Tense and Aspect[1]

1. A first proposal for tense

1.1. Tenses as Priorian operators

Tense logic, or temporal logic, is a branch of logic first developed by the aptly named Arthur Prior in a series of works, in which he proposed treating tense in a way that is formally quite parallel to the treatment of modality discussed in Chapter 3. Since tense logic (and modal logic) typically is formulated at a high level of abstraction regarding the structure of sentences, it doesn't concern itself with the internal make-up of "atomic" sentences and thus treats tenses as sentential operators (again, in parallel to the way modal operators are typically treated in modal logic). We will begin by integrating a version of Prior's tense logic into our framework.

The first step is to switch to a version of our intensional semantic system where instead of a world parameter, the evaluation function is sensitive to a parameter that is a pair of a world and a time. Such a pair will also be called an "index". We use metalanguage variables i, i', ... for indices, and write w_i and t_i to pick out the world in i and the time in i respectively. (I.e., $i = \langle w_i, t_i \rangle$). Predicates will now have lexical entries that incorporate their sensitivity to both worlds and times:[2]

(1) $[\![\textbf{tired}]\!]^i = \lambda x \in D.\ x \text{ is tired in } w_i \text{ at } t_i$

The composition principles from Heim & Kratzer and the preceding chapters stay the same, except that type s is now the type of indices, and intensions are functions from indices to extensions. For example, the intension of sentence is now a function from world-time pairs to truth-values.[3] We might call this a "temporal proposition", to distinguish it from a function from just worlds to truth-values, but we will often just call it a "proposition". From now on, the semantic type s stands for indices rather than worlds. So a function of type <s,t> is a temporal proposition.

In this framework, we can formulate a very simple-minded first analysis of the present and past tenses and the future auxiliary *will*. As for (LF) syntax let's assume that complete sentences are TPs, headed by T (for "tense"). There are two morphemes of the functional category T, namely

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[1] These notes start out as a version of the chapter "Basics of Tense and Aspect" from the 2011 version of the "Intensional Semantics" lecture notes by von Fintel & Heim. Then they continue with material that was mostly written by Irene Heim in 2016, based on handouts from many earlier years and contributions from other 24.973 instructors (Danny Fox, Sabine Iatridou, and especially Kai von Fintel). The current (2018) version also contains revisions and additions contributed by Roger Schwarzschild, who edited the 2016 version and accompanied it with extensive handouts of his own in 2017.

[2] We remain vague for now about what we mean by "times" (points in time? time intervals?). This will soon need clarification, and we will decide that we should mean "intervals".

[3] This necessitates a slight rewriting of our previous entries for modals and attitude verbs. We will attend to this when we get to relevant examples later on.

PAST (past tense) and *PRES* (present tense). The complement of T is an MP or a VP. MP is headed by M (for "modal"). Morphemes of the category M include the modal auxiliaries *must, can*, etc., which we talked about in previous chapters, the semantically vacuous *do* (in so-called "do-support" structures), and the future auxiliary *will*. Evidently, this is a semantically heterogeneous category, grouped together solely because of their common syntax (they are all in complementary distribution with each other). The complement of M is a VP. When the sentence contains none of the items in the category M, we assume that MP isn't projected at all; the complement of T is just a VP in this case. (TP is always projected in a root clause[4], whether there is an MP or not.) We thus have LF-structures like the following. (The corresponding surface sentences are given below, and we won't be explicit about the derivational relation between these and the LFs. Assume your favorite theories of syntax and morphology here.)

(2) $[_{TP}$ Mary $[_{T'}$ PRES $[_{VP}$ t $[_{V'}$ be tired]]]]
= Mary is tired.

(3) $[_{TP}$ Mary $[_{T'}$ PAST $[_{VP}$ t $[_{V'}$ be tired]]]]
= Mary was tired.

(4) $[_{TP}$ Mary $[_{T'}$ PRES $[_{MP}$ t $[_{M'}$ woll $[_{VP}$ t $[_{V'}$ be tired]]]]]]
= Mary will be tired.

woll in (4) stands for the underlying uninflected form of the auxiliary which surfaces as *will* in the present tense (and as *would* in the past tense[5]). When we have proper name subjects, we will assume for simplicity that they are reconstructed into their VP-internal base position.

What are the meanings of *PRES, PAST,* and *woll*? For *PRES,* the simplest assumption the seems to work is that it is semantically vacuous. This means that the interpretation of the LF in (2) is identical to the interpretation of the bare VP *Mary be tired:*

(5) For any index i: $[\![\text{PRES (Mary be tired)}]\!]^i = [\![\text{Mary be tired}]\!]^i = 1$
iff Mary is tired in w_i at t_i.

Does this adequately capture the intuitive truth-conditions of the sentence *Mary is tired*? It does if we make the following general assumption:[6]

(6) Utterance Rule:
An utterance of a sentence (= LF) ϕ that is made in a world w at a time t counts as true iff $[\![\phi]\!]^{<w,t>} = 1$ (and as false if $[\![\phi]\!]^{<w,t>} = 0$).

This assumption ensures that (unembedded) sentences are, in effect, interpreted as claims about the time at which they are uttered ("utterance time" or "speech time"). If we make this assumption and we stick to the lexical entries we have adopted, then we are driven to conclude that the present tense has no semantic job to do. A tenseless VP *Mary be tired* would in principle

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[4] Many subordinate clasues – those we call "finite" – also always have a TP. As for embedded clauses more generally (including infinitives etc.), we don't need to take a stand here.

[5] But let's not talk about *would* at this point. See the exercise right before section 2.1.

[6] As far as the world parameter is concerned, we have tacitly been making this assumption all along.

be just as good as (2) to express the assertion that Mary is tired at the utterance time. Apparently it is just not well-formed as an unembedded structure, but this fact then must be attributed to principles of syntax rather than semantics.

What about *PAST*? When a sentence like (3) *Mary was tired* is uttered at a time t, then what are the conditions under which this utterance is judged to be true? A quick answer is: an utterance of (3) at t is true iff there is some time before t at which Mary is tired. This suggests the following entry:

(7) For any index i: $[\![\text{PAST}]\!]^i = \lambda p \in D_{\langle s,t \rangle}. \exists t \text{ before } t_i : p(<w_i,t>) = 1$

So, the past tense seems to be an existential quantifier over times, restricted to times before the utterance time.

For *will,* we can say something completely analogous:[7]

(8) For any index i:
$[\![\textbf{woll}]\!]^i = \lambda p \in D_{\langle s,t \rangle}. \exists t \text{ after } t_i : p(w_i,t) = 1$[8]

Apparently, *PAST* and *woll* are semantically alike, even mirror images of each other, though they are of different syntactic categories. The fact that *PAST* is the topmost head in its sentence, while *woll* appears below *PRES,* is due to the fact that our syntax happens to require a T-node in every complete sentence. Semantically, this has no effect, since *PRES* is vacuous.

Both (7) and (8) presuppose that the set or times comes with an intrinsic order. For concreteness, assume that the relation 'precedes' (in symbols: <) is a strict linear order on the set of all times.[9] The relation 'follows', of course, can be defined in terms of 'precedes' (t follows t′ iff t′ precedes t).

1.2. Time frame adverbials

In this section, we take a brief look at temporal adverbials, specifically so-called frame adverbials, such as:

(9) Mary was tired on February 1, 2001.

There are two ideas that come to mind. One is that phrases like *on February 1, 2001* are

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[7] Are there also tenses with universal force? Two possible candidates that call for closer examination were suggested in class. Rafael Abramovitz mentioned gnomic tenses (e.g. in Ancient Greek), and Maša Močnik mentioned the (universal reading of the) English perfect (as in *I have been tired since yesterday morning*). Both have been written about in the formal semantics literature (the latter extensively –you could start with Iatridou, Anagnostopoulou & Izvorski 2001 in M. Kenstowicz (ed.) *Ken Hale: A Life in Language*, MIT Press).

[8] Here and later on, we omit angled brackets inside parentheses and write "p(w,t)" when it strictly should be "p(<w,t>)".

[9] Definition: A relation R is a strict linear order on a set S iff it has the following four properties:

(i) $\forall x \forall y \forall z((Rxy \& Ryz) \rightarrow Rxz)$ "Transitivity"
(ii) $\forall x(\neg Rxx)$ "Irreflexivity"
(iii) $\forall x \forall y(Rxy \rightarrow \neg Ryx)$ "Asymmetry", and
(iv) $\forall x \forall y(x \neq y \rightarrow (Rxy \vee Ryx))$ "Connectedness"

restrictors of temporal operators (kind of like *if*-clauses are restrictors of modals). The other idea is that they are modifiers of the proposition in the temporal operator's scope. If we want to go with the first idea, we have to make some changes. Our current *PAST* and *woll* are unrestricted (1-place) operators, so there is no place for a restrictor. The second idea is easier to implement, and we try that first.

A propositional modifier is a function from propositions to truth-values, where "proposition" for us now means "temporal proposition". Here is an entry for *on February 1, 2001*. Intuitively, this modifier takes a proposition and returns a proposition[10] that puts an added condition on the time-ccordinate of its index-argument.

(10) $[\![\textbf{on February 1, 2001}]\!]^i = \lambda p \in D_{\langle s,t \rangle}. [p(i) = 1 \ \& \ t_i \text{ is part of February 1, 2001}]$

(11) LF: PAST $[_{VP}$ $[_{VP}$ Mary be tired] $[_{PP}$ on February 1, 2001]]

Exercise 1: Imagine that sentence (9) is not given the LF in (11), but this one, with the PP attached higher:

(11') $[_{T'}$ PAST $[_{VP}$ Mary be tired]] $[_{PP}$ on February 1, 2001]]

What would the truth-conditions of this LF be? Does this result correspond at all to a possible reading of this sentence (or any other analogous sentence)? If not, how could we prevent such an LF from being produced?□

The truth conditions that we derive given (10) and (11) look good: the sentence is predicted true as uttered if there is a time which is both before the utterance time and within Feb 1, 2001 and at which Mary is tired, and it is predicted false if there is no such time. But arguably this is not *exactly* right. Suppose that somebody uttered this sentence at an utterance time that *preceded* the date in the adverbial, say at some time in the year 2000. Our analysis predicts that this utterance is false. But in fact it feels more like a presupposition failure; the speaker is heard to be taking for granted that Feb 1, 2001 is in the past of his speaking. Standard presupposition tests confirm this. E.g. the negated sentence (*Mary wasn't tired on Feb 1, 2001*) and the polar question (*Was Mary tired on Feb 1, 2001*?) also convey that the speaker assumes he is speaking after Feb 1, 2001.

If we want to account for this more fine-grained intuition, the restrictor approach has an advantage after all.[11] Let's revise the entries for *PAST* and *woll* so that they denote *2-place* operators, and moreover they encode a non-emptiness presupposition.[12]

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[10] Technically, the modifier returns a truth-value, not a proposition. (Thanks to Stan Zompí for pointing out this inaccuracy.) We get back a proposition only when we compute the intension of the phrase that includes the modifier.

[11] It also has the virtue of avoiding the potential overgeneration issue that you looked at in the exercise above.

[12] How about present tense? Should we make this presuppositonal as well – which would imply it is not, after all, completely vacuous? Frame adverbials in present tense sentences do occur. Typically they are adverbials like *today*, *on this beautiful Monday*, which in virtue of their own meaning already are required to contain the speech time. The following entry would make room for them and duplicate this requirement as a presupposition.

(12) For any index i:
$[\![\textit{PAST}]\!]^i = \lambda p \in D_{\langle s,t\rangle}: \exists t\, [t < t_i \ \& \ p(w_i,t) = 1].$
$\lambda q \in D_{\langle s,t\rangle}. \exists t\, [t < t_i \ \& \ p(w_i,t) = 1 \ \& \ q(w_i,t) = 1]$

(13) For any index i:
$[\![\textit{woll}]\!]^i = \lambda p \in D_{\langle s,t\rangle}: \exists t\, [t > t_i \ \& \ p(w_i,t) = 1].$
$\lambda q \in D_{\langle s,t\rangle}. \exists t\, [t > t_i \ \& \ p(w_i,t) = 1 \ \& \ q(w_i,t) = 1]$

Furthermore, let's change (i.e., simplify) the meaning of the adverbial so that it has a suitable type to serve as the temporal operator's first argument. The LF-structure must be accordingly different as well. Instead of (11) above, we now posit (15), where the adverb forms a constituent with the tense. This requires the surface order to be derived by some reordering, perhaps extraposition of the adverbial.[13]

(14) $[\![\textbf{on February 1, 2001}]\!]^i = 1$ iff t_i is part of February 1, 2001

(15) LF: $[_{T'}$ PAST $[_{PP}$ on February 1, 2001]] $[_{VP}$ Mary be tired]

The meanings we now derive contain the desired presuppositions: The past tense sentence (9) presupposes that Feb 1, 2001 is at least in part before the utterance time, the future sentence *Mary will be tired on Feb 1, 2001* presupposes that this date is at least in part after the utterance time, and the present tense sentence *Mary is tired on Feb 1, 2001* presupposes that the utterance time is on this date. Apart from the presuppositions, the meanings are the same as before.

On the down-side, the new analysis posits both more complex meanings for the tenses and a less direct correspondence between LF constituency and surface structure. Furthermore, how is it supposed to apply to simple sentences without adverbials? Not every tensed sentence contains an obligatory frame adverb, after all. We are forced to say there is a covert restrictor whenever there isn't an overt one. But this, upon reflection, turns out to be a virtue, as we will see in the next section.

Exercise 2: When a quantifier appears in a tensed sentence, we expect two scope construals. Consider a sentence like this:

(i) Every professor (in the department) was a teenager in the Sixties.

We can imagine two LFs:

(ii) [PAST in the sixties] [every professor be a teenager]

(iii) [every professor] 7[[PAST in the sixties] [t_7 be a teenager]]

(i) For any index i: $[\![\textit{PRES}]\!]^i = \lambda p \in D_{\langle s,t\rangle}: p(w_i,t_i) = 1. \lambda q \in D_{\langle s,t\rangle}. q(w_i,t_i) = 1$

For the purposes of these lecture notes, we leave the matter open and stick with the vacuous meaning for *PRES* in the discussions of the upcoming sections.

[13] We saw a similar issue of apparent mismatch between LF-constituency and surface order when we decided to treat if-clauses as restrictors of modals. As Mitya Privoznov pointed out, both issues might be addressed by simply letting modal and temporal operators take their arguments in the opposite order. Rewriting the lexical entries in this way is a routine exercise. We leave this matter open. The syntax of frame adverbials is a non-trivial object of study.

Describe the different truth-conditions which our system assigns to the two LFs. Is the sentence ambiguous in this way? If not this sentence, are there analogous sentences that do have the ambiguity?□

Exercise 3: Our official entry for *every* makes it a time-insensitive (and world-insensitive) item:

(i) for any index i, $[\![\text{every}]\!]^i = \lambda f \in D_{\langle e,t\rangle}. \lambda g \in D_{\langle e,t\rangle}. \forall x[f(x) = 1 \rightarrow g(x) = 1]$

Consider now two possible variants (we have underlined the portion where they differ):

(ii) $[\![\text{every}]\!]^i = \lambda f \in D_{\langle e,t\rangle}. \lambda g \in D_{\langle e,t\rangle}. \forall x \underline{\text{at}}\ t_i\ [f(x) = 1 \rightarrow g(x) = 1]$

(iii) $[\![\text{every}]\!]^i = \lambda f \in D_{\langle e,t\rangle}. \lambda g \in D_{\langle e,t\rangle}. \forall x[f(x) = 1\ \underline{\text{at}}\ t_i \rightarrow g(x) = 1\ \underline{\text{at}}\ t_i]$

Does either of these alternative entries make sense? If so, what does it say? Is it equivalent to our official entry? Could it lead to different predictions about the truth-conditions of English sentences?□

1.3. Are Tenses Referential?

Our first semantics for the past tense, in section 1.1, treated it as an unrestricted existential quantifier over times. This seems quite adequate for examples like (16), which seem to display the expected unrestricted existential meaning:

(16) John went to a private school.

