operators, ‘N’ is the now operator (which, letting the first index be the index shifted by operators, the *time of evaluation*, and the second index be the index picked up by ‘now’, the *time of reference*, makes the time of evaluation for the formula it embeds the time of reference—‘Ax’ in 27a and 28a) and ‘K’ is Vlach’s operator that “does the opposite” of ‘N’ (i.e. it makes the time of evaluation the time of reference of the formula it embeds). Now if we take the operator proposal seriously syntactically, as we should (i.e. as claiming that tenses are really syntactically operators), 27a and 28a are the LFs for 27 and 28. The crucial point is that even though 27 and 28 appear to have the same number and sort of syntactic constituents combined in the same ways, and differ only in tense and the words ‘now’ and ‘then’, they have *very* different LFs: 27’s LF contains two operators and 28’s contains four! Surely this looks ad hoc, and presupposes a very messy relation between the surface structures of sentences and their LFs.

Admittedly, we are looking at only one version of the operator approach, but such ad hocery and messiness in the relation between surface structure and LF is typical of such approaches. And indeed, perhaps this is why such approaches were championed more in a period during which things like 27a and 28a were probably not thought of as providing *LFs* for 27 and 28, but rather as just getting their truth conditions right. But as mentioned above, surely now we need to understand the claim that tenses are operators as an empirical syntactical and semantical claim about natural languages. And on the basis of considerations of the sort just adduced, it seems an implausible empirical claim.

By contrast, in the tenses as quantifiers type framework, in which ‘now’ and ‘then’ may designate times, 27 and 28 have *LFs* very roughly as follows:

- 27b. $\exists t (t^* < t \ \& \ \text{All persons alive } (t^*):x \text{ dead } (x,t))$
 28b. $\exists t (t'' < t \ \& \ \text{All persons alive } (t''):x \text{ dead } (x,t))$

where ‘ t^* ’ again is an expression designating the time of utterance, and ‘ t'' ’ is an expression designating a contextually determined time (in 28b, a time prior to the time of utterance).⁵⁶ Now looking at 27a and 28a and 27b and 28b, surely having something like the latter as *LFs* for 27 and 28 looks less ad hoc and results in a cleaner relation between surface structure and LF than does having 27a and 28a as *LFs* for these sentences. At least 27b and 28b have the same number and sorts of constituents!

To repeat, then, treating tenses as involving quantification over times (and expressing relations between times) rather than index shifting sentence operators (i) allows for a simpler more elegant less ad hoc treatment of tenses and temporal expressions than does an operator treatment; and (ii) allows for a more plausible account of the relation between the surface structures of English sentences and the syntactic representations of those sentences at the level of syntax that is the input to semantics. As I said above, this is why current researchers on tense adopt the former approach; and this is good reason for thinking it is the correct empirical, syntactical claim about tense in natural language.⁵⁷

But if the proper way to treat tenses is *not* as index shifting sentence operators, then there is no need for temporal coordinates in indices of evaluation. This, in turn, means that we are no longer forced to hold that variable but simple semantic values are, or determine, functions from worlds, locations, standards of precision *and times* to truth values, as Lewis claimed. At most, we are stuck with the view that the variable but simple semantic values of sentences are, or determine, functions from worlds, locations and standards of precision to truth values.

But I don’t think we are stuck with this result either. Specifically, I don’t think there is a good case for locations being coordinates of indices either. The reader will be relieved to hear that I shall be more concise here than I was in the case of times.

Why does Lewis think that locations must be coordinates of indices? Lewis suggests that in sentences such as

29. Somewhere, the sun is shining.

‘Somewhere’ is an index shifting “location” operator. He thinks that 29 is true relative to an index *i* iff ‘the sun is shining’ is true relative to some *i*’ that differs from *i* only on its location coordinate.⁵⁸

Now Lewis gives no argument that ‘somewhere’ is an index shifting location operator, and it seems to me that there are good reasons for resisting this view. For in a variety of ways, ‘somewhere’ behaves like a quantifier over places, as indeed it superficially appears to be. First, ‘somewhere’ appears to occur in argument position in a variety of sentences, such as:

- 30. Somewhere is prettier than here.⁵⁹
- 31. John was somewhere.
- 32. Chris went somewhere.
- 33. Annie resides somewhere.

Though quantifiers (and NPs generally) occupy argument position in sentences (‘Every woman is beautiful.’; ‘Chris loves every child’), operators (e.g. modal operators, etc.) don’t (*‘Necessarily is beautiful.’; *‘Chris completed necessarily’). Second, in such constructions, ‘somewhere’ allows for restriction by further predicative material, as do other quantifiers (e.g. ‘Every woman *from Carnelian Bay* is beautiful’):

- 30a. Somewhere in North Lake Tahoe is prettier than here.
- 31a. John was somewhere in North Lake Tahoe.
- 32a. Chris went somewhere in North Lake Tahoe.

Note too that, as with other quantifiers, additional further restrictions can always be added:

- 31b. John was somewhere in North Lake Tahoe near Carnelian Bay by a marsh.

“Normal” sentence operators, by contrast, do not allow the addition of such further restrictive descriptive material.

Third, in such constructions ‘somewhere’ exhibits what appear to be quantifier scope ambiguities with respect to other quantifiers:

- 32b. Chris went somewhere in Lake Tahoe every Friday night.

32b seems to have a reading on which Chris went different places on different Friday nights, as well as a reading on which she frequented one place every Friday (to bring out the latter reading, imagine that a private investigator is attempting to determine how Chris spends her time, and having determined that she spends every Friday at the same location, utters 32b—perhaps the continuation ‘and I’m going to find out where it is’ helps bring out the reading). Other constructions also make clear that ‘somewhere’ (plus descriptive material) exhibits scope ambiguities with other quantifiers. For example:

34a. A monitor will be set up somewhere near every volcano.

34b. The next debate will be held somewhere that every candidate visited during the last year.

For pragmatic reasons, 34b is naturally read with ‘somewhere...’ taking widest scope, whereas the opposite is true of 34a. Of course, operators too exhibit scope ambiguities with respect to quantifiers. But the point, again, is that here ‘somewhere’ allows further descriptive material to restrict it as do quantifiers generally (and operators do not) and occupies argument position as do quantifiers generally (and operators do not). Thus, the fact that it exhibits what appear to be quantifier scope ambiguities here as well constitutes further evidence that it really is a quantifier.

Of course, one might claim that ‘somewhere’ is ambiguous, and that though it is a quantifier in 30–34 above, it is an index shifting operator in 29. However, I’m not sure what the independent evidence for such a claim might be. For example, even in 29, ‘somewhere’ allows for the addition of restrictive descriptive material just as it does in 30–34, and, again, just as other quantifiers do and as operators don’t:

29a. Somewhere in California near the coast the sun is shining.

