Tense and Aspect

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:[1]

(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.[2] 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".

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 *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

[1] We remain vague for now about what we mean by "times" (points in time? time intervals?). This will eventually need clarification.

[2] 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.

complement of T is just a VP in this case. (TP is always projected, 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[3]). 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 is actually 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: $[\![$PRES (Mary be tired)$]\!]^i$ = $[\![$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) 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 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 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: $[\![$PAST$]\!]^i = \lambda p \in D_{\langle s,t \rangle}. \exists t$ 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.

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[3] But let's not talk about *would* at this point. See the exercise right before section 2.1, and section x later.

For *will,* we can say something completely analogous:[4]

(8) For any index i:
$[\![\textbf{woll}]\!]^i = \lambda p \in D_{\langle s,t \rangle}. \exists t \text{ after } t_i : p(w_i,t) = 1$[5]

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.[6] 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 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 propositions, 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 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]]

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[4] The question came up in class whether there are also tenses with universal force. I quickly said no, but people suggested two possible candidates that call for closer examination. 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).

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

[6] 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"

Exercise: 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.[7] Let's revise the entries for *PAST* and *woll* so that they denote *2-place* operators, and moreover they encode a non-emptiness presupposition.[8]

(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 (in fact, 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

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

[8] How about present tense? Should we make this presuppositonal as well (which would imply it is not, after all, completely vacuous)? Frame adverbials with present tense sentence are not so common, but they 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.

(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.

extraposition of the adverbial.[9]

(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 it 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 and a less direct correspondence between LF constituency and surface structure (but see footnote). 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 1: 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]]

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 2: 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?□

[9] 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.

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 here is arguing that neither of the two plausible LFs derivable in our system from section 1.1. correctly captures the meaning of (17). Given that the sentence contains a past tense and a negation, we need to consider 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: 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 in fact deal with (17), if one allows the existential quantifier over times to be contextually restricted to times in the salient interval of Partee leaving her house. 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 is 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 leaving her house). But the sentence is not interpreted as saying that *this* interval is not a time at which she turned off her stove, which would have to be a fairly absurd turning-off-of-the-stove (turning off the stove only takes a moment and doesn't take up a significant interval). Instead, the sentence says that *in* that salient interval there is no time at

which she turned off the stove. Clearly, we do need an existential quantifier in there somewhere and the Priorean theory provides one.[10] 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 did well? Let us say that the covert restrictor in this case picks out a very long interval, perhaps John's entire life-time, or the entire past from the big bang to the utterance time, or even 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: Assuming the restricted existential quantifier analysis of past tense that we adopted in section 1.2, which of the LFs in (18) captures the meaning of (17) correctly?□

2. Tenses in the scope of other tenses: relative clauses

In this section we consider predictions that our analysis from the previous section makes about tenses that are in the scope of other tenses. The examples we will look at are multiclausal structures, with one tense in a relative clause[11] and the other tense in the next higher clause.

Why do we turn to multiclausal structures at this point? We could, in principle, begin by looking at the predictions for stacked temporal operators in a single clause. The syntactic properties of the temporal operators *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 many have argued to be (on at least one of its readings) simply an allomorph of *PAST*. 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, and even a superficial examination indicates that some revisions will be required to get things right. But we postpone this task to a later point.

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[10] The alternative is to say that the existential quantifier is not expressed by tense but comes from somewhere else, perhaps from aspect. We will come back to this.

[11] We will also discuss tenses embedded in complement clauses, but not until section 3.

Exercise: Assume that *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?

2.1. Basic examples and an overgeneration problem

Let's examine the following paradigm[12]:

(1) (a) *PRES* over *PRES*: John is married to someone who is famous.
(b) *PAST* over *PRES*: John was married to someone who is famous.
(c) *will* over *PRES*: John will be married to someone who is famous.
(d) *PRES* over *PAST*: John is married to someone who was famous.
(e) *PAST* over *PAST*: John was married to someone who was famous.
(f) *will* over *PAST*: John will be married to someone who was famous.

In each case, we can generate one LF in which the *someone*-DP scopes below the matrix tense, and another LF in which it scopes above it. So each sentence is predicted to have two readings, though they may not always be truth-conditionally distinct. One case where it is immediately obvious that the two readings must collapse is when the matrix tense is the semantically vacuous present tense.