All we learn from (16) is that at some point in the past, whenever it was that John went to school, he went to a private school.

Partee in her famous paper "Some structural analogies between tenses and pronouns in English" (Partee 1973) presented an example where tense appears to act more "referentially":

(17) I didn't turn off the stove.

"When uttered, for instance, halfway down the turnpike, such a sentence clearly does not mean either that there exists some time in the past at which I did not turn off the stove or that there exists no time in the past at which I turned off the stove. The sentence clearly refers to a particular time — not a particular instant, most likely, but a definite interval whose identity is generally clear from the extralinguistic context, just as the identity of the *he* in [He *shouldn't be in here*] is clear from the context."

Partee argues, in effect, that neither of the two plausible LFs that our system from section 1.1. derives can correctly capture the meaning of (17). Given that the sentence contains a past tense and a negation, there are two possible scopings of the two operators:

(18) a. PAST NEG I turn off the stove.
b. NEG PAST I turn off the stove.

Exercise 4: Using our old semantics from section 1.1, show that neither LF in (18) captures the meaning of (17) correctly.□

In a commentary on Partee's paper (at the same conference it was presented at), Stalnaker

pointed out that a minor amendment of the Priorean theory can deal with (17). One just needs to allow the existential quantifier to be contextually restricted to times in a salient interval. Since natural language quantifiers are typically subject to contextual restrictions, this is not a problematic assumption. Note that Partee formulated her observation in quite a circumspect way: "The sentence refers to a particular time"; Stalnaker's suggestion was that the reference to a particular time is part of the restriction to the quantifier over times expressed by tense, rather than tense itself being a referring item.

Ogihara (1995) argued that the restricted existential quantification view is in fact superior to Partee's analysis, since Partee's analysis needs an existential quantifier anyway. It is clear that the time being referred to in the *stove*-sentence (17) is a protracted interval (the time during which Partee was preparing to leave her house). But the sentence is not interpreted as merely saying that *this* interval is not a time *at* which she turned off her stove. That would only exclude a fairly absurd kind of slow-motion turning-off-of-the-stove (turning off the stove only takes a moment). Instead, the sentence says that *in* the salient interval there is no time at which she turned off the stove. Clearly, we need an existential quantifier in there somewhere and the Priorean theory provides one.[14] Ogihara made the point with the following example:

(19) John: Did you see Mary?
Bill: Yes, *I saw her,* but I don't remember exactly when.

The question and answer in this dialogue concern the issue of whether Bill saw Mary at *some* time in a contextually salient interval.

Stalnaker's and Ogihara's conclusions converge with what we already ended up with in section 1.2, after considering the interaction of tenses with time frame adverbials. In order to capture presuppositions of tensed sentences with frame adverbials, we already modified Prior's original proposal and made room for a restrictor in the semantics of the past tense. Given this revised analysis of the past tense as a *2-place* existential quantifier, it is unsurprising, in fact expected, that an implicit, contextually salient restrictor should be present when there isn't an overt one.

What then about example (16), *John went to a private school*, for which the unrestricted analysis seemed to do well? Let us say that the covert restrictor in this case picks out a very long interval, perhaps John's entire life-time, or even the entire past from the big bang to the utterance time, or all eternity. (What exactly the right restrictor is in this case, and what makes it contextually available, may be a bit unclear, but we leave it at that.)

Exercise 5: Assuming the restricted existential quantifier analysis of past tense that we adopted in section 1.2, which of the scope constellations in (18) captures the meaning of (17) correctly?□

[14] The alternative is to say that the existential quantifier is not expressed by tense but comes from somewhere else – perhaps from aspect, or from the lexical entry of the verb itself. We will come back to these options.

2. Stacked temporal operators

When we talked about modals, we attended to complex sentences with one modal verb scoping over another modal verb in the same clause. What about analogous cases with temporal operators? The syntactic properties of the morphemes *PRES*, *PAST*, and *woll* sharply limit the possibilities in this regard. But they do allow one combination that we could test, namely *woll* below *PAST*, which we assume surfaces as *would*. Also, we could extend the theory to include an entry for the auxiliary *have*, which some have argued to be, on one of its readings, simply an allomorph of *PAST* (see e.g. Ogihara 1995). This would give us more structures to look at (in fact, eight syntactically well-formed and interpretable combinations). The predictions that our present analysis makes for these so-called complex tenses certainly need to be tested. Even a superficial examination indicates that some new assumptions will be required to get things right.

Exercise 6: Assume that (temporal[15]) *have* heads an (optional) *have*P between MP and VP and has the same meaning as *PAST* (as in entry (12).) Given this extension of our analysis, work out the predicted truth conditions for the five sentences *Mary has been tired/ will have been tired/ would be tired/ had been tired/ would have been tired*. To what extent are they adequate, or perhaps can be made adequate by means of minor friendly amendments?

[the rest of this section is missing for now – I.H.]

[15] There is also the modal *have to* that we saw in examples in chapter 3. That's a different homophonous word, we assume. In the literature, what I call "temporal *have*" is more often called "aspectual *have*" or perfect aspect. The distinction between tense and aspect is a complex and theory-laden affair. The position entertained in this exercise is that at least one reading of temporal *have* is in fact (semantically equivalent to) a tense. See Stumpt 1985 and Ogihara 1995 for a defense of this view.

3. Referential tense and perfective/imperfective aspect

3.1. Referential tense after all

Let us revisit Partee's stove and the prospects of a "referential" theory of tense. Our earlier discussion of Partee's example (following Stalnaker in 1973 and Ogihara 1996) came to the conclusion that we did need past tense to be an existential quantifier over times, albeit a contextually restricted one. The stove-example is interpreted as a claim about a particular contextually relevant interval. But the speaker's claim is not merely that she didn't turn off the stove *at* that interval. That in itself would be compatible with her turning off the stove at some smaller interval *inside* the contextually relevant interval. The speaker's claim is stronger: she did not turn off the stove at *any* time that is *contained* in this interval. This is a negative existential claim. So there needs to be an existential quantifier somewhere in the LF and below the scope of *not*, and we concluded that past tense must be supplying it.

But this conclusion is not inescapable. Granted that there has to be an existential quantifier somewhere – but couldn't it be somewhere else than in the meaning of tense? One alternative that comes to mind is to locate it in the lexical meaning of the verb (here *turn off*). This means we abandon the lexical entry in (1) and instead adopt the one in (2).

(1) $[\![\textbf{turn-off}]\!]^i = \lambda y.\ \lambda x.$ x turns off y in w_i at t_i

(2) $[\![\textbf{turn-off}]\!]^i = \lambda y.\ \lambda x.$ x turns off y in w_i <u>in</u> t_i

The difference between 'at' and 'in' looks small at first, but if we reflect on the meaning of 'in', we see the hidden existential quantifier. When something happens *in* an interval, it happens *at some part of* the interval. We can make this more transparent in the metalanguage and rewrite (2) as (2').

(2') $[\![\textbf{turn-off}]\!]^i = \lambda y.\ \lambda x.\ \exists t\ [t \subseteq t_i$ & x turns off y in w_i at $t]$

The subset sign here stands for the containment relation between time intervals. A time interval can be defined as a certain kind of set of moments, as in (3), so the subset relation is well defined.

(3) A set of moments S is an <u>interval</u> iff for any two moments that are in S, every moment between them is also in S.

Another way to clarify the distinction between 'at' and 'in' is to use the kind of metalanguage that is familiar from the literature on Davidsonian event semantics.

(4) abbreviations in "event talk":
  (a) turn-off(e, x, y) = e is an event of turning off y by agent x
  (b) τ(e) = the (exact) time-interval occupied by event e
  also called the "run-time" or "temporal trace" of e

(5) event-talk formulation of (1), the old entry with 'at':
$[\![\textbf{turn-off}]\!]^i = \lambda y.\ \lambda x.\ \exists e$ [turn-off(e, x, y) & e occurs in w_i & $\tau(e) = t_i$]

(6) event-talk formulation of (2), the new entry with 'in':
$[\![\textbf{turn-off}]\!]^i = \lambda y.\ \lambda x.\ \exists e\ [\text{turn-off}(e, x, y)\ \&\ e \text{ occurs in } w_i\ \&\ \tau(e) \subseteq t_i]$

Let us spell out now how Partee's proposal for the meaning of past tense can be upheld after all, once we assume the lexical semantics specified in (2)/(2')/(5). The first task here is to write new lexical entries for the tense morphemes, which encode Partee's idea that tenses refer to specific time intervals and are semantically and pragmatically akin to personal pronouns. We will defer the full execution of this task until later and make do for the time being with a couple of syncategorematic *ad hoc* rules for the interpretation of TPs.

(7) $[\![\text{PAST } \phi]\!]^i = 1$ iff $[\![\phi]\!]^{<w_i, t'>} = 1$, where t' is the contextually salient time before t_i
(no truth value defined if there is no such time)[16]

(8) $[\![\text{woll } \phi]\!]^i = 1$ iff $[\![\phi]\!]^{<w_i, t'>} = 1$, where t' is the contextually salient time after t_i
(no truth value defined if there is no such time)

(PRES remains vacuous as before, i.e., $[\![\text{PRES } \phi]\!]^i = [\![\phi]\!]^i$.)

The stove example has the two potential LFs in (9) and (10).

(9) **not [PAST [I turn off the stove]]**

(10) **PAST [not [I turn off the stove]]**

We can compute the truth conditions for both of these under the new semantics for **PAST** and **turn off**, and it turns out that they are the same.

(11) $[\![(10)]\!]^i = 1$ iff $[\![(11)]\!]^i = 1$ iff $\neg\exists e\ [\text{turn-off}(e, x, y)\ \&\ e \text{ occurs in } w_i\ \&\ \tau(e) \subseteq t']$,
where t' is the contextually salient time before t_i
(no truth value defined if there is no such time)

The fact that both scopal orders yield the same truth conditions is arguably a point in favor of this approach. The English sentence is not in fact perceived as ambiguous. Our earlier approach, on which past tense was a contextually restricted existential quantifier, did not make this prediction – at least not without the help of additional assumptions (such as a syntactic constraint on the position of negation with respect to other heads on the clausal spine). Now that the existential quantifier comes bundled with the lexical verb, its scope is automatically "frozen" below everything that scopes over the verb.

3.2. Event semantics and perfective aspect

Up to now in this semester, we have presupposed a pre-Davidsonian view of lexical meanings, on which verbs take only individuals or propositions as their arguments. Even when we recently inserted some event-talk into the metalanguage of our lexical entries, we still defined the denotation of a verb like *turn off* as a function from two individuals to a truth value. In this section, we switch to a Davidsonian treatment of verbs as predicates of events and integrate this

[16] This contextually salient time is also called the "topic time" (Klein 1994) or the "reference time" (a term which goes back to Reichenbach 194x, but which has various other uses in the literature).

with our conception of sentence-intensions as temporal propositions.[17]

In an extensional Davidsonian semantics, lexical entries look like (12).[18]

(12) $[\![\text{laugh}]\!] = \lambda x.\, \lambda e.$ e is an event of x laughing
abbreviated: $[\![\text{laugh}]\!] = \lambda x.\, \lambda e.\, \text{laugh}(e,x)$

Assuming that events are not in D_e, but have their own basic type v, VPs thus are of type <v,t>. (All the verb's non-event arguments are merged inside the VP.)

In a semantics that is both Davidsonian and intensional, do we have to rewrite these entries? For example, should we perhaps rewrite (12) as (13)?

(13) $[\![\text{laugh}]\!]^i = \lambda x.\, \lambda e.$ e is an event of x laughing in w_i at t_i

That depends. Here we follow Kratzer and assume that each event occurs in just one world and at just one time.[19] It is not possible for a given *e* to be an event of x laughing in one world and to be some other kind of event in another world. Nor is it possible for one and the same *e* to be an event of x laughing at one time and something else at another time. Reformulations such as (13) are uncalled for then, and we can essentially stick with (12).[20]

But how then does world and time dependence enter the semantic computation? And how can tenses and modal operators combine with VPs? VPs are now type <v,t>, which leads to a type-mismatch if we try to combine them directly with a modal operator or with a tense (regardless of whether the tense is a Priorian temporal operator or a Partee-style referential tense). The way out of this problem is to posit a more complex clause structure, with a further functional head that intervenes between T (or M) and V. This is called an "aspect" head (category label "Asp"), and its semantic job is to existentially bind the event argument of the VP and return a world- and time-sensitive denotation of type t.

One instance of Asp is the so-called "perfective", for which we posit the following entry.[21]

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[17] We share the goal of integrating Davidsonian event semantics and traditional intensional semantics with a paper by Beck & von Stechow (2014), from whom we borrow a number of ideas.

[18] Many practitioners of event semantics also assume that the event argument is the *only* real argument of the verb, whereas the subject, object, etc. are arguments of abstract theta-role heads that combine with the verb in the manner of modifiers. Here we remain agnostic on this matter. For concreteness, we assume that verbs take all the traditional arguments in addition to their event-argument, but the other view is equally compatible with everything we will say. We just abstract away from the internal compositional semantics of the VP.

[19] This assumption is made here mostly to keep things simple. It is not innocuous and not uncontroversial. See e.g. Hacquard (200x) for an analysis of root modals that makes crucial use of the idea that an actual event exists in non-actual worlds and has different properties there.

[20] Strictly speaking, we should now write (12'), but since i in (12') does not occur on the right side of =, (12) can be shorthand for (12').

(12') for any index i: $[\![\text{laugh}]\!]^i = \lambda x.\, \lambda e.\, \text{laugh}(e,x)$

[21] (14) combines the standard formal analysis of perfective aspect (Krifka 1989, Klein 1994, Kratzer 1998, etc.) with the semantics of Beck & von Stechow's (2014) *Modl* head. I.e. it locates the event both in a time interval and in a possible world.

(14) $[\![\text{PFV}]\!]^i = \lambda P_{<v,t>}. \exists e\, [P(e) = 1 \;\&\; \tau(e) \subseteq t_i \;\&\; e \leq w_i]$
notation: $\leq$:= is part of (= occurs in)
τ := the run time of (temporal trace of)

PFV is morphologically zero in English, so we can posit it in the LFs of sentences with simple tensed verbs. Here is an example.

(15) (a) Barbara turned off the stove.
(b) LF: $[_{TP}$ **PAST** $[_{AspP}$ **PFV** $[_{VP}$ Barbara turn-off the stove]]]

Using the syncategorematic rule (7) for referential PAST, our entry (14) for PFV, and a Davidsonian entry for the verb, we compute the following interpretation. (Do this as an exercise.)

(16) $[\![(15b)]\!]^i = 1$ iff $\exists e\, [\text{turn-off}(e, \text{Barbara}, \text{the stove}) \;\&\; \tau(e) \subseteq t' \;\&\; e \leq w_i]$,
where t' is the contextually salient time before t_i
(no truth value defined if there is no such time)

This is the same meaning that we obtained in the previous section, when we had built the existential quantification into the lexical meaning of the verb. What used to be the meaning of VP is now the meaning of AspP. We have located the event-quantifier in its own functional head, but otherwise it is the same analysis.

Exercise: What about the negated sentence that was Partee's original example? Where can we now generate negation in an interpretable LF? Does the current analysis still predict that the sentence is not in fact ambiguous?