Further in sentences like:

35. John was somewhere in California near the coast, and the sun was shining.

‘somewhere in California near the coast’ occupies an argument position occupied by normal quantifiers, and it allows for a reading of the second sentence on which it is equivalent to 29a. So here, where the expression ‘Somewhere in California near the coast’ appears to be a quantifier, it affects the interpretation of ‘the sun was shining’ in 35 just the way the very same expression does in 29a. Surely all of this suggests ‘somewhere in California near the coast’ is a quantifier in 29a as well (and that ‘Somewhere’ is in 29).

Now if ‘Somewhere’ is a quantifier in 29 (as well as the related expressions in 30–34), in order to have a semantic effect on the embedded sentence it must

bind a variable in it. This means that the sentence must contain some sort of “covert” location variable. Though I don’t intend to speculate on the exact nature of that variable, there are a couple things worth saying about it. First, I am agnostic with respect to the question of exactly what sort of variable it is (e.g. there may actually be a location variable; or it may be that the embedded sentence in 29 contains only an event or situation variable, which itself gets bound by ‘somewhere’ (since an event assigned to such a variable has locational properties); or it may be that ‘somewhere’ is a quantifier over locational *properties* of events, and so binds a variable that takes these as values, etc.). Second, whatever the nature of the variable, I am agnostic with respect to whether it is an argument or an adjunct (e.g. it may be that ‘somewhere’ binds the “covert” temporal variable in the covert adjunct ‘at t’). And indeed, it may be that, for some sentences that ‘Somewhere’ embeds in the way that it embeds 29, the variable it binds is an adjunct and in other cases it is an argument.

To summarize, we have seen that there is no reason to think that ‘somewhere’ in 29 is, as Lewis assumes, an index shifting location operator. Further, I don’t think there are any other expressions that are properly treated as index shifting locational operators (indeed, ‘somewhere’ would probably be the best candidate). I conclude that there is no reason to think that English contains any index shifting location operators, and hence no reason to think that locations must be features of indices of evaluation.

Thus far we have argued that neither times nor locations are needed as coordinates of indices. This leaves only worlds and standards of precision. In turn, this means that in general the variable but simple semantic values of sentences are or determine functions from worlds and standards of precision to truth-values. Below, I shall argue that such semantic values can be identified with propositions, and thus that Stalnaker did give the right reason for favoring an approach yielding variable but simple semantic values over an approach yielding constant but complicated semantic values (i.e. we independently need propositions, and only variable but simple semantic values of sentences can be identified with them). But before getting to that, I need to consider Lewis’s objection to the sort of view we have developed.

The fact that what appear to be index shifting operators can be reconstrued as object language quantifiers was not lost on Lewis. And thus Lewis anticipated the strategy of reconstruing all apparent index shifting operators except modal ones (i.e. world shifting ones) as e.g. object language quantifiers, thus leaving only a world as an index and so allowing the identification of variable but simple semantic values of sentences with propositions, as Stalnaker proposed.⁶⁰ This is a version of what Lewis derisively called *the schmentencite strategy*.⁶¹ It is worth highlighting a consequence of our version of the strategy. As already mentioned, if e.g. ‘somewhere’ is a quantifier, then sentences it embeds (when it is non-vacuous) must contain a free variable of some sort. But this means that they are in some sense not genuine *sentences* and will not be assigned propositions as semantic values. They can only be assigned propositions *relative to an*

assignment of values to variables. Hence, when I claim that propositions expressed by sentences relative to contexts can be identified with Lewis's variable but simple semantic values (or compositional semantic values) had by these sentences relative to contexts, 'sentences' here must be understood to be expressions lacking free variables. On this way of using the term, the expression 'somewhere' embeds in a sentence like 'Somewhere the sun is shining' is not a sentence!⁶² What is being claimed can be put more conspicuously as follows: sentences without free variables can be assigned propositions relative to contexts compositionally; and so the variable but simple semantic values assigned to sentences without free variables relative to context are propositions.

So what is Lewis's argument against the schmentencite strategy? It is difficult to tell, because Lewis is so dismissive. Considering the strategy precisely as we have used it, as a way of defending Stalnaker, Lewis writes:⁶³

There is always the schmentencite way out: to rescue a generalization, reclassify the exceptions. If we said that seeming sentences involved in shiftiness of features other than the world...were not genuine sentences, then we would be free to say that the semantic values of a genuine sentence, in context, was its propositional content. But what's the point?

Note that in effect we have done what Lewis mentions. We have reanalyzed cases of "seeming shiftiness" (apparent time and location operators) in other terms (e.g. 'somewhere' as a quantifier, which embeds a "sentence" with a free variable, and hence not a "genuine sentence"). Since the above quotation contains all Lewis says about why this shouldn't be done, it isn't clear what his argument is. But putting this together with his earlier remarks on the schmentencite strategy, I think we can reconstruct his thinking. Lewis's remarks suggest that he thought that reconstruing alleged index shifting sentence operators as object language quantifiers was a sort of ad hoc technical trick. It can be done, but it is just an unmotivated, ad hoc move designed to save a theory ("...to rescue a generalization, reclassify the exceptions...").

The important point here is that Lewis's attitude would be justified if and only if the independent evidence available favored the view that the alleged operators in question really are operators. For suppose it didn't. Then either: (1) the independent evidence is neutral, and we should be indifferent as to how the expressions are treated; or (2) the independent evidence favors the view that the alleged operators aren't operators. If option 1 is correct, how can Lewis claim that it is ad hoc to treat the expressions as non-operators? Since there is no independent evidence either way, one treatment is no more unmotivated and ad hoc than the other. Treating the alleged operators other than as operators can only amount to "reclassifying exceptions" in some pejorative sense if there is some reason for the initial classification to begin with. But on option 1 there isn't. In any case, we have argued that in fact option 2 is correct: we claim that the independent evidence available favors the view that the expressions in

dispute (tense and location expressions) are not operators. Thus, Lewis's objection here carries no weight against us.

At this point, then, we are left with only modal operators and standard of precision operators ('Strictly speaking'). This, in turn means that in the general case variable but simple semantic values of sentences have to be or determine functions from worlds and standards of precision to truth-values. Can we claim that such semantic values are propositions, and hence that the need for propositions gives us some reason to favor variable but simple semantic values over constant but complicated semantic values? First, let me note that I am not convinced that there really are standard of precision operators. That is, I am not sure that the proper semantic treatment of things like 'Strictly speaking' is that they shift a standard of precision coordinate of an index of evaluation. But I will not argue against that view here. For even if indices are a world and a standard of precision, I think that functions (or things that determine such functions) from a world and a standard of precision to a truth value are plausible candidates to be the objects of attitudes and hence propositions. For this is simply to say that propositions can vary their truth-values across worlds and standards of precision. Of course, to say that the objects of our attitudes vary truth value across worlds is perfectly fine. But to say that they vary truth value over standards of precision, if one thinks such things are needed, seems fine as well. To say that the object of one of my beliefs is the claim that France is hexagonal, and that whether what I believe is true or false depends not just on what the world is like, but also on how much precision we require seems completely unobjectionable. Thus, I conclude that Stalnaker *has* given Lewis a reason for favoring variable but simple semantic values over constant but complicated semantic values. We need propositions, and they *can* be identified with variable but simple semantic values. We thus vindicate the view that the compositional assignment of propositions to sentences in contexts is the primary job of semantics *and* undermine the sorts of arguments Jason Stanley offers against RT and for a version of two dimensionalism.