We skip the tedious one-by-one examination of the six examples (although, of course, we presuppose that the reader has done it) and proceed right to the executive summary. There is one example among the six for which our analysis clearly makes a wrong prediction, and that is (b), the case of present embedded under matrix past. Consider the two LFs that we generate and the truth conditions that we compute for them (evaluating the sentence at the utterance world and utterance time $<w_u, t_u>$).

(2) narrow scope DP:
LF: *PAST* C^{13} [[some one 7[*PRES* t_7 be famous]] 8[John be married to t_8]]
$\exists t [t < t_u$ & ... & $\exists x$ [person(x, w_u, t) & famous(x, w_u, t) & married(j, x, w_u, t)]][14]

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[12] You can also look at three more sentences, with embedded *will*.

[13] *C* stands for the covert restrictor, whose content we leave open. Depending on the utterance context, it might have a very weak meaning, such as (i),

(i) for any i, $[\![C]\!]^i = 1$,

(in which case we effectively get the same truth-conditions as with the unrestricted Priorian *PAST* operator), or it could encode a substantive restriction to times in a specific contextually salient interval, as in (ii).

(ii) for any i, $[\![C]\!]^i = 1$ iff t_i is within the year 2012

[14] "..." stands for the contribution of the covert restrictor *C*, which we have left unspecified (see previous footnote). These truth conditions are also simplified in that they don't show the presupposition. (We give the predicted conditions for truth, but are not explicit about the conditions for falsity as opposed to no truth value.) The semi-formal metalanguage abbreviations (such as *married(x, y, w, t)* for 'x is married to y in w at t') are hopefully self-explanatory.

(3) wide scope DP:

LF: [some one 7[*PRES* t_7 be famous]] 8[*PAST C* [John be married to t_8]]

$\exists x$ [person(x, w_u, t_u) & <u>famous(x, w_u, t_u)</u> & $\exists t$ [$t < t_u$ & ... & married(j, x, w_u, 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 (past) time as the predicate *married-to* (a so-called "simultaneous reading"), whereas in (3), *famous* is evaluated at the utterance time. So (2) says that at some past time, John was married to a person who was famous *then*, whereas (3) says that he was married to a person who is famous *now*.

The truth-conditions in (3) capture the actual meaning of the English sentence *John was married to someone who is famous*. We understand this sentence to imply that the person John was married to is famous *now*. (They may also have been famous already at the past time of the marriage – the sentence doesn't contradict this, but it leaves it open). This much is good news for our theory. But there is bad news too: the theory predicts a second reading, the one in (2), and that reading is not attested for the English sentence. If John was married to someone who was famous at the time of the marriage but is now forgotten and unknown, the English sentence is judged false. The present tense in the embedded clause unambiguously refers to the utterance time.[15]

So we have a problem of overgeneration. How might we fix it? For the time being, we will just indicate two possible directions for a solution, without trying to make either one precise. (We return to this task after we have gathered a bit more evidence that tells us which direction is more likely to be correct.)

Since the problem stems from the fact that we generate the LF in (2), one idea is to block the generation of this LF. In (2), *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 of a negation;[16] *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 (1b), 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

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[15] An analogous problem arises with matrix *PAST* over embedded *will*. Given that we are analyzing *will* as *PRES+woll*, the possible solutions we are about to sketch would both generalize to this case.

[16] 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.

the DP that contains the *PRES* above the matrix *PAST*. So the only licit LF for (1b) will be (3) – which was the one that captured the attested meaning.

Another, completely different, approach to the problem says that (2) is basically a fine LF – except it doesn't get pronounced as (1b). Rather, it gets pronounced as (1e), *John was married to someone who was famous*. In other words, when *PRES* is in the LF-scope of *PAST*, it gets pronounced like a past tense. This is a version of the "Sequence of Tense" rules of traditional grammar. Since a *PRES* that is in the LF-scope of *PAST* can't be pronounced as a morphological present, 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 correctly predict that (1b) doesn't have the reading in (2). This approach, of course, places the burden on a theory of morphological spell-out that is far from trivial to work out.