3.3. An imperfective aspect: the English progressive

Besides perfective aspect, there is imperfective aspect – or more accurately, there is probably a family of imperfective aspects in different languages that have some shared and some non-shared properties.[22] English has an imperfective aspect known as the "progressive", with an overt morphology that consists of a copula which governs a present-participial form of the VP (V-*ing*). We posit a functional head *be-PROG* as the aspect head in the English progressive construction.[23]

The basic intuition behind much work on the perfective-imperfective distinction is that, whereas perfective aspect locates an event within the evaluation time, imperfective aspect does the reverse, i.e., it places the evaluation time within the event time. If we formalize this intuition directly, without introducing any further differences from the perfective, we come up with (17).[24]

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[22] see e.g. Arregui, Rivero & Salanova NLLT for a recent approach to cross-linguistic semantic variation in imperfective aspects

[23] We are not serious about morphology here. The meaning may well be carried by an abstract head and the *be* a vacuous element.

[24] This is similar to the first formal analysis of the progressive, due to Bennett & Partee (1972/78). They did not work in an event semantics, however. Also, their semantics required t_i to be a *non-final* subinterval of $\tau(e)$, rather than merely $t_i \subseteq \tau(e)$. This requirement seemed too strong in light of examples such as Dowty's (1977) *John was watching TV when he fell asleep* (which does not say that TV-watching continued beyond the point of falling asleep). However, as Dowty showed, it turned out to be the right

(17) first attempt:
$[\![\text{be-PROG}]\!]^i = \lambda P_{<v,t>}. \exists e\ [P(e) = 1\ \&\ \underline{t_i \subset \tau(e)}\ \&\ e \leq w_i]$

It is well-known, however, that there is also a difference in how the event is related to the evaluation *world*. While perfective places the event within the actual world, the progressive permits it to be partly in another world, so to speak. This point, which was at the center of Dowty's (1977) seminal work on the progressive, is brought home by examples like (18).

(18) John was going to the store when he ran into Mary.

We can't infer from this sentence that John actually made it to the store, or will ever make it there.[25] The sentence leaves this open. Perhaps John does complete his trip to the store after the encounter, and perhaps he doesn't. The truth-conditions of the sentence (18) are compatible with either scenario. The entry in (17), on the other hand, would require that there be a John-going-to-the-store event which occupies a super-interval of the time of the encounter with Mary and which *occurs in the actual world*. So (17) can't be quite right.

Dowty's analysis of the progressive says instead that a John-going-to-the-store event occurs in certain *possible* worlds. These possible worlds are related to the actual world in a particular way: they are worlds which share a history with the actual world up to a certain point and then develop (possibly counterfactually) in such a way that no events that were already in progress get interrupted ("inertia worlds"). The idea is, very roughly, that the sentence tells us: either John actually went to the store, or if he didn't, then at least he *would have* gone there if he hadn't been interrupted. Since the publication of Dowty's paper, there has been a succession of sophisticated counterexamples and refinements to his original proposal, but this is beyond the scope of this introduction.[26] Here is a version based on Dowty.[27]

(19) second attempt (and final version for us):
$[\![\text{be-PROG}]\!]^i = \lambda P_{<v,t>}. \forall w\ [w \in \text{Inert}(i) \rightarrow \exists e\ [P(e) = 1\ \&\ t_i \subset^{<} \tau(e)\ \&\ e \leq w\ ]\ ]$
where $\subset^{<}$ abbreviates: "is a non-final subinterval of"
(i.e., $\tau(e)$ includes every moment in t_i as well as some moment after the end of t_i)

(20) Definition: $w \in \text{Inert}(i)$ iff
w is exactly like w_i up to the end of t_i and then develops in such a way that no events are interrupted.

We will see in a minute that there is a class of VPs for which the truth-conditions predicted by

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requirement in the context of the modalized analysis that he proposed, see below.

[25] Dowty dubbed this the "imperfective paradox", although it's not really a paradox, just a counterexample to a certain analysis that looked plausible at first.

[26] refs Vlach, Parsons, Landman, Portner, ...

[27] This is the same as Beck & von Stechow's (37) (modulo correction of a typo).

Apart from introducing quantification over other worlds, (19) also differs from (17) in that it strengthens the requirement on the temporal relation between t_i and $\tau(e)$: not only must $\tau(e)$ contain all of t_i, but it must moreover extend into the time after t_i. This is intended to capture the intuition that e.g. (18) is not appropriate if John already reaches the store during his encounter with Mary; see Dowty (1977) for discussion.

(19) come very close to those predicted by the simpler (17). But examples like (18) show that this must not always hold.

Let's do a simple example.

(21) (a) John is laughing.

(b) LF: $[_{TP}$ PRES $[_{AspP}$ bePROG $[_{VP}$John laugh$]$ $]$ $]$

(c) $[\![(21b)]\!]^i = 1$ iff

$\forall w\, [w \in \text{Inert}(i) \rightarrow \exists e\, [t_i \subset^{<} \tau(e)\ \&\ e \leq w\ \&\ \text{laugh}(e, \text{John})]\ ]$

Just as it stands, (21c) does not logically entail that any laughing happens in the world w_i (i.e., in the utterance world w_u if this is an unembedded assertion). It only talks about the inertia worlds. However, there is a property of the lexical meaning of *laugh* that permits us to draw further inferences. Laughing events are made up of lots of sub-events which themselves are laughing events, down to very little ones that don't last much more than an instant. Given this, consider a world in Inert(w_u, t_u), say w. If (21b) is true in w_u at t_u, it follows that w contains an event of John laughing whose run-time includes t_u. Among the subevents of this event, which themselves are events of John laughing, there will most likely be one that is early enough and small enough to have transpired by the end of t_u.[28] And since up to the end of t_u, the histories of w and w_u are identical, this small John-laughing event in w must have a perfectly matching counterpart in w_u. That's why we infer from (21a) that there is *actual* laughing at the utterance time.

This is the kind of example for which (19) and the simpler entry (17) predict almost identical truth conditions. (19) demands something slightly stronger, namely that moreover the laughing continues at least a little bit beyond the utterance time unless it is interrupted (which means it *would* have continued). So they are not quite equivalent, but the difference is very subtle.

Importantly, however, this almost-equivalence depends on the particular property of the meaning of the VP that we just exploited in our reasoning. Had the VP been *John go to the store*, it would have been a very different matter. Events of John going to the store are *not* made up of lots of smaller events which each are events of John going to store. They are made up of smaller events which are events of John going *towards* the store, but since most of these don't end with John at the store, they are not events of John going *to* the store. So if we are told that every $w \in$ Inert(i) contains an event of John going to the store which occupies a super-interval of t_i, we cannot infer that John goes to the store in w_i. We can merely infer that w_i contains an event that is indistinguishable from those *parts* of the inertia-worldly trips-to-the-store which fall *before the end of* t_i. In other words, we infer that w_i contains the *beginning* of a John-go-to-the-store event, but not necessarily anything more.

The attentive reader may have wondered why we used a *past* tense example to illustrate the perfective in the previous section, but a *present* tense example for the progressive in the current section. Indeed, it is incumbent upon us to examine what the theory predicts for every possible

[28] The only condition under which this would not hold is if the laughing starts right at the beginning of t_u and t_u itself is too short to fit even a minimal laughing event. This would have to be a very short utterance time, shorter than it realistically takes to say *John laughs*, so we disregard this possibility.

combination of a tense and an aspect.

3.4. The limited distribution of the perfective ("stativity effects")

It is well known that non-stative predicates in the simple present tense have a limited range of felicitous uses. Sentences such as those in (22) are spontaneously judged as odd by speakers of English.[29]

(22) (a) #John laughs.
(b) #John wakes up.
(c) #John goes to the store.

Let us see what our theory predicts. We see no progressive morphology, but there has to be an aspect head for the sentence to express a proposition, so the aspect must be PFV. With present tense semantically vacuous, we then have LFs and predicted meanings like (23) for (22c).

(23) LF: $[_{TP}$ PRES $[_{AspP}$ PFV $[_{VP}$John go to the store$]$ $]$ $]$
true at i iff $\exists e\, [\tau(e) \subseteq t_i \,\&\, e \preceq w_i \,\&$ go-to(e, John, the store)]

This says that if *John goes to the store* is asserted in w_u at t_u, the assertion is true iff there is a John-go-to-the store event in w_u whose run-time is contained within t_u. This is a somewhat implausible scenario, given that trips to the store typically take longer than the production of such a short sentence. One may be tempted to attribute the strangeness of (22c) to this fact. But upon reflection, that doesn't look like the right explanation. We can set up a scenario that eliminates the implausibility. Imagine John was already very close to the store, and/or he is on a very fast vehicle ... The judgment about (22c) is not really affected by such manipulations, but we would expect it to be if pragmatic plausibility were all that mattered. And the pragmatic explanation looks even less convincing when we consider the other examples in (22). Waking-up events are very short, if not instantaneous, so such events should have no problem fitting inside the utterance time and (22b) should be just fine. As regards (22a), we have already said that longer laughing events are made up of shorter laughing events. So if John laughs for any duration that overlaps with the utterance time, there is probably a laughing event within the utterance time, and (22a) should be fine as well.

Friends of pragmatic approaches like to remind us that the examples in (22) are not ungrammatical. Sentences of this sort are acceptable in a variety of special contexts or registers, such as play-by-play sportscasting, the historical or narrative present, newspaper headlines, stage directions, plot summaries, explicit performatives ... to name some.[30] It is appealing to say that

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[29] I am choosing examples that do not have prominent habitual (generic) readings. Ignore such readings if you can get them anyway. The # judgments apply to an intended episodic reading (describing a single event). See footnote below on the analysis of habitual readings.

[30] Simple present tense on a non-stative verb is also systematically grammatical when the sentence has a generic or habitual interpretation, or when it describes the content of a plan or schedule. We don't worry about these cases here, since they very plausibly involve a covert modal operator of some kind that applies to the VP before any tense or (higher) aspect. (refs incl Copley, Thomas) That modal operator may itself be an aspect head, or it may create a bigger VP which is a predicate of states. In the latter case, whatever explains the acceptability of stative VPs under present tense will also explain the acceptability

the essence of (at least some of) these special uses is a pretense that the utterance time is something other than what it is, a pretense that one is speaking at a time closer to the events being reported, at a pretend-utterance-time that is earlier and/or longer than one's actual utterance. This may or may not be right.[31] At any rate, it does not directly address the question why (22a - c) are unacceptable *outside* of these special registers or contexts. One seems to need a concomitant assumption that the "ordinary" register involves a different pretense, namely that the utterance time is *shorter* than it actually is, in fact, that it is a mere instant in the technical sense (a singleton of one moment)[32], and hence too short to contain even a getting-up event or a minimal laughing-event.

For the sake of the argument, let's see how it may help to stipulate that t_u is always an instant.[33] To get the desired mileage out of this assumption, we must also sharpen some specifics regarding the lexical meanings of verbs.[34] These assumptions are not uncontroversial, but widely accepted in the literature: None of the VPs in (22) describe events that can possibly have run-times that are instants. Any VP that entails a change of state – whether it is a change that takes time (like getting from some place else to the store) or a virtually "instantaneous" change (like from asleep to awake) – *ipso facto* applies only to events whose run-time contains at least two moments (one at which the previous state holds and one at which the result state holds). Likewise, any VP that describes an activity or movement or other happening of some sort (like laughing, oscillating, raining, even sleeping) describes events that may have very short run times but never just a single moment. These assumptions about lexical semantics make the predicted truth-conditions for clauses with PFV (as computed in (23)) impossible to satisfy unless t_i is a proper interval, i.e., not a singleton.

From this perspective there is a straightforward account of what makes stative predicates different. Once we change the VPs in (22) to stative ones, the simple present tense becomes perfectly fine (in every register).

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of present tense generics/habituals. See below.

Some kind of modal analysis might also work for some of the cases in the list, like stage directions and plot summaries, but less plausibly to e.g. the sportscaster style or the historical present.

[31] There are few formal semantic analyses of the historical present. An exception is Zucchi 2003 http://dipartimento.filosofia.unimi.it/~bonomi/Zucchi Historical.pdf.

[32] Cf. Bennett & Partee (1972/1978): "We regard a speech act as occurring at a moment of time and understand the assertion as being true at that moment. Accordingly, we are inclined to only use the reportive simple present when the act being described seems to be almost instantaneous and to be occurring at the moment of utterance." See also Dowty (1979).

[33] As Milo Philipps-Brown pointed out, one worry about this assumption is that it undermines our earlier reasoning about the progressive *John is laughing*. There we attributed the intuition that this sentence entails the existence of laughter in w_u to the fact that t_u was long enough to contain a minimal laugh. It is not clear how to resolve this tension. Perhaps we can get out of it by convincing ourselves that we judge the utterance true, after all, if all that actually happens before the interruption is an instant-sized beginning of a minimal laugh.

[34] These ideas are common in the literature and go back at least to Taylor (1977, L&P). See e.g. Filip (2012, OUP volume) for a recent and comprehensive survey.

(24) (a) John is tired.
(b) John is at home.
(c) John owns a factory.

Suppose the distinguishing semantic feature is precisely that predicates like *tired*, *at home*, and *own a factory* describe eventualities ("states") whose run-times *can be instants*. A state of John being tired may be long or short, but it is necessarily made up of shorter and shorter sub-states which are also states of John being tired. And not only that – it is even made up of such sub-states that occupy a single instant. The latter makes *tired* different from *laugh* or even *move*, which apply to eventualities whose run-times may be infinitesimally short but are still always proper intervals. What does this buy us? It lets us say that the sentences in (24) have the exact same parses as those in (22), with a perfective aspect head, and yet they have truth-conditions which can be satisfied by an instant.

(25) LF: PRES [PFV [John *be* tired]]
meaning: true at i iff $\exists e\, [\tau(e) \subseteq t_i \,\&\, e \leq w_i \,\&\, \text{tired}(e, \text{John})]$
lexical entry: $[\![\textit{tired}]\!] = \lambda x.\, \lambda e.$ e is a state of x being tired

(Type v must be understood in such a way that D_v includes states in addition to "events" in a narrow sense. Bach (19xx) coined the term "eventuality" for this broader sense of "event".)

So, together with the stipulation that the utterance time is treated as an instant, this approach to the stative/non-stative distinction provides an explanation for why stativity is required in the simple present tense. We can also reassure ourselves that present *progressives* are still expected to be uniformly good even if t_u must be an instant. This is because *bePROG* places the event a *super*-interval of t_i.[35]

Whether or not the assumption that t_u is an instant can ultimately be defended, it is important to be aware that the stativity effect we witness in present tense matrix clauses is replicated perfectly in certain environments which are neither matrix nor (morphologically) present. These environments include the complements of epistemic necessity modals and the infinitival complements of verbs like *believe* and *claim*.

(26) (a) John must sleep/ go to the store.
deontic reading only[36]
(b) John must be at home/ be sleeping.
epistemic reading okay

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[35] Is is often said in this context that progressives pattern with statives in the present tense because progressive VPs *are* stative. This is not literally true on our analysis, because bePROG is an aspect head and AspPs are not predicates of states (or of eventualities of any kind). One might, however, entertain a different analysis on which (at least some of) the operators we are used to calling "aspects" have meanings of type <vt,vt>. (Another head higher in the structure would then have to be responsible for binding the state argument and introducing the world and time.)

[36] Again, this judgment presupposes an intended episodic reading for the VP. To the extent that the VP can be read habitually, the epistemic reading becomes available. The point here is that the judgments for the contructions in (26) and (27) are parallel to the judgments for the same VPs in the simple present

(27) John claimed to *work/ *go to work/ ok be at work/ ok be going to work.

(28) John believed Mary to *sleep/ *go to the store/ ok be at home/ ok be sleeping.

We will return to this observation in a later section, in connection with the discussion of so-called "Sequence of Tense".

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tense.