One final worry looms here. I have argued that various expressions are not operators, and hence indices do not need to contain coordinates for them to shift. What if a similar argument could be mounted for modal expressions? This would mean that worlds would not be needed as coordinates of indices, and hence that variable but simple semantic values would not vary truth-value over worlds! But surely the objects of our attitudes, propositions, do vary truth-value across worlds. Thus, if modal expressions turn out not to be operators, variable but simple semantic values may be unsuited to be propositions, and once again we will have no argument for preferring variable but simple semantic values over constant but complicated ones.

I won't try here to provide a definitive response to this worry, but let me say a couple things to quell it. First, modal "operators" ('It is necessary that' etc.) do seem to iterate, as operators are supposed to (unlike tenses and 'somewhere'). Second, they (*and* modal verbs like 'could' etc.) do not appear to exhibit

quantifier like behavior, as does ‘somewhere’ (e.g. modal “operators” do not occupy argument positions in sentences, do not allow the addition of restrictive material descriptive, etc.) Third, extended intensive investigation of modal phenomena in natural languages has not driven virtually all researchers away from the view that modal expressions are index shifting operators, whereas this has happened with tense. In short, the prospects of an argument that modal expressions are not index shifting operators based on considerations of the sort we have used to argue that ‘somewhere’ and tenses are not do not seem good. Still, this question deserves further thought.⁶⁴

Appendix 1: Other Possible Responses to Lewis

Let’s now consider two ways other than the one I have given that one might attempt to respond to Lewis’s argument that the objects of the attitudes cannot be identified with simple but variable semantic values. First, one might consider a Lewisian-inspired response to Lewis.⁶⁵ Lewis argues that variable but simple semantic values must be functions from indices whose coordinates are worlds, times, locations and standards of precision to truth-values. On this basis, he says that such things cannot be objects of the attitudes. Of course Lewis [1979] argues that *properties* are the proper objects of the attitudes: in e.g. believing one self ascribes properties. One might attempt to use considerations of the sort Lewis [1979] adduces in favor of the view that properties are objects of the attitudes, to argue that Lewis’s variable but simple semantic values are suitable objects of the attitudes. Construing such values as sets of world, time, location, standard of precision four-tuples, e.g. having a belief whose object is such a set would amount to a space-time slice of oneself self ascribing the property of being an “inhabitant” of some member of the set. That is, the space time slice ascribes to himself the property of there being some four-tuple in the set in question such that he is in the world of the four-tuple, at its location and time relative to the standard of precision.⁶⁶ If such a view could be worked out, it would provide a reason for favoring a semantics that employs variable but simple semantic values over one that employs constant but complicated semantic values: the former, but not the latter, are proper objects of the attitudes. However, since I am an advocate of the view that propositions, things that are or determine functions from possible worlds to truth values, are the proper objects of the attitudes, I shall not press this response to Lewis.

There is a second response one might make to Lewis. Lewis’s argument against Stalnaker hinges in the first instance on the claim that the variable but simple semantic values and constant but complicated semantic values can be converted into each other. The ease of interconversion is the reason given by Lewis for thinking that there is no reason to prefer one to the other. But the demonstration of interconversion assumes that both sorts of semantic values are *functions* (from indices to truth values in one case and from context-index pairs to truth values in the other), and hence *unstructured*.⁶⁷ But of course, the

variable but simple semantic values favored by structured proposition theorists are not functions (that is, structured proposition theorists assign structured semantic values in a context to sentences, where the values assigned vary with context). And one cannot convert a constant but complicated semantic value, functionally construed, into a *structured* variable but simple semantic value. For consider the following two sentences:

I am here now.

I am here now and arithmetic is incomplete.

These sentences will have the same functional constant but complicated semantic value (i.e. the same function from context-index pairs to truth values). But they express different *structured* variable but simple semantic values. Hence one cannot convert the constant but complicated semantic value into the variable but simple semantic value. Thus, the advocate of structure can claim that a crucial premise in Lewis's argument, that the two sorts of semantic values are interconvertible, is false.

However, one might respond on Lewis's behalf that if one is an advocate of structure, one should introduce structure into constant but complicated semantic values as well. E.g. one might assign to lexical items as constant but complicated semantic values functions from context-index pairs to appropriate entities; and assign to complex expressions structured constant but complicated semantic values consisting of the concatenation, in accordance with the syntactic structure of the complex expression, of the constant but complicated semantic values of its simple parts. Though one would have to consider particular, properly formulated versions of the two semantic approaches, it seems plausible that on at least some formulations, structured variable but simple semantic values and structured constant but complicated semantic values would once again be interconvertible.⁶⁸ This is why I didn't pursue this line of criticism and attempted to meet Lewis more on his own ground. Thus, though I am an advocate of structured propositions, the response I gave to Lewis was neutral on the question of whether semantic values are structured or not.

Appendix 2: Some Complex Data Involving Embedded Tenses

Here we consider some of the complex data involving natural language tense that current semantic theories of tense have to account for. After displaying this data, I show that Salmon's theories of tense cannot handle such data as formulated and that straightforward extensions of his account cannot handle it either.

To begin with, consider a sentence containing a noun phrase with a relative clause, such as:

1. Peter saw a man who was a cyclist.

The matrix verb is past tense, as is the verb in the relative clause. It appears as though 1 could be true when uttered at *t* in any of the following three cases:

- (i) Peter saw at *t'* prior to *t* a man who prior to *t'* was a cyclist.
- (ii) Peter saw at *t'* prior to *t* a man who was a cyclist at *t'*.
- (iii) Peter saw at *t'* prior to *t* a man who was a cyclist after *t'* and before *t*.

(This last reading can be made prominent by inserting temporal adverbs: ‘Ten years ago, Peter saw a man who was a cyclist from two years ago until last week’)

By contrast, consider:

- 2. Peter heard that Liz was ill.

Again, the matrix verb is past tense, as is the verb of its sentential complement. 2 could be true when uttered at *t* in either of the following two cases:

- (i) Peter heard at *t'* prior to *t* that Liz was ill at *t'*.
- (ii) Peter heard at *t'* prior to *t* that Liz was ill prior to *t'*.