We promised not to fill pages going through all the examples in (1a - f). But one thing is worth highlighting, namely that *future* over present does *not* pose an analogous problem for our theory as does past over present. (1c), *John will be married to someone who is famous*, does permit the predicted reading according to which John's (future) spouse will be famous at the future time of the marriage – and may not yet be famous now. (Imagine (1c) being uttered by a fortune-teller when John is a baby.) So the right empirical generalization is not that the present tense refers to the utterance time no matter where it is embedded. *PRES* can*not* have a simultaneous reading under a matrix *PAST*, but it *can* have a simultaneous reading under a matrix *will*.

2.2. Against the scopal account of "later-than-matrix" interpretation

In this section, we review an argument from Kusumoto (2005), which will inform our eventual approach to the overgeneration problem that we identified in the previous section.

Suppose we succeed (by one amendment to the theory or another) in preventing a surface sentence of the form of (1b) (past matrix and present relative clause) from being paired with an LF of the form (2) (DP in the scope of matrix tense). Then the wide-scope-DP LF (3) will be the only available LF for this type of surface sentence and we predict that the superficially embedded present tense must be evaluated with respect to the matrix evaluation index, i.e., with respect to the utterance time. So far so good. But there is a further prediction. Suppose we altered the example in some way so as to create an independent obstacle to scoping the DP above the matrix tense. We should then have an example that has no good LF at all and should therefore be ungrammatical.

How do we test this prediction? Well, one way to constrain the scopal possibilities of a DP is to use a negative polarity determiner. Kusumoto offers examples like (4) and (5).[17]

(4) She failed to talk to any prospective student who is (still) undecided.

(5) I tried not to hire anybody who is putting on a terrible performance.

The design feature of these examples is that the (only available) licenser for the NPI *any* is

[17] Her actual examples have past tenses in both clauses (see below) but the logic of the argument is just the same. She credits (her version of) (5) to Danny Fox.

clearly within the scope of the matrix past tense. In (4), it is the inherently negative verb *fail*, and in (5) it is the negation in the infinitival complement of *try*. So if the *any*-DP wanted to QR above the matrix tense, it would also have to QR above its NPI-licenser. This dilemma should result in ungrammaticality. But the sentences are grammatical and have clear truth conditions. 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 [(5)], claiming no responsibility for the failure of the play." (Kusumoto 2005, p. 327)[18] For (4), "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, ..." Suppose furthermore that the five students the faculty member talked to made their decisions right after the visit, whereas the five who she failed to talk to remain undecided at the utterance time. (4) is judged true in this scenario.[19]

The same problem arises with past-tense relative clauses in past-tense matrix clauses (which is what Kusumoto was actually talking about). Let's first see cases where the current theory seems to get it right. Kusumoto offers (6), or we could use our (1e) with an appropriately rich context or facilitating adverbs.

(6) Hillary married a man who became president of the U.S.

(7) (Back in the sixties) John was married to someone who was famous (in the nineties).

Our theory predicts two LFs as usual: one with the matrix past scoping over the object DP (and hence over the embedded past), and one with the object DP taking maximal scope (and hence neither tense in the scope of the other). In the first kind of LF, the evaluation time for the embedded *PAST* is the time bound by the matrix *PAST*, hence a time prior to the utterance time, and so the evaluation time for the embedded predicate (*become president*, *be famous*) is a time prior to *that*. On the other hand, in the second kind of LF, where the DP scopes on top, the *PAST* of the relative clause is evaluated w.r.t. the utterance time, as is the matrix *PAST*. So both predicates (the matrix *marry*/*be married* as well as the embedded *become president*/*be famous*) are evaluated at times prior to the utterance time but no particular temporal order between them is entailed – unless, of course, there are overt or covert adverbials which entail such an order. This means that the second kind of LF – but crucially, not the first kind of LF – can be true in what Kusumoto dubs "later-than-matrix" scenarios, i.e., the kind of scenario in which the (only) time at which the embedded predicate holds is later than any time at which the matrix predicate holds. (6), for example, owes its truth in the the actual world to a later-than-matrix scenario, since Bill did not become president until after Hillary married him. (7) with the added frame adverbs likewise can be true in a later-than-matrix scenario, in which no spouse of John's achieved fame until after the sixties and after divorce from John.

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[18] Since Kusumoto's version of the example has past tenses in both clauses, she imagines the casting director to be speaking after the performance. For our version, he must be speaking during the play. But the judgment is the same, and so we take the liberty of misquoting Kusumoto as making a claim about a sentence she was not actually considering.