3.5. Appendix: formalizing the referential analysis

Above we stated Partee's proposal as follows:

(1) $[\![\textbf{PAST}\ \phi]\!]^i = 1$ iff $[\![\phi]\!]^{<w_i, t'>} = 1$, where t' is the contextually salient time before t_i
(no truth value defined if there is no such time)

Apart from not being fully compositional, this is a bit vague for us to work with when (in the next section) we consider complex sentences with several occurrences of past tense. Let us therefore make it a little more precise.

Partee suggested that past tense was analogous to a pronoun like *he*. We are used to representing pronouns as variables (see e.g. Heim & Kratzer), so Partee-style tenses too should then have denotations that are sensitive to a variable assignment. So let's make two assumptions: First, each occurrence of **PAST** and **woll** at LF must carry a numerical subscript, like a pronoun. Second, the domain D_e contains times (intervals) along with more run-of-the mill individuals.[38] We now write the following entries. (**PRES** remains vacuous for now and therefore needs no entry.)

(2) $[\![\textbf{PAST}_\mathbf{n}]\!]^{i,g} = \lambda p \in D_{\langle s,t\rangle}$: g(**n**) is a time interval & g(**n**) < t_i. $p(w_i, g(\mathbf{n})) = 1$

(3) $[\![\textbf{woll}_\mathbf{n}]\!]^{i,g} = \lambda p \in D_{\langle s,t\rangle}$: g(**n**) is a time interval & g(**n**) > t_i. $p(w_i, g(\mathbf{n})) = 1$

Let's illustrate how this works in a simple example.

(4) Barbara turned off the stove.
new LF: **PAST7** [PFV [Barbara turn off the stove]]
interpretation:
$[\![\textbf{PAST}_\mathbf{7}$. PFV. Barbara turn off the stove$]\!]^{i,g}$ is defined
iff **7** ∈ dom(g) & g(**7**) is a time interval & g(**7**) < t_i
when defined, $[\![\textbf{PAST}_\mathbf{7}$. PFV. Barbara turn off the stove$]\!]^{i,g} = 1$
iff ∃e [τ(e) ⊆ g(**7**) & e ≤ w_i & turn-off(e, Barbara, the stove)]

If this is a matrix sentence, we evaluate it with respect to the utterance world and time, and we also rely on the utterance context to furnish a suitable assignment (call it g_u), which maps the free variable **7** to a time interval that precedes t_u. Intuitively, this is the salient past interval that the speaker has in mind when making this past-tense claim (also called the "topic time"). So we have:

(5) An utterance u of the LF ***PAST7*** *[PFV [Barbara turn off the stove]]* is felicitous only if g_u is such that **7** ∈ dom(g_u) & g_u(**7**) is a time interval & g_u(**7**) < t_u, and it is moreover true iff ∃e [τ(e) ⊆ g_u(**7**) & e ≤ w_u & turn-off(e, Barbara, the stove)].

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[38] Alternatively (and more in line with the literature), with might posit a new basic type i (for "intervals") and assume that a variable assignment maps object-language variables (i.e., numerical indices) to elements of $D_e \cup D_i$. Notice that this new type i would not the same as our existing type s (world-interval-pairs), though the second member of an element of D_s is always a member of D_i.

It will also be useful to clarify how frame adverbials might be treated in a Partee-style approach to tense. A natural idea here is that a frame adverb contributes a further presupposition about the intended topic time. Recall our treatment of frame adverbs as having extensions of type t.

(6) $[\![\textbf{on February 1, 2001}]\!]^i = 1$ iff t_i is part of February 1, 2001

To make room for this in the LF of a sentence with a Partee-style tense, we want to revise the entries from (2) and (3) and give $\textbf{PAST}_\textbf{n}$ and $\textbf{woll}_\textbf{n}$ a second argument.

(7) $[\![\textbf{PAST}_\textbf{n}]\!]^{i,g} = \lambda p \in D_{\langle s,t\rangle}$: $g(\textbf{n})$ is a time interval & $g(\textbf{n}) < t_i$ & $p(w_i, g(\textbf{n})) = 1$.
$\lambda q \in D_{\langle s,t\rangle}$. $q(w_i, g(\textbf{n})) = 1$.

For example:

(8) Barbara turned off the stove on February 1, 2001.
LF: [$\textbf{PAST}_\textbf{7}$ on Feb 1, 2001 [PFV [Barbara turn off the stove]]]
uttered felicitously iff
$\textbf{7} \in \text{dom}(g_u)$ & $g_u(\textbf{7})$ is a time interval & $g_u(\textbf{7}) < t_u$ & $g_u(\textbf{7}) \subseteq$ Feb 1, 2001,
and uttered truly iff $\exists e\, [\tau(e) \subseteq g_u(\textbf{7})$ & $e \leq w_u$ & turn-off(e, Barbara, the stove)].

Notice that there is still some room for context-dependency, in that the speaker may be referring to either the whole of Feb 1st or to a proper part of it (e.g. the morning of that day). But the role of context is greatly reduced by the contribution of the adverb.

The revised, 2-place, entry for the future is analogous. When we have frame adverbs with present tense, we also need a non-vacuous semantics for **PRES**, but this is no different in the Partee-approach than it was in the Priorian approach, repeated here from footnote 12 of section 1.2.

(9) $[\![\textbf{PRES}]\!]^i = \lambda p \in D_{\langle s,t\rangle}$: $p(w_i,t_i) = 1$. $\lambda q \in D_{\langle s,t\rangle}$. $q(w_i,t_i) = 1$.

To conclude, let us highlight how the Partee-style, "referential", analysis of tenses differs from the Prior-as-modified-by-Stalnaker-style analysis, and also what they have in common. The essential difference is that Partee-style $\textbf{PAST}_\textbf{n}$ and $\textbf{woll}_\textbf{n}$ do not express existential quantification over times, but instead rely on a contextually furnished variable assignment to supply a particular time. In the Partee-approach, the denotations of past and future clauses are always context-dependent; in the modified-Prior approach, they only are if there happens be a silent restrictor together with the existential quantifier. Both approaches assume that the extensions of $\textbf{PAST}_\textbf{(n)}$ and $\textbf{woll}_\textbf{(n)}$ are sensitive to the evaluation time, and both assume that these items shift the evaluation time for their complements. The two approaches also agree on the treatment of **PRES**, which, according to both, does not shift evaluation time and makes no semantic contribution other than a presupposition when there is a frame adverb.

4. Tense in embedded clauses: relative clauses

In this section we consider predictions that our analyses of tense from the previous sections make about multiclausal sentences in which an embedded tense is in the scope of another tense. Specifically, we will look at the interpretation of tenses in relative clauses[39].

For most purposes of this discussion, we can and will remain neutral about the choice between a Partee-style ("referential") analysis of tenses and a more traditional Priorian ("existential operator") analysis. We will cast the main discussion in the latter framework – specifically, we will take *PAST* and *woll* to be contextually restricted existential quantifiers (as spelled out in section 1 above), and assume that *PAST* and *woll* combine directly with a VP whose intension is of type <s,t>. Footnotes or excursions will be added to show how the relevant issues play out under the referential analysis and the division of labor between aspect and lexical verb meaning that we introduced in section 3. In the text, we generally stick to stative VPs and assume that a stative VP is true at an evaluation time if the state holds *throughout* that time.

Throughout this section, we will also reduce clutter by disregarding the world-component of the evaluation index. I.e., we will pretend here that type s is just times (intervals) rather than world-time pairs. (But this simplification will have to be undone again when we turn to tensed complement-clauses in section 5.)

4.1. A predicted correlation between DP-scope and temporal interpretation

Surface sentences of the form $[_{\text{matrix-clause}}$ .. *tense* $[_{\text{VP}}$ . ..... $[_{\text{DP}}$ .. $[_{\text{relative-clause}}$ ... *tense* ....]]]] generally should allow two different LFs, depending on where the DP is QRed: either within the matrix VP or above the matrix tense. Since the relative clause and its tense are contained in the DP, the scope of the DP determines whether or not the embedded tense is in the scope of the matrix tense. Let us look at some concrete examples to see how the relative scopes of the tenses affect the truth-conditions of the sentence.

We begin with an example with matrix future and embedded present.

(1) John will be married to someone who is famous.

To simplify matters, we disregard the covert restrictor that should come with each tense.[40] The two LFs then are (2a) and (3a), and the truth conditions that we compute for them, evaluating the sentence at the utterance time t_u, are (2b) and (3b).[41]

(2) (a) LF: *PRES* woll [[some one[42] 7[*PRES* t_7 be famous]] 8[John be married to t_8]]
(b) $\exists t\, [t > t_u \ \& \ \exists x\, [\text{famous}(x, t) \ \& \ \text{married}(j, x, t)]\ ]$

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[39] We will also discuss tenses embedded in complement clauses, in a later section.

[40] But below we consider variants of the example that have added frame adverbs.

[41] We use some hopefully self-explanatory abbreviations in the metalanguage, e.g., *married(x, y, t)* for *x is married to y at t*.

[42] W simplilify here by disregarding the pro-head-noun *one* (i.e, treating it as semantically vacuous). Strictly speaking, this contributes a predicate like 'person' or 'human', which is also evaluated at different

(3) (a) LF: [some one 7[*PRES* t_7 be famous]] 8[*PRES* woll [John be married to t_8]]
(b) $\exists x$ [famous(x, t_u) & $\exists t$ [t > t_u & married(j, x, t)]]

The scopal relations between the two existential quantifiers don't make a logical difference, but what does differ between the two LFs is where the predicate *famous* is evaluated: In (2), *famous* is evaluated at the same future time as the predicate *married-to*, whereas in (3), *famous* is evaluated at the utterance time. So (2) says that at some future time, John will be married to a person who will be famous *then* (a so-called "simultaneous reading"), whereas (3) says that he will be married to a person who is famous *now* – let's call this a "*now* reading". (Neither LF, of course, denies additional fame at other times than those required for its truth.) The two predicted readings are logically independent, i.e., there are scenarios that make (2) true and (3) false, and scenarios that make (3) true and (2) false. The English sentence can indeed be judged as true under either one of these types of scenarios, so our predictions look satisfactory.[43]

Our theory also makes correct predictions about what frame adverbs we can coherently add to this kind of sentence and how their addition narrows down the range of verifying scenarios. Consider, for example, the sentences in (4) - (6). (# marks a judgment of incoherence.)

(4) In 2020, John will be married to someone who is in jail then (in 2020).

(5) In 2020, John will be married to someone who is in jail now (in 2018).

(6) #In 2020, John will be married to someone who is in jail in 2019.

In order to interpret the adverbials, we need the 2-place meaning for *woll* and the non-vacuous, 2-place meaning for *PRES* (see sec 1.2. and fn 12). Spell out the details as an exercise. (4) has to have an LF where the *someone*-DP scopes below the matrix *woll*, and (5) an LF where it scopes above it. The opposite scope constellations can also be generated, but they receive unsatisfiable truth conditions (or presuppositions) due to the adverbs. (Assume that t_u is in 2018.)

Next we have an example with past tenses in both matrix and relative clause, (7). The two LFs and their truth conditions are in (8) and (9).

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times dependiing on the DP's scope. See below for an example with a more contentful head noun.

[43] In a Partee-style theory with a division of labor between tense and aspect, the predicted truth conditions also depend on the choices of (silent) aspect heads. We assume that, for type-reasons, the *someone*-DP cannot be QRed to the edge of VP (below aspect), but it can scope either just above AspP or above *woll*. If the aspects in both matrix and relative clause are imperfective, the predicted truth-conditions will be essentially the same as in the Priorian theory, modulo the difference that the speaker is referring to a specific future time. Also, if the DP scopes above *woll*, then no matter what aspects we have we predict a *now*-reading, in the sense that fame must hold at t_u for the LF to be true. When the DP scopes below *woll*, however, this isn't necessarily a "simultaneous" reading. If both clauses are parsed with perfective aspect, then the truth-conditions can be satisfied if the speaker's intended future topic time contains a period marriage and a period of fame, but not necessarily overlapping or in any specific order. We may wonder if such a truth-condition is attested, and if not, may want to constrain the system in such a way that at least the embedded stative must be parsed with imperfective. Be that as it may – we do still make the prediction that a *now*-interpretation for the embedded clause is contingent on scoping the DP above *woll*. This prediction is not affected by the switch from Priorian to Partee-style framework. Neither are the predictions regarding compatible frame adverbs.

(7) John was married to someone who was famous.

(8) (a) LF: *PAST* [[some one 7[*PAST* t_7 be famous]] 8[John be married to t_8]]
(b) $\exists t\, [t < t_u\ \&\ \exists x\, [\ \exists t'[t' < t\ \&\ \text{famous}(x, t')]\ \&\ \text{married}(j, x, t)]\ ]$

(9) (a) LF: [some one 7[*PAST* t_7 be famous]] 8[*PAST* [John be married to t_8]]
(b) $\exists x\, [\ \exists t'\, [t' < t_u\ \&\ \text{famous}(x, t')]\ \&\ \exists t\, [t < t_u\ \&\ \text{married}(j, x, t)]\ ]$

Again there is a difference in how the time of fame relates to the time of marriage. (8b) requires for its truth that the person be famous (at least) for some time *before* the marriage. (Though it does not deny that the person is also famous during or after the marriage.) (9b), by contrast, leaves the temporal relation between fame and marriage completely open. Both must obtain somewhere before the utterance time, but the onset of fame could be before, during, or after the marriage.[44] In this example, one of the predicted readings entails the other; i.e., any scenario that makes (8) true makes (9) true as well – but not the other way round. Again, speaker's judgments about the sentence (7) are consistent with our predictions. In particular, (7) can be judged true in a variety of scenarios, including a scenario where the (first) onset of fame is after the end of the marriage (but before the speech time). Following Kusumoto (2005), we call this type of scenario a "later-than-matrix" scenario.

Again we can add frame adverbs to sharpen intuitions and further test our predictions.

(10) In 2016, John was married to someone who was rich then (in 2016).

(11) In 2016, John was married to someone who was rich in 2015.

(12) In 2016, John was married to someone who was rich in 2017.

All these sentences are coherent, and we can account for this – provided again that we assume suitable scopes for the DP. (12), in particular, receives satisfiable truth conditions only if the DP scopes above the matrix *PAST*.

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[44] What about the Partee-style framework? Here we have two past tenses, each with its own variable subscript, which in principle could be two occurrences of the same free variable or two different variables. The speaker accordingly must have either just one or else two different salient ("topic") times in mind. It turns out, however, that coindexing is only an option if neither past is in the scope of the other; otherwise we generate a self-contradictory presupposition that the embedded topic time precedes itself. If the embedded past is in the LF-scope of the matrix past, it must refer to a different, and earlier, interval than the matrix past. The predicted truth-conditions for the LF with narrow DP-scope are then essentially the same as in the Priorian analysis (and not detectably affected by choice of aspects).

In the LF where the DP scopes outside the matrix tense, the two past tenses can be coindexed or not and can effectively refer to any two topic times as long as both of them are before t_u. Even if they corefer, the option of construing both predicates as perfective (if available for statives) implies that marriage and fame need not stand in any specific temporal relation to each other. Overall, the range of possible verifying scenarios for the wide-scope-DP LF ends up being the same as in the Priorian analysis. The crucial prediction we are aiming to highlight here – namely that later-than-matrix scenarios can *only* verify the wide-scope-DP LF – is made in the Partee-framework just as much as in the Priorian one.

4.2. An overgeneration problem for present under past

There are a number of other combinations of a matrix tense and an embedded tense that we could consider at this point, but mostly this will not teach us much more. The one exception concerns sentences with a matrix past and an embedded present or *will*.

(13) John was married to someone who is famous.

(14) John was married to someone who will be famous.

Given that *will* spells out *PRES* + *woll*, both (13) and (14) really are instances of *PRES* embedded under *PAST*. We focus our discussion on (13), and you should be able to work out how it extends to (14).