But 2 would not be true in the following case:

- (iii) Peter heard at *t'* prior to *t* that Liz was ill after *t'* and before *t*.

To get a sentence true in that case, one requires:

- (2a) Peter heard that Liz would be ill.

Thus 2 is not true in case (iii), which is the analogue of case (iii) above in which 1 would be true. Hence the past tenses in 1 and 2 interact differently, and this needs explaining by a proper theory of tense. This has proved to be not a simple matter.

All the past tenses in 1 and 2 at any rate require that certain things obtain in the past (i.e. corresponding to its two past tenses, 1 requires that both the seeing and the cycling occurred in the past; 2 requires that both the hearing and the purported illness occurred in the past). But the following example, due to Abusch (1997), who attributes a similar example to Kamp and Rohrer, shows that sometimes a past tense doesn't require this:

- 3. John decided a week ago that in ten days at breakfast he would say to his mother that they were having their last meal together.

Consider the past tense on the verb in the most embedded complement (‘were having’). Though it is in the past tense, the time of the alleged last meal lies in

the future of the time of utterance. How the tense works here and why it is past needs some explanation.

Finally, there are sentences that exhibit so-called “double access” readings:

4. Peter said that Liz is ill.

Put roughly, the embedded present tense here makes the alleged illness relevant both to the (past) time of Peter’s saying and to the (present) time of utterance. It is hard to even state exactly what the truth of 4 does require, but it seems that it requires that Peter’s saying was a past, present tense statement that Liz was ill (so that Peter in the past said ‘Liz is ill’); and that in some sense Peter’s statement committed him to Liz’s being presently ill. The former properly rules out 4 being true if yesterday Peter said ‘Liz will be ill tomorrow’. And the latter, again I think properly, rules out 4 being true if Peter said two days ago ‘Liz is sick but will be better tomorrow.’ Again here, formulating a theory that gets this data right has not proved easy. There is much more data of this sort to consider if we bring in more examples with present and future tense.

Let me now show that Nathan Salmon’s theories of tense as formulated cannot handle data of this sort, nor can straightforward extensions of his accounts. To begin with, consider 86. The first point is that the fragment in which 86 is implemented is very austere when it comes to temporal expressions and tenses. The only temporal operator in the fragment, or temporal expression of any sort for that matter, is ‘sometimes’ (I find it surprising that Salmon didn’t include what he calls “indexical temporal operators” (e.g. ‘present’, ‘now’) in the fragment since he uses their interaction with other temporal operators to motivate double indexing of information value to context and time—see Salmon (1986) p. 36–37). Obviously, then, as formulated 86 cannot handle the complex data involving tenses discussed in this appendix, since it contains no account even of the past tense.

More importantly, it is clear that a straightforward extension of 86 would not be able to handle the complex data we have discussed either. Consider, for example,

2. Peter believed that Liz was ill.

Now on a straightforward extension of 86, 2 would be rendered as:

2/. Past tense [Believes (p, that Past tense (ill(l)))]

(where ‘p’ is an individual constant whose information value with respect to any time and context is Peter, ‘l’ is an individual constant whose information value with respect to any time and context is Liz, ‘ill’ is a monadic predicate whose information value base with respect to any context is the property of being ill, and ‘Past tense’ is the past operator). This is on analogy with:

5. Sometimes Jones believes that sometimes Smith is bald.

which can be represented in the 86 fragment. The only difference (besides the new constants and predicates) is in having the past tense operator instead of ‘sometimes’. Recall that 2 has two readings. On one, 2 is true uttered at t iff Peter believed at t' prior to t that Liz was ill at t' . On the other, 2 is true uttered at t iff Peter believed at t' prior to t that Liz was ill prior to t' . Now if 86 is extended in such a way that ‘Past’ behaves on analogy with ‘Sometimes’ and in accordance with what Salmon’s remarks suggest, the information value of 2' with respect to a context c and time t will be true at a world w iff at some time t' prior to t in w , Peter believes that Liz was ill at a time prior to t' . So a straightforward extension of 86 only captures the second of the two readings of 2. Similarly, consider again:

4. Peter said that Liz is ill.

A straightforward extension of 86 to this sentence would have it that its information value with respect to any time t and context c is true at a world w iff at some time t' prior to t Peter said at t' in w that Liz was ill at t' . But these are the wrong truth conditions for 4, for this would allow 4 to be true uttered at t if a week before t Peter said that Liz was ill at that time, where he didn’t commit himself to Liz being ill at t . But this is incorrect. The truth of 4 when uttered at t requires Peter to have said something in the past that commits him to Liz being ill at t . Similarly, 86 has no resources to capture the differences we noticed between cases in which a past tense in a relative clause is embedded with respect to a past tense on a matrix verb (‘Peter saw a man who was a cyclist’) and a case in which a past tense matrix verb embeds a past tense sentential complement (‘Peter heard that Liz was ill’). Perhaps some revised version of 86 could handle all this data. But it is certainly not at all obvious that this is so.

Let’s now consider Salmon’s other theory of tense: 89. As I’ve already mentioned, Salmon provides no explicit formal semantics for 89, so it is hard to determine how it would handle, or would be extended to handle, complex data of the sort we have discussed above. Thus, the following remarks are quite speculative. But I want to stress that this is because as formulated 89 doesn’t handle the data under consideration at all. In any case, consider again:

2. Peter heard that Liz was ill.

And again recall that 2 has two readings. On one, 2 is true uttered at t iff Peter heard at t' prior to t that Liz was ill at t' . On the other, 2 is true uttered at t iff Peter heard at t' prior to t that Liz was ill prior to t' . Now it looks like 89 suitably extended would render 2 as:

2''. Then (Past tense (Heard (p, that Then (Past tense III (l))))))

The outermost “implicit” ‘Then’ is needed so that 2 has a truth-value as its extension (relative to a world, time and context) instead of a class of times. The inner most ‘Then’ is needed so that 2 asserts that Peter stands in the heard relation to something that is true or false (and not something that certain times instantiate). Now we could get the two readings of 2 if we just stipulated that the innermost ‘Then’ had to designate either the same time as the outermost ‘Then’ or a time prior to it.⁶⁹ But this is just brute stipulation! What is the principled reason for it? After all, ‘Then’ is a demonstrative here. And when other demonstratives are embedded with respect to each other there are no such restrictions. E.g. in ‘He believed that he was happy’ there are no constraints on what the innermost ‘he’ can designate. This question as to the principled reason underlying the required stipulation becomes more acute when we remember, as noted above, that the stipulation cannot hold when one past is embedded under another where the first is in a relative clause, as in:

1. Peter saw a man who was a cyclist.

This sentence can be true uttered at t if e.g. Peter saw at t' prior to t a man who was a cyclist after t' and before t . But now 89 suitably extended would render 1 as something like:

1'. Then(Past tense(A man: $x \lambda x(\text{Then (Past Tense (cyclist}(x)))) (x (\text{Saw}(p,x))))))$ ⁷⁰

Again, the outermost “implicit” ‘Then’ is required so that 1 has as its extension (relative to a world, context and time) a truth-value. The innermost “implicit” ‘Then’ is required so that the lambda expression designates a class of individuals instead of a class of individual/time pairs. Here the stipulation governing ‘Then’ needed to get the readings of 2 right cannot hold, on pain of not allowing 1 to be true in the situation described above (Peter saw at t' prior to t a man who was a cyclist after t' and before t). But why does the stipulation regarding past tense and ‘Then’ hold in the case of 2 and not 1? In both cases, we have a past tense and accompanying ‘Then’ embedded with respect to another past tense and accompanying ‘Then’. I suppose we could just stipulate that it holds in one case and not the other. But surely this is too much unilluminating stipulation. Finally, different stipulations would be needed for different tenses. Consider:

6. Leroy will hear that Doug will be married.

A straightforward extension of 89 would render this as follows:

6'. Then (Future tense Hear (l, that Then (Future tense M(d))))

But here, 6 uttered at t only has the reading according to which Leroy hears at some (particular?) time t' after t that Doug will be married after t' . So here we would have to have the different stipulation governing 'Then' that the innermost 'Then' must designate a time after that designated by the outermost 'Then'.

A proper theory of tense should *explain* the differences in the behavior of the tenses in 1, 2 and 6; it should not simply contain brute stipulations that there are these differences. Thus, I conclude that a straightforward extension of 89 will not handle the complex phenomena we have discussed. As in the case of 86, perhaps *some* extension of 89 could handle our complex data. But again here it is not obvious that this is so.

Notes

1. Actually, things may be a bit more complicated than this. First, some word types may not be associated with characters. For example, a demonstrative pronoun like 'he' may not have a character. It would seem that only tokens accompanied by demonstrations or accompanying intentions have characters (perhaps such word types are associated with something like functions from demonstrations to characters). But then a sentence type containing such a pronoun will not have the character level semantic value I mention here, since the sentence type by itself is not associated with a function from contexts to propositions. So perhaps only a sentence type taken together with appropriate demonstrations has this character level semantic value. I ignore this complication here. Second, I am in fact somewhat skeptical as to whether a semantics assigns to *sentences* (and other syntactically complex expressions) characters at all, and I have expressed that skepticism elsewhere (King and Stanley 2003). It may be that only the syntactically simple parts of sentences are assigned characters by the semantics. One might hold this because one doesn't think that the characters of sentence parts are combined compositionally by the semantics to yield the character of a whole sentence. I shall nonetheless speak of sentence characters in the present work, because doing so will facilitate making contact with the work of other philosophers I discuss. Thanks to Jason Stanley for helping me get clear on these issues.
2. That is, the truth or falsity of a sentence relative to a context is derivative because it is determined by the truth or falsity of the proposition it expresses in that context.
3. Unless explicitly indicated, I use the term 'sentence operator' for non-truth-functional expressions that embed sentences.
4. For many of us, certainly for me, this tension was made manifest by some of David Kaplan's remarks in Kaplan [1989]. See pps. 502–504 including footnote 28, and p. 546. Kaplan talks primarily about modal and tense operators, but he does at least flirt with the idea of location operators (p. 504). Still, his formal fragment doesn't contain location operators, though it does contain the "position constant" 'here'. It is interesting that in Kaplan's formalism, 'now' is a sentence operator and 'here' is a position constant.
5. See Richard [1981].

6. At least Lewis [1980] agrees with this—see p. 37. Of course, Lewis [1979] may not agree.
7. Nor, of course, can they be *unrelativized* character level semantic values, since we are talking of the assignment to sentences of semantic values *relative to context*.
8. See pps. 575–76 and note 48.
9. This is the formulation from Stanley [1997b]. The formulation in Stanley [1997a] is slightly different in various respects, but the underlying general idea is clearly the same.
10. I here assume a thesis about compositionality of content.
11. Here I assume a principle of compositionality regarding assertoric content.
12. Note that Stanley need not deny that assertoric contents also determine modal profiles e.g. by being propositions construed as sets of worlds. What he is committed to is the claim that our *intuitions* about the modal profiles of sentence pairs such as 6/7 and 8/9 are intuitions about properties of ingredient senses and not assertoric contents. Stanley tells me (p.c.) that he intended to be neutral on the question of whether assertoric contents themselves determine modal profiles.
13. For example, David Chalmers [2003] motivates his two dimensional semantics by assuming that some aspect of meaning needs to capture epistemic notions like a priority and two expressions differing in cognitive significance. Many philosophers, including me, are skeptical as to whether these notions should be captured/explained by semantics, and so see no reason here to embrace a two dimensional semantic framework. As I go on to say, this is why Stanley's way of motivating a two dimensional semantic approach is hard to resist. It rests on claims only about the proper semantics for tenses etc., and everyone agrees that semantics needs to capture the proper semantics for tenses, etc.!
14. Thanks to Jason Stanley for much help with the last three paragraphs. Stanley's view still may be importantly different from the two dimensionalist's described in the previous paragraph in the following two respects. First, Stanley certainly does not claim that what is asserted by a sentence relative to a context (its assertoric content in that context) is the diagonal proposition expressed by the sentence in that context, (see note 12). Second, Stanley must hold that our intuitions about modal profiles of sentences like 6/7 and 8/9 track properties of the ingredient sense and not what is asserted (see note 12). Two dimensionalists may hold that intuitions about modal profiles track properties of what is asserted, even if modal operators operate on something else. Lewis's own view is interesting here. The proposition expressed by a sentence relative to a context has/determines a modal profile, since it is a set of worlds. But modal operators, like other operators, operate on the compositional semantic values of the sentences they embed.
15. Lewis [1980] writes: 'No two contexts differ by only one feature. Shift one feature only and the result of the shift is not a context at all.' (p. 29).
16. For the sake of brevity, I shall sometimes speak of operators shifting indices, but this should be understood as shorthand for the claim that operators shift coordinates of indices.
17. Converting one approach into the other in the way sketched by Lewis requires understanding both types of semantic values as functions (from indices to truth values; or from context/index pairs to truth values), and hence as *unstructured*. This is discussed below.