[19] In this case, we had to adapt Kusumoto's scenario a little bit more to make it fit our (5) rather than the original past-under-past version. See below for the original.

There is no immediate problem with the predictions of the theory as far as these particular examples go. But again, the analysis is committed to a prediction: If we want a reading that is verifiable by a later-than-matrix scenario, we must scope the relative-containing DP above the matrix tense. And if something happens to prevent this scoping, then this reading should disappear and the only remaining possible reading should require "earlier-than-matrix" scenarios in order to be true. Kusumoto shows that this prediction is not borne out. Her examples are (8) and (9).

(8) I tried not to hire anybody who put on a terrible performance.

(9) She failed to talk to any prospective student who (later) decided to come to UMass.

The logic of the argument is the same as above, and the relevant scenarios to consider are almost the same. For (8), take the very scenario whose description we already quoted, just imagine the casting director to be speaking after the performance is over. For (9), we just quote Kusumoto verbatim now: "..., 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 [(9)] is judged true." (loc.cit.)

Notice that in this case, the argument against the present theory crucially relies on truth-value judgments, not just on judgments of grammaticality. In the case of present-under-past examples like (4) and (5), the theory (amended by whatever ruled out narrow-DP-scope-LFs for these surface sentences) predicted that these examples could not be paired with any LF at all without violating some grammatical constraint or other. So the prediction was that (4) and (5) should be ungrammatical. In the case of past-under-past examples such as (8) and (9), by contrast, the theory does not predict ungrammaticality. But it does predict that there should be no reading which can truthfully describe a later-than-matrix scenario.

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.

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

2.3.1. The extensional system (mostly review[20])

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

[20] from ch. 8 of 2011 lecture notes

semantics that we do retain is the expanded type system and ontology. We have a third basic 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.[21]

(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* and the counterfactual modal *would*[22].

(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 $\textbf{pro}_\textbf{n}$, 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.

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.[23] – We also stipulate that a complete

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[21] 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.

[22] 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 the current Topics class taught by Kai and Sabine.)

[23] 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*

(matrix) sentence must not contain any free variables of type s[24] 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.[25]

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).

2.3.2. Relative clauses and their tenses

The rule of Predicate Modification (PM) has not changed from the original H&K system[26]. 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, and this pronoun remains free at the point where 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

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Canadian).

[24] Suzana Fong noted that this stipulation is *prima facie* less appealing than the alternative assumption that type-s pronouns are exactly like type-e pronoun in every respect, including the ability to remain free and get values from a contextually supplied assignment. I tried to sketch some principled reason why it might not be possible to refer to a specific world other than the world one is in. But as Mitya Privoznov pointed out, a similar idea is not plausible for times, given the existence of temporal deictics like *then*. So at best there might be a principled reason why the *world*-coordinate of a free index-pronoun would always have to be w_u. I had to concede therefore that the ban against free index-pronouns was just a stipulation. We want to think more about (a) whether we really need it, and (b) if we do what might explain it.

[25] 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 $[\![\phi]\!](w,t) = 1$.

[26] What we say here supersedes a remark to the contrary in a footnote in ch. 8 of the 2011 notes.

free pronoun will be the argument of *PAST* or *woll*; if it is in the present tense (which we still treat as vacuous), the free pronoun will be the argument of the verb (or the adjective/noun after a copula). 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>.[27] (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.[28]

(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 one-$\mathbf{pro_2}$ *who*$_6$[*PRES* t_6 *be* famous-$\mathbf{pro_2}$]] 7[John *be* married-$\mathbf{t_2}$ *to* t_7]]
$\lambda i.\ \exists t\ [t > t_i\ \&\ \exists x\ [person(x,w_i,t)\ \&\ famous(x,w_i,t)\ \&\ married(j,x,w_i,t)]\ ]$
("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 one-$\mathbf{pro_1}$ *who*$_6$[*PRES* t_6 *be* famous-$\mathbf{pro_1}$]] 7[John *be* married-$\mathbf{t_2}$ *to* t_7]]
$\lambda i.\ \exists t\ [t > t_i\ \&\ \exists x\ [person(x,w_i,t_i)\ \&\ famous(x,w_i,t_i)\ \&\ married(j,x,w_i,t)]\ ]$
("famous now" reading)

(17) LF3: wide DP scope:
OP$_{\mathbf{1}}$ [[some one-$\mathbf{pro_1}$ *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]]
$\lambda i.\ \exists x\ [person(x,w_i,t_i)\ \&\ famous(x,w_i,t_i)\ \&\ \exists t\ [t > t_i\ \&\ married(j,x,w_i,t)]\ ]$
("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.[29]

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[27] Mitya Privoznov asked whether we could 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.