As with the earlier examples, our theory predicts a scopal ambiguity due to multiple possible landing sites for QR of the *someone*-DP.

(15) (a) LF: *PAST* [[some one 7[*PRES* t_7 be famous]] 8[John be married to t_8]]
(b) $\exists t\, [t < t_u\ \&\ \exists x\, [\text{famous}(x, t)\ \&\ \text{married}(j, x, t)]\ ]$

(16) (a) LF: [some one 7[*PRES* t_7 be famous]] 8[*PAST* [John be married to t_8]]
(b) $\exists x\, [\text{famous}(x, t_u)\ \&\ \exists t\, [t < t_u\ \&\ \text{married}(j, x, t)]\ ]$

In (15), *famous* is evaluated at the same (past) time as the predicate *married-to*,[45] and in (16), *famous* is evaluated at the utterance time. Unfortunately for our theory, only (16) corresponds to an attested reading of the English sentence. Present under past can *only* have a "*now* reading". (13) doesn't have an additional "simultaneous" reading with the truth-conditions (15b) that are expressed by LF (15a). This fact is further highlighted by the deviance that results from adding simultaneity-forcing adverbs as in (17).

(17) # In 2016, John was married to someone who is famous at that time/then (in 2016).

So here we have a problem of overgeneration. How might we fix it? For the time being, we will just hint at three general directions for a solution, without trying to make any one of them precise. We will return to this task after we have gathered a bit more evidence that tells us which directions are more likely to be correct.

Since the problem stems from the fact that we generate the LF in (15), one idea is to block the generation of this LF. In (15), *PRES* is in the scope of *PAST*. Perhaps this scope constellation is for some reason not allowed. Stowell (1993, 1995) suggested an analogy with polarity-sensitive items such as *any* and *some*, which mean the same thing but are subject to different distributional constraints at LF. *any* is a negative polarity item (NPI) and as such is required to be in the scope

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[45] Again, the Partee-framework yields essentially the same prediction. In particular, since present tense in that framework too is vacuous (except for possible presuppositions), a present AspP within the scope of the matrix past tense will be evaluated at the past topic time that the speaker intends for the matrix predicate. Whether this amounts to a genuinely simultaneous reading depends again on the choice of embedded aspect, but either way, it is a reading according to which fame holds in the past and need not hold at t_u. So the overgeneration problem carries over.

of a negation;[46] *some* is a positive polarity item (PPI) and as such is required to be *outside of* the scope of negation. Stowell called the present tense an "anti-past-polarity item", meaning an item that is barred from occurring in the scope of *PAST* at LF – just as *some* is barred from occurring in the LF-scope of *not*. If we place *some* in the surface c-command domain of *not*, as in *John didn't solve some problems*, QR must apply to give it wide scope at LF, and only an inverse-scope reading is therefore attested. Similarly, Stowell suggested, if *PRES* is in the surface c-command domain of *PAST*, as in our sentence (13), the only way to satisfy its anti-past polarity requirement is to change scope relations by means of covert movement – in this case by QRing the DP that contains the *PRES* above the matrix *PAST*. So the only licit LF for (13) will be (16) – which indeed is the LF that captures the attested meaning.

A second, completely different, approach to the problem says that (15a) is basically a fine LF – except it doesn't get pronounced as (13). Rather, it gets pronounced as *John was married to someone who <u>was</u> famous*. In other words, when *PRES* is in the LF-scope of *PAST*, it gets pronounced like a past tense. (This is reminiscent of the "Sequence of Tense" rules of traditional grammar.) If a *PRES* that is in the LF-scope of *PAST* can't be pronounced as a morphological present, then a morphological present can't be parsed as a *PRES* that is in the scope of *PAST* at LF. So again we get rid of the overgeneration problem and predict correctly that the surface sentence (13) doesn't have the reading in (15b). This second approach places the burden on a theory of morphological spell-out which is far from trivial to work out.

Yet another direction to take is to question our assumptions about the semantics of present tense. So far we have assumed that *PRES* is either vacuous or, if restricted by an adverb, introduces a presupposition about the evaluation time. Either way, *PRES* doesn't shift the evaluation time, and therefore the sister-VP of a *PRES* is evaluated at the same time as the material right above it, whatever time that may be. Our semantics recognizes no intrinsic connection between *PRES* and the utterance time t_u. Only when a *PRES* happens to be topmost in a matrix clause (or embedded, but not under any operators that shift evaluation time), will its sister-VP be interpreted at t_u. This is then due to the Utterance Rule (see (6) in sec 1.1.) and not to the meaning of *PRES*. But perhaps what the data in (13) and (17) should be teaching us is that this was wrong. Even when embedded under an evaluation-time shifter such as the matrix *PAST* in LF (15a), *PRES* seems to select t_u as the evaluation time for its VP. So perhaps we must refer to t_u in the semantics of *PRES* itself rather than just in the Utterance Rule. On this type of approach, (15a) would be a well-formed LF and also a possible parse of the surface sentence (13), but it wouldn't have the meaning in (15b).

4.3. Counterexamples to the correlation of DP-scope and temporal interpretation

Even though the overgeneration problem we identified in section 4.2 is the most glaring shortcoming of our current theory, we will set it aside for a while. Instead, we now take a closer

[46] This is grossly oversimplified. (For one thing, NPIs can also be in the scope of downward-entailing operators other than negation.) We are just pointing to Stowell's analogy here, not being serious about NPIs and PPIs.

look at the predictions that we drew out in section 4.1. concerning the systematic connection between DP-scope and temporal interpretation in relative clauses. Let's remind ourselves of the predictions.

(18) Prediction 1: In a sentence of the (surface) form

$[_{\text{matrix-clause}} \ldots \textit{past/will} \ [_{\text{VP}} \ldots\ldots [_{\text{DP}} \ldots [_{\text{relative-clause}} \ldots \textit{present} \ldots.]]]]$,

the DP must scope higher than the matrix *PAST* or *woll* in order to get a *now* reading for the VP in the relative clause.

(19) Prediction 2: In a sentence of the (surface) form

$[_{\text{matrix-clause}} \ldots \textit{past} \ [_{\text{VP}} \ldots\ldots [_{\text{DP}} \ldots [_{\text{relative-clause}} \ldots \textit{past} \ldots.]]]]$,

the DP must scope higher than the matrix *PAST* for the sentence to be true in a later-than-matrix scenario.

We will consider two types of examples that turn out to violate these predictions. One is a kind of example discussed by Keshet (2010)[47], in which the head noun of the relative clause gets evaluated at a different time than the predicate in the relative clause.

(20) Five years ago, Jill married a 30-year-old who made partner two years later.

It is easy to understand (20) as saying that Jill's spouse was 30 at the time of marriage and that two years later, at the age of 32, the spouse made partner. Given the adverb *five years ago,* we can conclude that the spouse is 35 at the time of utterance. The later-than-matrix reading of the relative clause requires the object DP to take scope above the tense, allowing it to be interpreted relative to t_u. But then the noun phrase *30 year old* will also be interpreted relative to t_u and we'll get the set of individuals who are 30 years old at the time of utterance. Jill's spouse is not in that set. Summarizing, the head noun interpretation requires the object DP to be in the scope of matrix past tense. But the relative clause needs to be outside the scope of the matrix tense, given the theorem in (19). This contradiction reveals a flaw in the system of interpretation.

The second type of example, due to Kusumoto (2005)[48], contains a negative polarity item in the DP whose licenser is below the matrix tense, as in (21).[49]

(21) Next year, he will try not to rent to anybody who lives in this building now.

(22) They failed to write a single law that was signed by the Governor.

The point of using NPIs (here *anybody*, *a single*) is to confine scope of the DP. Since the NPI must be in the scope of its licencer (here *not*, *fail*), it is *ipso facto* in the scope of the matrix tense. In (21), NPI *anybody* must be in the scope of negation and hence it must be in the scope of *woll*. But *lives* is interpreted relative to the time of utterance, which as the theorem in (18) says,

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[47] Keshet, E. (2010) "Situation Economy," *Natural Language Semantics* **18.4**:385-434

Keshet, E. (2011) "Split Intensionality: A New Scope Theory of De re and De dicto," *Linguistics and Philosophy* **33.4**:251-283

[48] Kusumoto, K. (2005) "On the Quantification over Times in Natural Language," Natural Language Semantics 13.4:317–357

[49] (21) and (22) were provided by Roger Schwarzschild. See below for Kusumoto's own examples.

requires the DP to have scope above tense.

(22) describes a dysfunctional state government in which the legislature writes laws and then nothing happens to them because when they reach the governor's desk, they don't get signed. NPI *a single* must be in the scope of *fail* and hence it must be in the scope of **PAST** on *fail*. The potential signings are later than the writing, hence the relative clause has a later-than-matrix interpretation, which as the theorem in (19) says, requires the DP headed by *a single* to have scope above the tense.

Homework: Kusumoto uses *failed to* rather than *didn't* in order to make sure that the semantic negation is clearly within the scope of the matrix PAST and not e.g. right above it. (If the negation were above the tense, the NPI could be licensed by scoping the DP between them, and this way we could capture the desired reading that's true in the later-than-matrix scenario.) However, this makes sense only within a Partee-style referential approach to tense, not in the modified-Prior framework we have employed here in the main text.[50] To see the issue, consider a simple *fail*-sentence such as (i).

(i) She failed to turn off the stove.

A reasonable semantics for *fail* is (ii).

(ii) $[\![\textbf{fail}]\!]^i = \lambda u \in D_t.\ u = 0$

This says that *fail* is means the same as *not*, it just has a different syntax.[51]

(a) Show that, in the context of the Partee approach to tense (as spelled out above in the Appendix to section 3), this meaning for *fail* allows us to assign a reasonable syntactic analysis and intuitively appropriate interpretation to example (i). Explain why the same is not true for the modified Priorian approach.

(b) Analyze example (22) within the Partee approach and spell out how it makes Kusumoto's point.

(c) [To be done after you have read to the end of section 4.4.2.] Show how the problem is solved in the "extensional" framework (Partee-style version) that we introduce in the next section below (incl. footnote). □

Kusumoto's original examples are the past-under-past sentences (23) and (24), to which we can also add present-under-past variants (25) and (26).

(23) (At the audition last month), I tried not to hire anybody who put on a terrible performance (tonight).

(24) (At the Open House last week), she failed to talk to any prospective student who (later) decided to come to UMass.

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[50] Kusumoto's paper does employ a version of the Partee approach, so this is not a criticism of her argumentation.

[51] Perhaps there is an additional modal component to the meaning of *fail*, something like 'didn't, but should have'. Even so, this won't affect the argument regarding the scope of the negation in *fail*.

(25) (At the Open House last week), she failed to talk to any prospective student who is still undecided (today).

(26) (At the audition last month), I tried not to hire anybody who is putting on a terrible performance (tonight).

The logic of the argument is the same as above. The (only available) licenser for the NPI *any* is clearly within the scope of the matrix past tense. So if the *any*-DP wanted to QR above the matrix tense, it would also have to QR above its NPI-licenser. So our theory predicts that none of these examples should be verifiable by later-than-matrix scenarios, and with the parenthesized adverbs, they should be incoherent. (On Stowell's proposal, the examples with embedded present tense (i.e., (25), (26)) should even be plainly ungrammatical.) But (at least for Kusumoto's informants[52]), these sentences are coherent descriptions of later-than-matrix scenarios. Kusumoto offers the following verifying scenarios. "Suppose we are watching a play with a casting director. Some of the cast members are very bad and the play is a failure. The casting director can truthfully say something like [(23)], claiming no responsibility for the failure of the play." (Kusumoto 2005, p. 327)[53] For (24), "..., suppose that ten prospective students showed up at the UMass open house, all of whom had not decided whether to come to UMass yet. A faculty member talked to only five of them, and none of them decided to come. Among those who she failed to talk to, four decided to come to UMass. In this situation, sentence [(24)] is judged true." (loc.cit.)

Kusumoto's conclusion is that, to avoid these false predictions, we need a theory which allows embedded tenses to be evaluated with respect to the utterance time, even when these embedded tenses are in the LF-scope of higher tenses that shift the evaluation time for their sisters. This situation should remind you of a problem we discussed earlier in the semester: the "third readings" of DPs in the scope of modal operators. Indeed we will join a widespread consensus in the field that the two problems are the same and have a single solution.

4.4. Relative clauses in a framework with index variables in the object language

4.4.1. The extensional system (mostly review[54])

We return to the basic system used in Heim & Kratzer up to chapter 11. The interpretation function is relativized only to an assignment function, not to any other evaluation parameters such as a world, a time, or an index. The semantic rules are Functional Application, Predicate Abstraction, and Predicate Modification, in their formulations from the earlier part of H&K. There is no rule of Intensional Functional Application. The only ingredient of intensional semantics that we do retain is the expanded type system and ontology. We have a third basic

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[52] Roger Schwarzschild reports disagreement with these judgments.

[53] Since Kusumoto's example (23) has past tenses in both clauses, she imagines the casting director to be speaking after the performance. For the pres-under-past version (26), he would have to be speaking during the play.

[54] from ch. 8 of 2011 lecture notes

type besides e and t, the type s. D_s is the set of all indices, i.e., world-time pairs. A new assumption (different from both our previous extensional and intensional systems) is that assignment functions are now (partial) functions from object-language variables (natural numbers) into $D_e \cup D_s$, i.e., their possible values include world-time pairs as well as individuals.

There are a number of innovations in the lexicon and in the syntax. As for the lexicon, the main change concerns the treatment of predicates (verbs, nouns, adjectives). They now all get an additional argument, of type s.[55]

(10) $[\![\textbf{tired}]\!] = \lambda i \in D_s.\ \lambda x \in D_e.$ x is tired in w_i at t_i
$[\![\textbf{like}]\!] = \lambda i \in D_s.\ \lambda x \in D_e.\ \lambda y \in D_e.$ y likes x in w_i at t_i
$[\![\textbf{person}]\!] = \lambda i \in D_s.\ \lambda x \in D_e.$ x is a person in w_i at t_i
etc.

This also applies to attitude predicates, modals, and tenses. We illustrate with *PAST*[56] and the counterfactual modal *would*[57].

(11) $[\![\textbf{would}]\!] = \lambda i \in D_s.\ \lambda p \in D_{<s,t>}.\ \lambda q \in D_{<s,t>}.$
$\forall w\ [\ p(w,t_i) = 1\ \&\ w$ is otherwise similar to $w_i\ \rightarrow\ q(w,t_i) = 1\ ]$

(12) $[\![\textbf{PAST}]\!] = \lambda i \in D_s.\ \lambda p \in D_{<s,t>}.\ \lambda q \in D_{<s,t>}:\ \exists t\ [\ t < t_i\ \&\ p(w_i,t) = 1\ ].$
$\exists t\ [\ t < t_i\ \&\ p(w_i,t) = 1\ \&\ q(w_i,t) = 1\ ]$

There is no change to the entries of proper names, determiners, or truth-functional connectives; these keep their purely extensional ("s-free") types and meanings.

Finally, there are two new kinds of abstract (i.e., unpronounced) morphemes. One is a series of pronouns of type s ("index pronouns" or "world-time pronouns"). We write them as $\textbf{pro}_{\mathbf{n}}$, with a numerical subscript **n**. (This makes them look just like covert pronouns of type e, but the environment will disambiguate. Besides, we won't be using examples with both types of pronouns in them.) Their semantics is what you expect: they get values from the assignment function.

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[55] The decision to make the index-argument the predicate's first (lowest) argument is arbitrary, and nothing hinges on it. For all we know, it could be the highest argument, or somewhere in between.