18. p 35.
19. The dialectic here is actually somewhat more complex than Lewis represents it as being. For Stalnaker [1970] is defending the view that we must keep separate two different determinants of the truth-values of sentences: contexts and possible worlds (as points of evaluation). Thus, the theory he is arguing against is one that doesn't distinguish contexts from worlds of evaluation, since it merges the two into what Stalnaker calls *points of reference*. The view he opposes, then, assigns sentences semantic values that map points of reference to truth-values. Thus, it is not strictly a version of Lewis' constant but complicated semantic values option, since even that option distinguishes context and index (here, possible world) as Stalnaker argues we must do. At the end of Lewis [1980], Lewis makes clear that he too opposes a view that merges contexts and indices, and assigns sentences semantic values that are or determine functions from points of reference to truth values (see third paragraph of section 12 of Lewis [1980]). I ignore this complication in the dialectic, as did Lewis. For if Stalnaker successfully argues that a theory that has propositions as middlemen is superior to one that maps points of reference straight to truth values (because of the independent interest of propositions), then this same argument will show that Stalnaker's account is superior to one that maps context-index pairs straight to truth values. For here too we fail to have the independently interesting propositional middlemen.
20. The qualification that propositions be sets of worlds is important here. If propositions are structured, a definition of the relation *S* is true wrt to *i* and *c* won't allow for an assignment of propositions to sentences. The problem is that sentences that are true with respect to the same context/index pairs may express different structured propositions. In Appendix 1 I discuss another claim made by Lewis that may fail if propositions (qua variable but simple semantic values) are structured.
21. Lewis supposes, reasonably, that "real" semantic values are assigned compositionally.
22. Like Kaplan himself, Richard and Salmon consider only tense and modal expressions, and say little or nothing about location expressions. However, certain brief remarks in Salmon (1986) (pps. 35–36) and Salmon (1989) (p. 343, 345, 346, 348 and 350) strongly suggest that Salmon envisages treating location expressions like temporal ones. Thus, the objects of our attitudes do not vary across time or location, and temporal and location expressions both operate on things that are not the objects of our attitudes.
23. More precisely, Richard defends the view that all English sentences that express propositions relative to times express propositions (relative to those times) that don't change truth values over time.
24. Actually, for reasons I won't go into, Richard's meanings are functions from a pair of a context and a time to a proposition.
25. More precisely, where 'P' is the past tense operator and 'q' is atomic and *f* is the character level meaning assigned to 'q', the proposition expressed by 'P(q)' relative to the context *c*, whose time is *t_c*, and time *t* = {*w* | for some *t'* < *t_c*, *f*(*t*,*c'*) is true at *w*, where *c'* is like *c* except that the time of *c'* is *t'*}. Note that the proposition expressed by 'P(q)' is characterized in terms of the behavior of *f*, the *meaning* of 'q' (and not the proposition expressed by 'q' relative to *c*,*t*).

26. See Salmon (1986) p. 43 and p. 145 clauses 22 and 23; and Salmon (1989) p. 375–376.
27. Salmon (1986) p. 39.
28. Salmon [1986] clause 37 p. 147 and clause 21 p. 151.
29. Salmon [1986] clause 36 p. 147.
30. Salmon [1986] p. 147–148.
31. Salmon [1986] p. 150 clauses 19 and 20.
32. See Salmon [1989] p. 382–383.
33. See p. 381.
34. See p. 383—Salmon suggests that other specific temporal operators function essentially as definite descriptions designating times, (see p. 381 and remarks there on ‘when Frege wrote “Thoughts”’).
35. See p. 386.
36. See p. 381 and 383.
37. Though Salmon doesn’t mention that 89 is non-compositional, as he did with 86, I feel sure that he is aware of it.
38. At least it is compositional so far as I can see. Again, Salmon doesn’t formulate an explicit semantics here.
39. See pps. 382, 385.
40. Indeed, the attentive reader will recognize that among other things, these do the work in 89 that was done in 86 by the notion of eternalization and the corresponding special semantic clauses required to handle cases like 18. Just as the latter is ad hoc, so are these “implicit operators” that come and go at all the right times. Indeed, I believe that the above considerations show that the latter are even more ad hoc, since they are even required to get simple tensed sentences to have truth values (with respect to a context, world and time)!
41. This point is discussed in King and Stanley 2003.
42. Sophisticated readers might be thinking that the problem here is that I have assumed a semantics with a single time index. We all know that in a language that contains temporal indexicals like ‘Yesterday’ and time index shifting operators like past tense, we need to have *two* time indices. And so in assuming a single time index I am making the operator treatment fail. But double indexing does not solve the problem. Kaplan’s [1989] semantics, which has double indexing to context (which includes a time) and time, doesn’t get the interaction of ‘yesterday’ and past tense right either. Kaplan’s account would allow two readings of 20 corresponding to 20a and 20b. 20a is true with respect to time *t* context *c* and world *w* iff given the day *d* prior to the day that includes the time of the context of utterance, ‘John turns off the stove’ is true with respect to a time prior to *d*, *c* and *w*. 20 does not have this reading. 20b is true with respect to *c*, *t* and *w* iff on the day *d* prior to the time of the context, ‘John turns off the stove’ is true with respect to *d* (*c* and *w*). See. p. 545. The second truth conditions here are actually correct! However, this is just an odd coincidence. The truth conditions are correct only because the semantics of ‘Y’ (yesterday) results in its ignoring the shift in the time index induced by the wide scope ‘P’ (past) operator. But this means that on Kaplan’s semantics, for a formula ‘ ϕ ’, ‘P(Y(ϕ))’ and ‘F(Y(ϕ))’ (where ‘F’ is the future operator) should have the same truth value with respect to *c*, *t*, *w*, since ‘Y’ ignores the shifting induced by ‘F’ and ‘P’. Applied to English and the present case, this means that 20 (on the reading in question) should have the same truth conditions (taken in the same context) as ‘Yesterday, John will

turn off the stove'. Obviously, this is not correct. Also, as indicated, Kaplan's theory predicts that 20 is ambiguous, and, again, it is not.