[56] (12) is the version for the Priorian framework (as modified to accommodate frame adverbs). A Partee-style tense now gets an entry like (i):

(i)(a) full version that accommodates frame adverbs:
$[\![\textbf{PAST}_{\mathbf{n}}]\!]^g = \lambda i \in D_s.\lambda p \in D_{\langle s,t\rangle}$: g(**n**) is a time interval & g(**n**) < t_i & $p(w_i, g(\mathbf{n})) = 1$.
$\lambda q \in D_{\langle s,t\rangle}.\ q(w_i, g(\mathbf{n})) = 1.$

(b) simplified (no adverb):
$[\![\textbf{PAST}_{\mathbf{n}}]\!]^g = \lambda i \in D_s$: g(**n**) is a time interval & g(**n**) < t_i.
$\lambda q \in D_{\langle s,t\rangle}.\ q(w_i, g(\mathbf{n})) = 1.$

Rewriting the entries for aspect heads is also routine, e.g.:

(ii) $[\![\textbf{PFV}]\!] = \lambda i \in D_s.\ \lambda P_{<v,t>}.\ \exists e\ [P(e) = 1\ \&\ \tau(e) \subseteq t_i\ \&\ e \leq w_i].$

[57] We take this modal to be accidentally homophonous with the spell-out of *PAST+woll*. That's probably not right, but this is a complex research area beyond the scope of this class. (See Iatridou's 2000 LI-article and current work by Kai and Sabine.)

The other new item is a semantically vacuous operator, *OP*, which moves and leaves a trace of type s. Its syntactic properties are such that it must end up in C or right below a functional head in the "clausal spine" between C and V, and it must get there by a very short movement, a kind of "head movement". We are leaving this rather vague.[58] – We also stipulate that a complete (matrix) sentence must not contain any free variables of type s and must receive a denotation of type <s,t>. This implies that there is a CP layer in matrix clauses and there is always an instance of *OP* in the matrix C.[59]

We have everything in place now to return to the discussion of tense. Let's just finish our review session with a quick reminder of the analysis for third readings in modal contexts.

(13) If everyone in here were outside, Building 56 would be empty.
LF (ignoring tense):
OP$_1$ [[would-**t$_1$** [*if OP*$_2$. every*one* in-here-**pro$_1$** *be* outside-**t$_2$**]] [*OP*$_3$. Bg56 *be* empty-**t$_3$**]]

To make interpretable the node immediately above each lexical predicate or modal, some pronoun or trace must occupy its innermost (type-s) argument position. We can't just use pronouns everywhere, because then they would all remain free. There is no free insertion of lambda-binders in this theory. All binding depends on movement, so we need to generate operators in at least some of the argument positions and we must move them. The semantic type of the modal *would* furthermore demands two arguments of type <s,t>, and constituents of this semantic type can only be created by moving an operator to their edges. The complete sentence also must be of type <s,t> and therefore have an operator at the very top. These strictures together determine almost everything in the LF in (13) – except the fact that the *if*-clause must have a pronoun in the subject and an operator in the predicate and not the other way round. We attribute the latter fact to (vaguely stated) syntactic constraints on the operator's movement path and landing site (pending a deeper explanation).

4.4.2. Relative clauses and their tenses

The rule of Predicate Modification (PM) has not changed from the original H&K system. It applies to two phrases of type <e,t>. Therefore a relative clause must have this type in order to be able to combine with its head noun. This means that we don't want an *OP* at the edge of a relative clause, neither below nor above the moved relative pronoun. (We would get the wrong semantic type either way, be it <e,st> or <s,et>.) Instead we have to use a pronoun in the argument structure of the highest predicate/modal/tense within the relative clause. This pronoun is free in the constituent to which we apply PM. (Though, of course, it can be – in fact, must be – bound eventually in the higher structure.) If the relative clause is past or future, this free

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[58] As noted in the lectures on the "third reading", there is a substantial recent literature exploring various ways to give principled explanations for Percus's "Generalization X" and similar constraints on the distribution and binding of world variables. Here we just assume that some principles or other are in place to prevent overgeneration (e.g., the unattested reading of Percus's *Mary thinks that my brother is Canadian*).

[59] It also requires rewriting the definition of truth/falsity of an utterance. Instead of (6) in section 1.1, we now need this: An utterance of a sentence ϕ that is made in a world w at a time t is true iff $[\![\phi]\!](w,t) = 1$.

pronoun is the argument of *PAST* or *woll*; if the relative clause is in the present tense (which we still treat as vacuous), the free pronoun is the argument of the verb (or the adjective/noun after a copula)[60]. On the other hand, at the edge of the VP-complement to *PAST* or *woll* we always need a moved *OP*, because these temporal operators select for arguments of type <s,t>.[61] (Furthermore we need to merge an *OP* in the inner argument position of the matrix tense, so that we can move this to the matrix C and satisfy our requirement that the matrix clause denote a proposition of type <s,t>.)

Let us illustrate all this with one of our examples from section 2.1.[62]

(14) John will be married to someone who is famous.

(15) LF1: narrow DP scope, local binding:
OP$_{\mathbf{1}}$ woll-$\mathbf{t_1}$
OP$_{\mathbf{2}}$ [[some *who*$_6$[*PRES* t$_6$ *be* famous-$\mathbf{pro_2}$]] 7[John *be* married-$\mathbf{t_2}$ *to* t$_7$]]
λi. ∃t [t > t_i & ∃x [famous(x, t) & married(j, x, t)]]
("simultaneous" reading, i.e., famous when married)

(16) LF2: narrow DP scope, non-local binding:
OP$_{\mathbf{1}}$ woll-$\mathbf{t_1}$
OP$_{\mathbf{2}}$ [[some *who*$_6$[*PRES* t$_6$ *be* famous-$\mathbf{pro_1}$]] 7[John *be* married-$\mathbf{t_2}$ *to* t$_7$]]
λi. ∃t [t > t_i & ∃x [famous(x, t_i) & married(j, x, t)]]
("famous now" reading)

(17) LF3: wide DP scope:
OP$_{\mathbf{1}}$ [[some *who*$_6$[*PRES* t$_6$ *be* famous-$\mathbf{pro_1}$]]
7[woll-$\mathbf{t_1}$ *OP*$_{\mathbf{2}}$ [John *be* married-$\mathbf{t_2}$ *to* t$_7$]]
λi. ∃x [famous(x, t_i) & ∃t [t > t_i & married(j, x, t)]]
("famous now" reading)

We are still considering both scopal relations between the *some*-DP and the matrix tense (for all we know, nothing rules one out). But the reading we obtain by scoping the DP high (LF3) is now equivalent to one of the LFs in which the DP scopes low, namely LF2, where the world-time pronoun in the relative clause is non-locally bound from the matrix C.

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[60] Or the argument of Asp, if we use the Davidsonian framework in which VPs are type <v,t>.

[61] Could we avoid this *OP* and instead move the tense operator itself from the argument position of the verb"? That kind of syntax has indeed been explored by Junri Shimada http://research.nii.ac.jp/~kanazawa/semantics/2007/0817/Head_Movement_Binding_Theory_Phrase_Structure.pdf, who credits the idea to Kai von Fintel http://web.mit.edu/fintel/choicepoints.pdf.

[62] Here we simplify again in various ways. First, we omit the world-component of the index. Second, we ignore the tenses' restrictors. Third, we disregard the dummy head noun 'one'. Notice that the relative clause nevertheless needs to be of type <e,t>, since this is the type that the determiner *some* combines with.

Please draw yourself some trees, they will be more readable than the bracketed strings. Some notational conventions I have used to improve readability at least a little: low numbers (1, 2, ...) and boldface for variables of type s, higher numbers (6, 7, ...) and plain font for variables of type e; hyphenating type-s arguments with the predicates they saturate; small italics for semantically vacuous items.

This equivalence is the key to the solution of Kusumoto's problems. What the system achieves is the freedom to evaluate the embedded tense with respect to the utterance time even when it is in the scope of the matrix tense. Therefore, we can trap the DP's scope below the matrix tense – for example, by introducing an NPI determiner and a suitably low licenser for it – and still evaluate the relative clause at the matrix index.

4.4.3. Present under past again: the overgeneration problem is still with us

Switching to the extensional framework has addressed Kusumoto's argument against the scopal theory of later-than-matrix interpretations, but it has not done anything yet to fix our overgeneration problem. We still predict an unattested simultaneous reading for present embedded under past. Here is its new LF.

(18) John was married to someone who is famous.

(19) LF with narrow scope DP and local binding:
OP$_{\mathbf{1}}$ PAST-$\mathbf{t_1}$
OP$_{\mathbf{2}}$ [[some *who*$_6$[*PRES* t$_6$ *be* famous-**pro**$_{\mathbf{2}}$]] 7[John *be* married-$\mathbf{t_2}$ *to* t$_7$]]
λi. ∃t [t < t_i & ∃x [famous(x, t) & married(j, x, t)]]
(unattested "simultaneous" reading, i.e., famous when married)

But we have made some progress. For one thing, we have learned something about how *not* to fix the problem. We don't want to legislate against the *scopal relations* that we see in (19). Whatever we do must not rule out the scopally isomorphic LF in (20).

(20) LF with narrow DP scope and non-local binding:
OP$_{\mathbf{1}}$ PAST-$\mathbf{t_1}$
OP$_{\mathbf{2}}$ [[some *who*$_6$[*PRES* t$_6$ *be* famous-**pro**$_{\mathbf{1}}$]] 7[John *be* married-$\mathbf{t_2}$ *to* t$_7$]]
λi. ∃t [t < t_i & ∃x [famous(x, t_i) & married(j, x, t)]]
(attested "famous now" reading)

This means that Stowell's analogy with polarity sensitivity is coming to look unhelpful. What about the traditional idea that a Sequence of Tense rule governs morphological spell-out and ensures that the LF in (19) is paired with the PF *John was married to someone who <u>was</u> famous*? This still also looks rather unappealing, given the lack of locality between the affected verb form and the environment that must trigger the rule. (Again, the rule must not apply indiscriminately to both (19) and (20), yet these structures are indistinguishable in the immediate local vicinity of the affected verb.) Nevertheless, something like a Sequence of Tense rule, a non-local morphological agreement mechanism, turns out to be the favored solution in much of the recent literature.[63] We present this in the next section. And we will see that the switch to our current extensional framework, while not by itself the solution to the problem, was a necessary prequisite for it. The solution to be presented is one that could not have gotten off the ground without a syntax that posits world-time pronouns and traces as part of syntactic representations.

[63] For a dissenting view and counterproposal, see two recent papers by Altshuler & Schwarzschild (Amsterdam Colloquium 2013, Sinn und Bedeutung 2013).

4.5. Sequence of Tense as feature-agreement under semantic binding

Kratzer (1998, SALT) proposed that the phenomenon of Sequence of Tense has the same nature and explanation as a certain phenomenon in the morphosemantics of personal pronouns that she dubbed "fake indexicality".[64] We take a brief excursion into this topic before we return to tense.

4.5.1. Fake indexicals and feature transmission

Fake indexicals are first or second person pronouns that are interpreted as bound variables. (This makes them "fake" because a genuine indexical refers, by definition, to a specific contextually determined individual.) An example is (21), on the prominent "sloppy" reading that denies that other people brushed *their* teeth.

(21) Only I brushed my teeth.

The challenge such examples pose emerges, for example, if one tries to extend the presuppositional account of gender features[65] to other phi-features including person. A presuppositional semantics for 1st-person presumably would say that $[\![my_{\mathbf{n}}]\!]^g$ is undefined unless g(**n**) is the speaker. But this would make it impossible for *my* in (21) to take on a range of alternative values, as it has to if it is to be bound by the quantifier *only I*.

We will not engage here in a serious discussion of fake indexicality, just sketch the analysis developed in Kratzer (1998) and related work. This assumes that grammar does not produce a perfect match between semantically interpreted and phonologically realized phi-features. In particular, what we witness in (21) is a 1st-person feature on *my* that is present at PF but absent at LF – hence not contributing to the meaning of this sentence (whatever the actual semantics of 1st person may be). Implementations use either a mechanism that deletes certain base-generated features in the LF-branch of the derivation while retaining them in the PF-branch[66], or else a mechanism that adds (copies) features in the PF-branch onto nodes that are feature-less underlyingly and at LF. Either way, the mechanism is crucially sensitive to a syntactic representation of semantic binding relations (such as coindexing) and it (probably[67]) operates non-locally. For concreteness we state the following rule (22), which employs the concept of "binding" defined in (23).[68]

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[64] Philippe Schlenker pursued a related but distinct approach to SOT-phenomena in his 1999 MIT thesis. For Schlenker, the essential analogy was between SOT and indexical shifting (in languages like Amharic) – or rather, actually, between indexical shifting and the *absence* of SOT (in non-SOT languages such as Japanese and Russian). How different the two approaches ultimately are depends on how one views the relation between fake indexicals and shifted indexicals, a question on which both Kratzer and Schlenker, as well as a number of later authors, have taken evolving positions over the years.

[65] Cooper, Heim & Kratzer. If one doesn't treat 1st-person pronouns as variables in the first place, but as indexicals in the sense of Kaplan, one has an even more basic problem. They cannot be bound variables then.

[66] see von Stechow 2003

[67] Kratzer (1998, 2005) argues that it obeys certain locality constraints after all, but this is controversial. Most other authors (Schlenker 1999, von Stechow 2003, Heim 2005, 2008, Wurmbrand 2015) assume or argue for non-local versions.

[68] See also H&K p. 263.

(22) Feature transmission under semantic binding:
In the derivation of PF, copy the features of a phrase onto any pronouns and traces it binds.

(23) α binds $\beta_{\mathbf{n}}$ iff α's sister node (not counting semantically vacuous material[69]) has the daughters **n** (a binder index) and γ, such that γ dominates $\beta_{\mathbf{n}}$ (and does not dominate any other occurrence of **n** that c-commands $\beta_{\mathbf{n}}$).

Applying this rule to examples requires a few more ancillary assumptions about feature traffic. E.g., for (21) we must assume that the 1st-person feature base-generated on *I* first percolates to the quantifier *only I*, from whence it then can be transmitted down to the possessive pronoun by rule (22). So the derivation of (21) goes like this.

(24) base-generate: [only [pro_7 1st]] brush pro_8's teeth
subject moves spec-V to spec-I: [only [pro_7 1st]] 8[t_8 brush pro_8's teeth]
derivation to LF: no further changes
derivation to PF: percolate in *only*-DP: [only [pro_7 1st]]-*1st* 8[t_8 brush pro_8's teeth]
transmit under binding: [only [pro_7 1st]]-*1st* 8[t_8-*1st* brush pro_8-*1st*'s teeth]

The point is that the trace and possessive pronoun bound by *only I* have 1st-person features at PF, but not at LF. At LF, the only 1st-person feature is on the subject *I*, where indeed it is interpreted and constrains the reference of the free variable 7 to pick out the speaker. The trace and bound pronoun are feature-less variables and thus have well-defined denotations under any assignment that assigns something to the variable 8.

4.5.2. Interpreted and uninterpreted tense features

Let us return to tense now and begin to spell out Kratzer's analogy between fake indexicals and Sequence of Tense. The first step is to clarify the relation between abstract tense morphemes (such as **PAST**) and tense morphology (such as an *-ed* suffix or a suppletive form like *was*). The idea is that this is similar to the relation between interpreted and uninterpreted phi features. There is the item, or – as we will now say – the "(interpreted) feature" **PAST**, which is part of the underlying structure and of the LF, and which is semantically contentful. (Its meaning is what we have been assuming, e.g., (12) in section 4.4.1). And there is an uninterpreted twin of it – we'll write it *PAST* in little italics – which shows up in various places at PF and informs the spell-out of verbs in its vicinity. The actual spell-out rules (e.g. *go PAST* → *went*) can work on very local configurations (and we won't say much more about them here – that's what we have morphologists for). But the mechanism by which the uninterpreted tense features get to be where they are is sensitive to a not necessarily local structural configuration with abstract ingredients like variables and binders. It is, in fact, the very mechanism that is behind fake indexicals. Let us see how our rule (22) "feature transmission under semantic binding" can apply to tense features.