43. Enc holds that Comp optionally carries an index, and when it does the index is assigned a time interval as its referent. Tenses can be bound by other tenses or by an indexed Comp.
44. See her footnote 9.
45. Though Abusch talks about a tense referring to a time (see e.g. p. 30), I don't see that she explains how such references are assigned, concentrating more on the complex relations tenses specify between the alleged referent and the local evaluation time.
46. See p. 35. I have suppressed the variable for a reference time in 22 (' t_{RT} ') as Ogihara himself often does. Strictly for Ogihara, 22 expresses a relation between times (and so is represented by an IL expression of type $\langle i, \langle i, t \rangle \rangle$, where denotations for type i are times, and denotations for type t are truth values). But his definition of truth in a context for sentences of his intensional logic (expressions of type $\langle i, \langle i, t \rangle \rangle$ —p. 58) assigns the one "free" time variable (really, one variable bound by a wide scope time variable lambda abstract) speech time, and existentially quantifies over the other in the metalanguage. Thus, 22a gives the truth conditions of 22. See p. 63. Ogihara comments, however, that introducing existential quantification in the truth definition in this way is "not meant to carry a substantial theoretical claim" (p. 62), and he indicates that at least for English, the existential closure could be introduced sentence internally (i.e. with an existential quantifier in the sentence as in 22a) "as part of the translation of the tense morpheme" (p. 62).
47. P. 28. See pps. 26–28.
48. P. 28.
49. Actually, Ogihara adopts the view that propositions are sets of world/time/individual triples. But that is only because, inspired by Lewis [1979], Ogihara thinks that believing is a matter of self ascribing a property and a temporal location, and that this must be reflected in the semantics of belief ascription (see pps. 108–120). Thus, the objects of belief must be world-time-individual triples. So strictly, the points of evaluation or indices for propositions have time coordinates. But the crucial point is that his adopting this view has nothing to do with how tenses or temporal expressions work, but has to do instead with his view about the objects of belief. We, by contrast, are investigating the question of whether the behavior of tenses forces us to treat them as operators, and hence requires having temporal coordinates of indices. It doesn't on Ogihara's view.
50. See pps. 209–210.
51. Ludlow [1999] might seem to be an exception to this. See note 57 below.
52. p. 426.
53. Let σ be an infinite sequence of times (or worlds) and let $\sigma(n)$ be the n th element of σ . Suppose that the interpretations of formulas of our language assign sets of such sequences to formulas, (I suppress reference to an assignment of values to variables). Intuitively, these are the sequences at which the formulas "are true" (on analogy with the assignment of sets of times to formulas in a standard tense logic, where these are the times at which the formulas "are true"). Then Cresswell's operators work as follows: for ' ϕ ' a formula, σ belongs to the set of sequences an interpretation V assigns to 'Then _{n} ϕ ' iff $\sigma[n/0]$ belongs to the set of sequences V

assigns to ' ϕ ', where $\sigma[n/0]$ is σ but with $\sigma(n)$ in place of $\sigma(0)$. And σ belongs to the set of sequences assigned to ' $\text{Ref}_n \phi$ ' iff $\sigma[0/n]$ belongs to the set of sequences V assigns to ' ϕ ', where $\sigma[0/n]$ is σ but with $\sigma(0)$ in place of the $\sigma(n)$. Here $\sigma(0)$ should be thought of as "the evaluation time", which is shifted by "ordinary" operators (e.g. in tense logic, past and future operators; in modal logic, necessity and possibility operators). See Cresswell (1990) p. 30, 46. So the 'Then' operators, which are a generalization of doubly indexed 'Now' or 'Actually' operators, take another time in the sequence and make it the new evaluation time, so that in the evaluation of the formula it embeds, the old evaluation time is ignored. The 'Ref' operators, which are a generalization of an operator introduced in Vlach (1973), take the evaluation time, and change another element in the sequence to it, so that it may be subsequently picked up by a later 'Then' operator.

54. If we think that the past tense in 24a picks out a particular past time, we could suppose that in context of utterance the existential quantification over times given in 24b is further restricted just as happens in cases like 'All the beer is in the fridge.' Similar remarks apply to the future tense (or modal) in 25a.
55. These, at any rate, are standardly taken to be the proper representations of such sentences using Kamp's and Vlach's operators. E.g. see van Benthem [1977] pps. 415–417. It seems to me that there may be some issues here concerning the domains over which the quantifiers range in 27a and 28a, but I won't worry about these here.
56. 27b and 28b would have to be more complicated on a serious theory of the sort being considered; on current ways of thinking, for example, 27 and 28 contain a present tense on 'will' and a past tense on 'would', respectively. So these expressions would do something like introduce two quantifiers: one for the tense on 'will'/'would', and a second for its (relative) future orientation. But this complication doesn't matter for my purposes, since I am simply claiming that having LFs something like 27b and 28b for 27 and 29 is less ad hoc and posits a cleaner relation between surface structure and LF than does having LFs like 27a and 28a.
57. Ludlow [1999] employs an operator like treatment of tense. Does Ludlow [1999] then constitute an argument to the effect that the correct empirical, syntactical claim about tenses is that they are index shifting operators? It seems to me that the answer is clearly 'no' for several reasons. First, though Ludlow's (absolute) tenses Past, Fut, Pres attach to sentences to form new sentences (actually they attach to inflectional phrases that have the form NP[I VP]) as operators do, Ludlow's tenses do not shift times in the index of evaluation, and indeed Ludlow does not have times in his indices of evaluation. The reason for this is that Ludlow believes, correctly I think, that if one's semantic theory quantifies over (past and future) times in the metalanguage one is metaphysically committed to those times (see p. 85). Since Ludlow is defending presentism and wants to avoid this commitment, he doesn't want any quantification over times in his metalanguage. But then he can't treat tenses as index shifting operators, since to do so requires quantification over times in the metalanguage (e.g. 'Past(ϕ)' is true at t iff ' ϕ ' is true at some $t' < t$). Hence, despite the fact that Ludlow's absolute tenses look a bit like operators, they are not index shifting operators at all, and times are not elements of his indices of evaluation. Second, and perhaps even more importantly, despite some rhetoric in Ludlow [1999] that suggests other-

wise, the book cannot be seen as having defended the empirical claim that tense in natural language works in the way given by the semantics for tense he provides. For a variety of reasons, some purely metaphysical, Ludlow is trying to give a semantic account of tense that employs only what he calls “A series resources” (see p. 111). It is not as though an empirical study of the behavior of tenses suggests this constraint. This is a constraint Ludlow brings to his attempt to construct a semantics of tense. In order to account for even quite simple tense phenomena (e.g. that an utterance of ‘I turned the stove off’ at a given time does not communicate the claim that I turned the stove off at some time prior to that time—see p. 9, 111) given this constraint, Ludlow must make some very radical moves. He is forced to claim that all natural language sentences have ‘when’ clauses (p. 118). When they appear not to (‘I turned the stove off’), such clauses are “implicit” (syntactically realized but not phonologically or inscriptionally realized). It is important to see here that these implicit ‘when’ clauses are not posited on the basis of any syntactic evidence. They are posited so that Ludlow can capture certain data given the constraints he is working under. Since these implicit ‘when’ clauses are an important part of Ludlow’s account of tense, in order to claim that tenses in fact work along the lines of Ludlow’s theory, one would have to provide independent empirical evidence of the existence of these implicit when-clauses. Though this is something Ludlow does not do, he clearly recognizes the burden to do so when he writes: “Whereas the B-theory looks for temporal reference, the A-theory [Ludlow’s] looks for implicit clausal structure...Whether this strategy can be carried out is an open empirical issue; perhaps the positing of this implicit clausal structure will collide with general principles of linguistic theory.” (p. 132) But then until it is shown that there is good reason for positing this implicit syntactical structure (other than that it allows Ludlow to capture certain data), it can’t be claimed that Ludlow has shown that tenses work in the way given by his semantic account (which presupposes the existence of this implicit structure). Ludlow himself admits that it is an open empirical question whether this implicit structure is really there. But then it is an open empirical question whether tenses in fact work in the way suggested by Ludlow’s semantics. Thus, Ludlow [1999] does not constitute an argument that tenses do work in that way. Finally, I should add that in any case, it isn’t clear that Ludlow’s account, even assuming implicit ‘when’ clauses (and implicit relative clauses—see p. 131), can handle all of the complex data discussed in Appendix 2. Ludlow doesn’t discuss the differences between the readings had by our sentences 1 and 2 in Appendix 2, and it isn’t clear to me how he would capture these differences. Further, Ludlow does not explain how he can get the “double access” reading of our sentence 4 in Appendix 2, and again it isn’t at all clear to me how he would do so.