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[69] This proviso becomes relevant later: the rule should apply also if there is a vacuous operator together with the binder index. For the moment you can ignore it.

First some mono-clausal examples.

(25) [**PAST-***OP* C] [John like-*OP* Mary]
move operators: *OP***1** [[**PAST-t1** C] *OP***2** [John like-**t2** Mary]]
percolate feature: *OP***1** [[**PAST-t1** C]-*PAST* *OP***2** [John like-**t2** Mary]]
transmit feature: *OP***1** [[**PAST-t1** C]-*PAST* *OP***2** [John like-[**t2**-*PAST*] Mary]]
spell out: John liked Mary.

(26) [**PAST-***OP* C] [John *be* rich-*OP*]
move operators: *OP***1** [[**PAST-t1** C] *OP***2** [John *be* rich-**t2**]]
percolate feature: *OP***1** [[**PAST-t1** C]-*PAST* *OP***2** [John *be* rich-**t2**]]
transmit feature: *OP***1** [[**PAST-t1** C]-*PAST* *OP***2** [John *be* rich-[**t2**-*PAST*]]]
spell out: John was rich.

We included the tense's restrictor (C) here to be fully explicit about the structure, but will go right back to ignoring it below. In the copular example, the uninterpreted tense feature has ended up a bit lower perhaps than we would want it. Tense gets spelled out on the copula after all, not on the adjective. We won't fret over this here.[70]

What about present tense? As long as we are treating it as vacuous, it isn't binding any variables and thus can't be a source of transmitted features. The most natural move at this point is to abolish the item or feature PRES altogether, and leave it to the morphology to spell out verbs without a tense feature in the form that we traditionally call their "present tense" form[71]. Given that present tense morphology is actually zero (once we factor out subject agreement), this is also reasonable from a morphologist's perspective. But bear in mind that we are not really wedded to the vacuous treatment of the present, but have entertained a non-vacuous version too (when we considered frame adverbs). There might then also be an uninterpreted twin *PRES* of a non-vacuous **PRES**, and the the analysis of *John likes Mary* might be (28). But here we go with (27) for simplicity.

(27) John like-*OP* Mary
move operator: *OP***2** [John like-**t2** Mary]]
spell out: John likes Mary.

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[70] The issue disappears, or at least changes, when we integrate aspect into the structure. The *PAST* feature will then end up no lower than the type-s argument of the Asp head – in both copular sentences and those with regular main verbs. When Asp is morphologically zero, the tense feature next to Asp gets spelled out on the verb immediately below. For a recent discussion of verbal morphology and the role of semantically vacuous auxiliaries like *do* and *be*, see Bjorkman's 2011 MIT thesis.

[71] At least it does this in finite environments. We must assume that the morphology somehow knows whether it is dealing with e.g. an infinitive or a participle, where all tense distinctions are systematically neutralized.

(28) [**PRES-***OP* C] [John like-*OP* Mary]
move operators: *OP***1** [[**PRES-t1** C] *OP***2** [John like-**t2** Mary]]
percolate: *OP***1** [[**PRES-t1** C]-*PRES* *OP***2** [John like-**t2** Mary]]
transmit: *OP***1** [[**PRES-t1** C]-*PRES* *OP***2** [John like-[**t2**-*PRES*] Mary]]
spell out: John likes Mary.

2.4.3. Sequence of Tense explained

Now we reap the benefits of this new morpho-semantic theory. Look again at our problematic sentence *John was married to someone who is famous*. First, here is a derivation for the attested "famous now" reading.

(29)(a) base-generate:
PAST-*OP* [John *be* married-*OP* *to* [some *one* [*who be* famous-**pro1**]]]

(b) move operators (note non-local binding of pronoun!):
*OP***1** PAST-**t1**
*OP***2** [John *be* married-**t2** *to* some *one who*6[t6 *be* famous-**pro1**]]]

(c) from (b), by percolation and transmission:
*OP***1** [PAST-**t1**]-*PAST*
*OP***2** [John *be* married-**t2**-*PAST* *to* some *one who*6[t6 *be* famous-**pro1**]]]

(d) from (b), by QR:
*OP***1** PAST-**t1**
*OP***2** [[some *one who*6[t6 *be* famous-**pro1**]] 7[John *be* married-**t2** *to* t7]]

The only trace or pronoun that receives a *PAST* feature by transmission is the argument of the matrix predicate *be married*, so the embedded verb remains without a tense feature and surfaces as present tense.

Now let's convince ourselves that we no longer generate the unattested simultaneous reading. An LF that expresses this reading must have the argument of the embedded predicate semantically bound by the matrix tense, as in the LF in (30).

(30) *OP***1** PAST-**t1**
*OP***2** [[some *one who*6[t6 *be* famous-**pro2**]] 7[John *be* married-**t2** *to* t7]]

But with semantic binding comes feature transmission, and therefore the embedded predicate would then have to surface as a past tense form. We can't have semantic binding without a morphological reflex. This is what is behind the phenomenon called "Sequence of Tense".

The system makes further predictions. One (closely related to the above) pertains to sentences with embedded future. Consider (31).

(31) John was married to someone who will be famous.

Our old theory predicted, falsely, that this sentence, as spoken in 2016, could be verified by a scenario in which John and Mary were married from 2004 to 2006 and Mary was famous from

2008 to 2010. (In other words, the temporal order in the scenario is marriage < fame < utterance.) When the sentence was given an LF where the *some*-DP scoped below the matrix past, the old theory made that LF true in the described scenario. As a matter of fact, however, the sentence unambiguously entails the existence of a person who is famous sometime *after the utterance time*.

The new theory generates the attested reading by coindexing the pronoun in the argument position of *woll* with the topmost operator in the matrix. (Exercise: Show this.) (It doesn't matter in this case how high the *some*-DP scopes.) For the unattested reading (that would be true in the above scenario), the inner argument of *woll* would have to be bound by the matrix PAST. In that configuration, however, the transmission rule applies and drops a *PAST* feature onto the argument of *woll*. For morphology, this means that *woll* spells out to *would*, not to *will*. So this is the LF of a different sentence, namely (32).

(32) John was married to someone who would be famous.

Indeed (32) sentence has a different meaning from (31) and *can* describe our scenario. (Perhaps it's most felicitous with added adverbials, e.g., *John was married to someone who would later be famous*, or *In 2005, John was married to someone who would be famous in 2009*.)

The new theory does not affect predictions for any of the sentences that have a matrix present. It also does not affect predictions for sentences with matrix future, i.e. *will* – provided we assume that **woll** (unlike **PAST**) is not a feature in the first place and has no uninterpreted twin-feature. (So if there is a feature at all that enters into spelling out *will*, it's just *PRES*.)

As for configurations with matrix past, we have already looked at embedded present and embedded future. What about matrix past embedding another past?

(33) John was married to someone who was famous.

We already know that one of the derivations for this surface configuration involves an underlying structure that has no tense (the equivalent of vacuous present) in the lower clause. This gave a simultaneous reading. (We call this the "SOT derivation".) But is that the only derivation which outputs (33) at PF? Suppose we generate an embedded PAST in the base structure. Then, after the operators have moved, we have a structure of the form in (34).

(34) *OP*$_{\mathbf{1}}$ PAST-$\mathbf{t_1}$
OP$_{\mathbf{2}}$ [John *be* married-$\mathbf{t_2}$ *to* some *one* *who*$_6$[PAST-$\mathbf{pro_n}$ *OP*$_{\mathbf{3}}$[t_6 *be* famous-$\mathbf{t_3}$]]]

I left the subscript on the pronoun unspecified, because we have choices there. We can have **n**=**1** or **n**=**2**.

First consider **n**=**1**. Then the pronoun is bound by the highest *OP* and no features get transmitted onto it. Each of the PAST's, however, transmits a *PAST* to the trace it binds, so we get *PAST* on $\mathbf{t_2}$ and $\mathbf{t_3}$, hence *was married* and *was famous*. The meaning has two independent quantifiers over times before g(**1**), i.e., before the utterance time if this is used as a matrix sentence. So this is a reading where the verifying marriage and fame can in principle be in any temporal order with respect to each other. (Adverbs can be added to constrain it further.) We are happy to generate

this derivation, since the surface sentence does allow this kind of interpretation.

Now consider **n**=**2** in (35). Meaning-wise, this imposes a requirement that the fame held before the marriage (i.e., either the fame began and ended before the marriage or it continued from before the marriage into it or beyond). Since that kind of scenario is already allowed as a special case of the truth conditions of the **n**=**1** LF, it is hard to determine with truth-value judgments whether the grammar ought to generate this as a separate reading. But it won't hurt, it seems. Now let's look at the PF side for this case. Given what we have made explicit about percolation and transmission, we get the following pre-spell-out structure in the lower clause.

(35) lower clause for (34) with **n**=**2**, after percolation and transmission:
... *who*$_6$ [[PAST-[**pro**$_2$-*PAST*]]-*PAST* *OP***3** [t$_6$ *be* famous-[**t**$_3$-*PAST*]]]

The left-most *PAST* (the one on **pro**$_2$) has been transmitted from the higher clause. The second *PAST*, the one attached to the complex phrase [PAST-[**pro**$_2$-*PAST*]], got there by percolation from the PAST-head of that phrase itself. And the third *PAST* (on **t**$_3$) has been transmitted from that complex phrase. How does all this get spelled out? Presumably the only place where morphology does something is in the predicate *(be) famous*, so we expect *was famous*. The structure in the complex phrase headed by PAST presumably must stay silent, because there is no verbal element there to carry tense inflection. So this is homophonous with the outputs of the other two derivations – an okay prediction, if not one that we can distinguish empirically at this point from another possibility that might be entertained as well, namely that the structure in (35) is not well-formed or not spell-out-able at all (for some reason to be identified).

A question that tends to come up at this point is whether we should work out a morphology which spells (35) out as a pluperfect, i.e., *who had been famous*. After all, this is intuitively the English sentence which best matches the interpretation we computed for the **n**=**2**-version of (34): *John was married to someone who had been famous* does entail fame before the marriage. Morphologically, however, it would seem to take a bit of *ad hoc* machinery to get from (35) to *had been famous*. We may have a more elegant way to generate the pluperfect. Assume (as was briefly mentioned earlier) that our lexicon contains an item that is synonymous with PAST, but syntactically different in that it is generated lower (below M, if any) and qualifies as "verbal" in the sense that's relevant to whether morphology can realize tense inflection on it.[72] Then we can generate a minimal variant of (35):

(36) ... *who*$_6$ [[have-[**pro**$_2$-*PAST*]] *OP***3** [t$_6$ *be* famous-**t**$_3$]]
(matrix same as in (34))

The meaning of (36) is the same as with (35), but the morphology is straightforward and outputs *had*.[73] (The copula then surfaces as a past participle form, but this is among the further morphological details that we are not attending to here.)

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[72] In the latter respect it is thus like *woll*.

[73] We assume, as we did for **woll**, that **have** is not a feature and ipso facto doesn't have an uninterpreted twin.

5. Embedded tense in complement clauses

We have only looked at relative clauses so far, but there are other multiclausal constructions to consider in which tenses occur in the scope of other tenses. In this section, we look at complement clauses to attitude and speech verbs.

A prerequisite for this discussion is the semantic analysis of verbs such as *believe*, *think*, *know*, *hope*, *tell*, *say*. We rely on earlier in the semester, where we developed lexical entries like (1).

(1) For any world w,
$[\![\text{think}]\!]^w = \lambda p_{\langle s,t\rangle}.\ \lambda x.\ \forall w'\ [w' \text{ is compatible with } x\text{'s beliefs in } w \rightarrow p(w') = 1]$

We adapt this to our current framework as follows.[74]

(2) $[\![\text{think}]\!] = \lambda i.\ \lambda p_{\langle s,t\rangle}.\ \lambda x.\ \forall w\ [w \text{ is compatible with } x\text{'s beliefs in } w_i \text{ at } t_i \rightarrow p(w, t_i) = 1]$

5.1 Simple cases: non-past matrix

Let's warm up with a sentence that has present tense in both clauses.

(3) John thinks that Mary has the key.

Since we have abolished PRES, the structure of (3) is quite simple. *believe* calls for an argument of type <s,t>, so we must generate an *OP* in the lower clause. The representation after *OP*-movement will be (4).

(4) OP_1[John think-$\mathbf{t_1}$ OP_2[Mary have-$\mathbf{t_2}$ the key]]

This structure is interpretable as it stands, so it can be our LF and we compute the meaning in (5a). It is also ready to be spelled out by the morphology, since there are no relevant features here to percolate and transmit. Recall that verbs with no tense feature are spelled out (in finite environments) as present tense.

(5) (a) $\lambda i.\ \forall w$ [w compatible with J's beliefs in w_i at $t_i \rightarrow$ M has the key in w at t_i]
(b) morphology: [think-$\mathbf{t_1}$] $\rightarrow$ *thinks*, [have-$\mathbf{t_2}$] $\rightarrow$ *has*

Examples with a non-present tense in the embedded clause but a present in the matrix are also straightforward, as you can verify yourself. Let's move on to the interesting cases, with non-present tenses in the matrix.

The first case we examine is a future embedding a present.

(6) John will think that Mary has the key.

Again the structure after operator movement can serve without further derivation as LF and as input to morphology (there are still no features to copy around).

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[74] There is another natural way to go, which is what you find in most of the contemporary literature (Ogihara, Abusch, Kratzer, von Stechow, Kusumoto, etc).

(i) $[\![\text{think}]\!] = \lambda i.\ \lambda p_{\langle s,t\rangle}.\ \lambda x.\ \forall i'\ [i' \text{ is compatible with } x\text{'s beliefs in } w_i \text{ at } t_i \rightarrow p(i') = 1]$

(i), unlike (2), quantifies over both worlds and times. The difference between (2) and (i) becomes important in the analysis of so-called *de se* readings, but it won't matter for the modest purposes of this introduction.

(7) $OP_{\mathbf{1}}$[woll-$\mathbf{t_1}$ $OP_{\mathbf{2}}$[John think-$\mathbf{t_2}$ $OP_{\mathbf{3}}$[Mary have-$\mathbf{t_3}$ the key]]]

(a) $\lambda i.\ \exists t\ [\ t > t_i\ \&$
$\forall w$ [w compatible with J's beliefs in w_i at t $\rightarrow$ M has the key in w at t]]

(b) morphology[75]: [woll-$\mathbf{t_1}$] $\rightarrow$ *will*, [have-$\mathbf{t_2}$] $\rightarrow$ *has*

The meaning we computed in (7a) amounts to a "simultaneous" reading. The worlds compatible with John's beliefs at the future time we are talking about are worlds in which Mary has the keys *then*, at the time of his thinking. This is indeed what the English sentence (6) means. In fact, it is its only possible reading. In distinction to the case of a present *relative* clause in a future matrix, there is not an additional reading here on which the present in the complement clause evaluates at the utterance time. The theory predicts this unambiguity. Because the attitude verb selects an argument of type <s,t>, we must generate an operator with the lower verb and move it to the embedded C. We cannot put a pronoun there and bind it non-locally. That would result in a type-mismatch, because the sister of *think* would be type t.

If we do want to talk about a belief that someone will hold in the future about our current utterance time, how do we express this in English? We have to use an embedded past.

(8) scenario: Arriving at the office one morning, Mary realizes that she left her keys at home. But as luck would have it, someone forgot to lock up the night before, so she can get in anyway. As she is entering the office, she thinks about the boss (John), who will arrive later and, not knowing any of the above, will not be surprised to find her sitting at her desk. She says:
John will think that I had my key.

(The analysis of this sentence in our theory is straightforward; do it as an exercise.) These examples provide an illustration of Ogihara's (1996) principle of "temporal directionality isomorphism", i.e., the generalization that tenses in an attitude complement must always reflect the *attitude holder*'s temporal perspective on the embedded event (rather than the speaker's). Kratzer (1998) and Kusumoto (2005) proposed to derive temporal directionality isomorphism from the semantic type of attitude verbs, and we have implemented this approach.

5.2. Past matrix and sequence of tense

Next we ask ourselves what underlying structures we can build with a matrix PAST and what will happen to them in their LF and PF derivations and their semantic and morphological interpretation. First let's base-generate PAST operators in both clauses.

(9) $OP_{\mathbf{1}}$[PAST-$\mathbf{t_1}$ $OP_{\mathbf{2}}$[John think-$\mathbf{t_2}$ $OP_{\mathbf{3}}$[PAST-$\mathbf{t_3}$ $OP_{\mathbf{4}}$[Mary have-$\mathbf{t_4}$ the key]]]]

Interpretability requirements once again determine the presence and landing sites of the OP's. (9) is interpretable and expresses what is called a "back-shifted" ("earlier-than-matrix") reading.

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[75] *think* does not spell out as *thinks*, because it is not in a finite VP. *woll* (like the other auxiliaries of syntactic category M) governs infinitival morphology on its complement VP, and it is irrelevant in this case what tense features, if any, might have been transmitted to the type-s-argument of V. Even when there is a *PAST* on the inner argument of an M (as in 'John could see the ocean', or 'John thought he would see the ocean'), the VP still spells out as a bare infinitive.

(10) $\lambda i.\ \exists t\ [\ t < t_i\ \&$
$\forall w\ [w$ compatible with J's beliefs in w_i at $t \rightarrow \exists t'\ [\ t' < t\ \&$ M has the key in w at $t']\ ]$

What about morphology? Each PAST operator certainly will transmit a feature to its trace, and the outcome will be past tense morphology in both clauses.

(11) *OP***1**[[PAST-**t1**]-*PAST* *OP***2**[J think-**t2**-*PAST* *OP***3**[[PAST-**t3**]-*PAST* *OP***4**[M have-**t4**-*PAST* key]]]]
spell out: John thought that Mary had the key.

So we generate a back-shifted reading for this surface sentence of English, and this is good. The sentence can be understood in this way. Imagine, e.g., that we are talking about the story in (8) at a later time. We could then say *John thought that Mary had her key* meaning that when John arrived in the late morning, he thought that Mary had her key at the earlier time of her arrival.

But the same surface sentence also has a "simultaneous" reading. In fact, this may be the most prominent reading out of context. The simultaneous reading is standardly attributed to Sequence of Tense. Let's see how our implementation of SOT as feature-transmission-under-binding might cover this case. To get the simultaneous truth-conditions, our LF must *not* have a PAST operator in the lower clause, so we don't base-generate one there. The structure needs to be as in (12).

(12) *OP***1**[PAST-**t1** *OP***2**[John think-**t2** *OP***3**[Mary have-**t3** the key]]]
$\lambda i.\ \exists t\ [\ t < t_i\ \&\ \forall w\ [w$ compatible with J's beliefs in w_i at $t \rightarrow$ M has the key in w at $t]\ ]$

Does this structure wind up at PF with a transmitted *PAST* feature on the argument of the embedded verb *have*? That actually doesn't quite yet follow from the assumptions we have in place. Percolating the feature in the phrase headed by PAST and then transmitting it down to variables bound by that phrase only gets us as far as (13).

(13) *OP***1**[[PAST-**t1**]-*PAST* *OP***2**[John think-[**t2**-*PAST*] *OP***3**[Mary have-**t3** the key]]]

We need a further assumption here, namely that there is percolation in the phrase headed by the verb *think*, in such a way that the tense feature from the argument of *think* gets passed up.

(14) Percolation in the verbal complex:[76]
[V [arg F]] becomes [V [arg F]]-F

If we apply (14) in (13), this will then feed another application of the transmission rule, and we arrive at (15).

(15) *OP***1**[[PAST-**t1**]-*PAST* *OP***2**[John [think-[**t2**-*PAST*]]-*PAST* *OP***3**[Mary have-**t3**-*PAST* the key]]]
spell out: John thought that Mary had the key.

So we generate the simultaneous reading for this surface sentence.

Two remarks are in order. First, the system does *not* generate any reading for the past-under-past sentence that could describe a "later-than-matrix" scenario. Suppose that someone at some time in the past had a thought about a time which was still in their future at the time of their thinking,

[76] For this to work as intended, it is actually crucial that the index-argument be the innermost argument of the verb – a decision which up to now was an arbitrary matter of exposition.

but which is now past in relation to our utterance time. This sort of thought cannot be reported by a sentence with a simple past in the lower clause, but requires instead an embedded *would* (another difference between complement clauses and relative clauses, and another illustration of Ogihara's "temporal directionality isomorphism"). The following minimal pairs make the point.

(16) (a) * We knew long before the test that you flunked.
(b) We knew long before the test that you would flunk.

(17) I wanted to go shopping before the stores closed last night,
(a) * because I was afraid you were hungry this morning.
(b) because I was afraid you would be hungry this morning.

(18) By the 1970s, people no longer expected
(a) * that Germany was reunified before the end of the century.
(b) that Germany would be reunified before the end of the century.

Examples with *would* (such as the (b)-cases above or *John thought that Mary would have the keys*) are generated with appropriate meanings by our current analysis, as the reader is invited to work out.

A second remark is that the analysis as it now stands does not generate the sentence in (19) at all.

(19) John thought that Mary has the keys.

If we base-generate no temporal operator in the lower clause, the only possible derivation is the one we saw above in (12) - (15), which leads to past tense morphology in both clauses. Interpretability constrains us to generate a locally bound operator in the embedded clause, not a pronoun that might be bound from higher up, i.e., from the matrix C. There is simply no way to derive (19), and the prediction is therefore that present tense in the complement of a past tense matrix attitude verb should be ungrammatical. Unfortunately the empirical facts are not so simple – a complication that we discuss in the following section.

5.3. Present under past and double-access readings

Present-under-past attitude and speech reports are not simply another way to express a simultaneous reading (in which case we could simply have dealt with them by making the new percolation rule in (14) optional). Nor do they simply report someone's past thought about the present time which was in the future of their thinking (which would make them counterexamples to temporal directionality isomorphism). Rather these sentences have a distinctive and peculiar meaning of their own, known in the literature as a "double access" reading. We introduce the phenomenon by quoting from a paper by Altshuler & Schwarzschild[77]:

"Suppose that ... at the mall, I ask Sylvia where her friend, Mary, is. She replies: “Mary is at home today”. Later that day, when I’m at the beach and asked for Mary’s whereabouts, I can truthfully say:

(9) Sylvia said that Mary is at home.

[77] (2013, Amsterdam Colloquium)

Taking our cue from Abusch's (1997) discussion of present complements of *believed,* we observe that (9) is true on the so-called *double access* reading because two conditions are met. To describe those conditions, we will need to refer to the time and world at which Sylvia replied to me at the mall. We symbolize those as $w@$ and t_{mall} respectively. Below, in (10) - (11), we first give each condition in descriptive terms ...

(10) Relative Present Condition
a. If Sylvia's utterance was true, then Mary is at home in $w@$ at t_{mall}.
[...]

(11) Deictic Present Condition
a. If Sylvia's utterance was true, then Mary is at home throughout an interval that includes the time at which (9) is uttered.
[...]

We call (10) 'Relative Present Condition' because it makes the present tense look like a relative present – a sort of Priorian present tense (Prior 1967) [...] We call (11) 'Deictic Present Condition' because it makes the present tense look like a deictic present – a tense that in any context picks out the utterance time of that context. [...] This would explain why (9) is true if uttered on the same day as t_{mall} but not if uttered on the following day.

In sum we propose that the present tense in English is an amalgam of both a relative and a deictic present. More concretely, we propose that the English present demands truth at the local evaluation time (relative tense component) and at or after the speech time (deictic tense component). In a simple present tense clause [...], the local evaluation time is the speech time so the two components cannot be told apart."

A&S propose, in effect, that "double access" is hard-wired into the meaning of the English present tense: this tense shifts to a new evaluation time that is constrained by its relations to *two* other times. We adopt a related idea[78], but without actually departing from our assumption that the present tense is vacuous and therefore does not shift evaluation time at all. We instead draw a parallel to a phenomenon with personal plural pronouns known as 'split antecedents' or 'split binding'.[79] An example is (20a), which has an LF like (20b), in which the **+**-sign denotes a function (of type <e,<e,e>>) which maps two individuals to the smallest (plural) individual that contains them both as parts. The truth-conditions of (20a) on this parse are fulfilled by a scenario in which everyone told someone "You and I should get together".

(20) (a) Everyone told someone that they should get together.
(b) everyone **1**[someone **2**[$\mathbf{t_1}$ told $\mathbf{t_2}$ that [$\mathbf{pro_1 + pro_2}$] should get together]]

The idea that we want to spell ou here is that the topmost type-s argument in a double-access complement is a world-time pair in which the time is kind of a plural time. This requires a special sum-operator for world-time pairs, whose definition is admittedly a little funny, since it uses both input times but effectively "throws away" one of the worlds.

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[78] Among other differences from A&S's proposal, we are not requiring either of the two arguments to be the utterance index. Empirical consequences of this difference will show up only in sentences with multiple levels of embedding, whose examination we leave to another occasion. There are several other differences too.

[79] refs

(21) $[\![\textbf{+}]\!] = \lambda i \in D_s.\, \lambda j \in D_s.\, \langle w_i, [t_i,t_j]\rangle$,
where $[t_i,t_j]$ is the interval from t_i to t_j, which is the smallest interval that contains both t_i and t_j

What we have in mind for the example sentence *Sylvia said that Mary is at home* is a representation of the form in (22).

(22) $OP_{\mathbf{1}}$[[**PAST** $\mathbf{t_1}$] $OP_{\mathbf{2}}$[Sylvia say-$\mathbf{t_2}$ $OP_{\mathbf{3}}$[Mary *be* at-home-[_+_]]]]

We have filled in the *OP*'s and traces that are required for the usual reasons of interpretability. Note that these include an *OP* ($OP_{\mathbf{3}}$) at the edge of the complement of *say*, to meet the latter's requirement for a proposition. One of the two blanks in the "plural" argument of the embedded verb thus has be occupied by the trace of $OP_{\mathbf{3}}$.[80] The other one is up for grabs and could in principle be bound by any one of the three higher *OP*'s ($OP_{\mathbf{1}}$, $OP_{\mathbf{2}}$, or $OP_{\mathbf{3}}$). There is, however, one more principled constraint that we can identify before we examine the remaining options one by one. The trace of the operator $OP_{\mathbf{3}}$ will have to go to the *left* of **+**, not to the right. This has to do with the asymmetry regarding the worlds in definition (21). Let's compute what would happen if $OP_{\mathbf{3}}$ were to bind (only) a variable on the right. (23) shows the result of interpreting the *say*-VP, assuming $\mathbf{n \neq 3}$.

(23) $[\![$Sylvia say-$\mathbf{t_2}$ $OP_{\mathbf{3}}$. Mary *be* at-home-$(\mathbf{pro_n + t_3})]\!]^g = 1$ iff
$\forall w$ [w is compatible with what Sylvia says in $w_{g(2)}$ at $t_{g(2)}$
$\rightarrow$ Mary is at home in $w_{g(n)}$ at $[t_{g(n)}, t_{g(2)}]$]

The universal quantifier over worlds binds vacuously here, so this is a pathological meaning.

We are down to three ways of filling the blanks in (22).

(24) $OP_{\mathbf{1}}$[[**PAST** $\mathbf{t_1}$] $OP_{\mathbf{2}}$[Sylvia say-$\mathbf{t_2}$ ...
(a) ... $OP_{\mathbf{3}}$[Mary *be* at-home-[$\mathbf{t_3 + pro_3}$]]]]
(b) ... $OP_{\mathbf{3}}$[Mary *be* at-home-[$\mathbf{t_3 + pro_2}$]]]]
(c) ... $OP_{\mathbf{3}}$[Mary *be* at-home-[$\mathbf{t_3 + pro_1}$]]]]

(24a), with the two arguments of **+** coindexed, amounts to the same meaning as if we had simply put $\mathbf{t_3}$ instead of $\mathbf{t_3 + pro_3}$. (Definition (20) implies that $[\![\textbf{+}]\!](i)(i) = i$.) This expresses a simultaneous reading. (24b) turns out to be equivalent with this as well (prove as exercise). (24c) is the only interesting choice. We compute the proposition in (25).

(25) $\lambda i.\, \exists t\, [\, t < t_i$ & $\forall w$ [w is compatible with what Sylvia says in w_i at t
$\rightarrow$ Mary is at home in w at $[t, t_i]$]]

This represents our desired double-access reading. It implies that, according to what Sylvia said at t_{mall}, Mary was at home at the interval from t_{mall} to the utterance time.

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[80] It is worth noting that this is another illustration of Ogihara's "temporal directionality isomorphism". Ogihara (1996) actually introduced that principle in the context of discussing the double access phenomenon. He thereby drew attention to the fact that even in this case – which may superficially look as if an embedded tense were chosen to reflect *solely* the *utterer's* perspective – we have a tense that upon careful examination turns out to relate the embedded event *also* to the subjective "now" of the subject in the reported past thought/speech act.

What about morphology? It is one thing to have a semantics that generates the double-access reading, and another to predict correctly that this reading – and *only* this reading – surfaces with a present tense in the embedded clause. Here the story that we need in order to get the facts right is not yet determined by our existing assumptions, unfortunately. Given those assumptions, including Percolation in the Verbal Complex from (14) above, the lower clause under the three disambiguations in (24a - c) will receive the transmitted features shown in (25).

(25) *OP*$_{\mathbf{1}}$[[PAST-$\mathbf{t_1}$]-*PAST* *OP*$_{\mathbf{2}}$[Sylvia [say-[$\mathbf{t_2}$-*PAST*]]-*PAST* ...
(a) ... *OP*$_{\mathbf{3}}$[Mary *be* at-home-[$\mathbf{t_3}$-*PAST* **+** **pro**$_{\mathbf{3}}$-*PAST*]]]]
(b) .... *OP*$_{\mathbf{3}}$[Mary *be* at-home-[$\mathbf{t_3}$-*PAST* **+** **pro**$_{\mathbf{2}}$-*PAST*]]]]
(c) ... *OP*$_{\mathbf{3}}$[Mary *be* at-home-[$\mathbf{t_3}$-*PAST* **+** **pro**$_{\mathbf{1}}$]]]]

In the two structures that express the simultaneous reading, (25a) and (25b), both arguments of **+** have a transmitted *PAST*. We would want to make sure that in this case, *PAST* percolates to the whole "plural" argument and is seen by the morphology and expressed on the verb, giving us *was at home*. (If that didn't happen and we got *is at home*, we would wrongly pair this morphology with an unattested simultaneous reading!) In the structure (25c), on the other hand, which expresses the double access reading, only one of the arguments of **+** is marked *PAST* and the other one is unmarked. In this case, we want to say that *PAST* does *not* percolate to the plural argument and is not spelled out, so that the embedded verb surfaces as *is at home*. Our structures are rich enough for us to be able to make the desired distinction, though the assumptions required don't look as principled as we might have hoped. More research is needed here. If this approach to double access is on the right track, the morphological mechanisms should ultimately fall together with independently attested mechanisms for assigning phi-features to plural personal pronouns and coordinated DPs.[81]

[81] refs include Podobryaev 2014 MIT PhD