58. See Lewis [1980] pps. 27 and 39.

59. Some find this sentence a bit awkward, but I think that is because of the completely unrestricted quantification here (‘something is beautiful’ seems similarly, if a bit less, awkward). If this is right, such sentences should improve when ‘somewhere’ takes on further restriction. As 30a illustrates, this seems correct.

60. As indicated above, I will argue that even having standards of precision and worlds as (the only) coordinates of indices allows the identification of variable but simple semantic values with propositions. I should also mention that

although I go on to talk as though *various* apparent operators have been reconstrued as object language quantifiers, strictly we have done this only for ‘somewhere’. With respect to tenses and temporal expressions, it may be that (at least some of them) are quantifiers, but we only really committed ourselves to the view that they are not index shifting sentence operators.

61. See Lewis [1980] p. 33 where he discusses various versions of the schmentencite strategy, ours included. Lewis actually discusses the strategy twice, as it is put to two uses. First, he discusses the strategy as a way of trying to avoid the claim that truth of sentences depends on both context *and index* (pps. 32–33). We don’t put the strategy to this use, since we have embraced the dependence of truth on context and index. He later very briefly discusses it as a way of rescuing Stalnaker (p. 39). As his language makes clear, Lewis is very dismissive of the strategy in both places.
62. This is worth highlighting, because I haven’t consistently used the word ‘sentence’ this way in the present work. To do so would have made exposition more difficult throughout and would have required tedious motivation early in the paper.
63. Lewis [1980] p. 39.
64. This paper never would have been written had it not been for conversations on these topics with Jason Stanley. He made me face the issues discussed herein, and helped me see how I might address them. He then nagged me off and on for a few years to write something like this paper. I should have acknowledged specific contributions he made to the paper throughout. But they were so numerous and we discussed the material so much over a period of years, that I can no longer recall precisely which contributions were his. At any rate, I am very much in his debt. Thanks also to Max Cresswell and Ted Sider for extremely helpful conversations about the topics of this paper early in its history. Finally, a version of this paper was given in Summer 2003 at the Australian National University and I thank the audience for the helpful discussion that ensued.
65. The response being considered here is suggested by a footnote on p. 39 of Lewis [1980] that was added in 1996.
66. With respect to standards of precision, I suppose the idea would be that one could be in a world at a place and time with different degrees of precision. E.g., if in the actual world I am one foot outside of the boundary of Carnelian Bay at precisely 2:00:01 PM PST July 12, 2004, whether I count as being in Carnelian Bay at 2 PM July 12, 2004 in the actual world or not depends on the standard of precision being employed.
67. See Lewis [1980] p. 35.
68. To illustrate, imagine one semantics that assigns to ‘I am here’ a structured semantic value relative to each context *c*, by assigning to each lexical item in the sentence a function from contexts to appropriate entities, as follows:

$$(i) \langle L(c), \langle s(c), p(c) \rangle \rangle$$

where *L* is a function from a context *c* to the obvious two-place relation between individuals and places, *s* is a function from *c* to the speaker of *c* and *p* is a function from *c* to the location of *c*. This is the “structured variable but simple” approach. (i) determines a function *g* from indices to truth values as follows:

$g(i) = T$ iff $\langle s(c), p(c) \rangle \in \text{ext}(L(c))_i$; $g(i) = F$ otherwise.

(where $\text{ext}(L(c))_i$ is the extension at i of $L(c)$)

Now imagine a second semantics (“structured constant but complicated”) that assigns to ‘I am here’ the following structured semantic value:

(ii) $\langle L^*, \langle s^*, p^* \rangle \rangle$

where L^* is a function from context/index pairs to the obvious two place relation between individuals and places, s^* is a function from context/index pairs to the speaker of the context, and p^* is a function from context/index pairs to the location of the context. (ii) determines a function f from context/index pairs $\langle c, i \rangle$ to truth values as follows:

$f(\langle c, i \rangle) = T$ iff $\langle s^*(\langle c, i \rangle), p^*(\langle c, i \rangle) \rangle \in \text{ext}(L^*(\langle c, i \rangle))_i$;
 $f(\langle c, i \rangle) = F$ otherwise.

(where $\text{ext}(L^*(\langle c, i \rangle))_i$ is the extension at i of the relation $L^*(\langle c, i \rangle)$)

Given (ii), define the proposition expressed by ‘I am here’ relative to any context c (i.e. (i)) as follows:

(iii) $\langle L^*(\langle c, i_c \rangle), \langle s^*(\langle c, i_c \rangle), p^*(\langle c, i_c \rangle) \rangle \rangle$

where i_c is the index whose coordinates are all drawn from c . And given L , s and p and the assignment to ‘I am here’ of a proposition for each context, define the structured constant but complicated semantic value for ‘I am here’ (i.e. (ii)) as follows:

(ii) $\langle L^*, \langle s^*, p^* \rangle \rangle$

where L^* , s^* and p^* are defined in terms of L , s , p as follows:

$L^*(\langle c, i \rangle) = L(c)$ for all i
 $s^*(\langle c, i \rangle) = s(c)$ for all i
 $p^*(\langle c, i \rangle) = p(c)$ for all i

69. Actually, this probably isn’t quite right. It appears that the semantics Salmon has in mind would have the consequence that when we evaluate 2” at a time t and world w , the sentence embedded with respect to the first ‘Then’ would have as its extension the set of times t' prior to t at which the sentence embedded with respect to the first Past Tense is true in w . But then for a given t' in this set, the second Past Tense would have us consider times t'' prior to t' . As a result, it would seem that Salmon’s theory couldn’t get the reading of 2 on which the time of Peter’s hearing is the same as the time as (as opposed to later than) Liz’s alleged illness. Because it favors Salmon’s account to do so, I waive this worry.
70. The only formal language Salmon formulates containing temporal expressions (in Salmon [1986]) doesn’t contain restricted quantifiers (‘a man’) nor relative

clauses, and so it is unclear exactly how Salmon would want to extend the language so that it contains (analogues of) things like 'a man who was a cyclist'. Thus, I am just guessing as to how the expression might be represented in some extension of Salmon's formal language. However, I don't think this makes any difference here because the crucial point has to do with the interaction of the two past tenses and the two 'Then' s.

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