[28] Here we simplify by ignoring the tenses' restrictors.

Please draw yourself some trees, they will be more readable than the bracketed strings (and hopefully will be included in future editions of these notes). Some notational conventions 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.

[29] We have not considered additional possible LFs in which the head noun (here *one*, i.e., 'person') takes an argument distinct from the pronoun free in the relative clause. Unless we have further constraints, the system predicts such LFs as well – specifically, two more narrow-DP-scope LFs which entail,

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.

2.3.3. Present under past again: the problem persists

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 original overgeneration problem. We still predict the unattested simultaneous reading of 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 one-**pro**$_{\mathbf{2}}$ *who*$_6$[*PRES* t_6 *be* famous-**pro**$_{\mathbf{2}}$]] 7[John *be* married-$\mathbf{t_2}$ *to* t_7]]
$\lambda i.\ \exists t\ [t < t_i\ \&\ \exists x\ [\text{person}(x,w_i,t)\ \&\ \text{famous}(x,w_i,t)\ \&\ \text{married}(j,x,w_i,t)]\ ]$
(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 try 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 one-**pro**$_{\mathbf{1}}$ *who*$_6$[*PRES* t_6 *be* famous-**pro**$_{\mathbf{1}}$]] 7[John *be* married-$\mathbf{t_2}$ *to* t_7]]
$\lambda i.\ \exists t\ [\ t < t_i\ \&\ \exists x\ [\text{person}(x,w_i,t_i)\ \&\ \text{famous}(x,w_i,t_i)\ \&\ \text{married}(j,x,w_i,t)]\ ]$
(attested "famous now" reading)

This means that Stowell's analogy with polarity sensitivity is coming to look less helpful. What about the traditional idea that a Sequence of Tense rule governs morphological spell-out and ensures that the LF in (20) 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 (20) and (21), 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

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respectively, the existence of (i) a current person who is famous and married in the future, and (ii) a person in the future who is currently famous and married in the future. For the example at hand, we may assume as a matter of world knowledge that persons stay persons throughout their existence, marriage is only between living people, and fame cannot precede existence (though it can continue or even start after death). Given these premises, the additional LFs each entail one of the ones we have listed and should not be detectable as separate readings. But with other examples there are testable predictions, and Kusumoto in fact devotes a major section of her paper (section 4) to this issue. This is beyond the scope of this introductory class.

morphological agreement mechanism, turns out to be the favored solution in the contemporary literature.[30] 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 after all. At least the solution to be presented is one that could not even have gotten off the ground without a syntax that posits world-time pronouns and traces as part of syntactic representations.

2.4. 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".[31] We take a brief excursion into this topic before we return to tense.

2.4.1. 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[32] 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 must if it is to be bound by the quantifier *only I*.

We will not engage here into 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[33], or else a mechanism that adds (copies) features in the PF-branch onto nodes that are feature-less

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

[31] 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.

[32] 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 obviously has an even more basic problem.

[33] see von Stechow 2003

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[34]) operates non-locally. For concreteness we state the following rule (22), which employs the concept of "binding" defined in (23).[35]

(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[36]) 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 pronoun bound by *only I* have 1st-person features at PF, but not at LF. At LF, the only 1st-person feature is on *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.

2.4.2. 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, i.e., entry (3) in section 2.3.1). And there is an uninterpreted twin of it –

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[34] 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.

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

[36] 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.

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.

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: *OP***1** [[**PAST-t1** C]-*PAST* *OP***2** [John like-**t2** Mary]]
transmit: *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: *OP***1** [[**PAST-t1** C]-*PAST* *OP***2** [John *be* rich-**t2**]]
transmit: *OP***1** [[**PAST-t1** C]-*PAST* *OP***2** [John *be* rich-[**t2**-*PAST*]]]
spell out: John was rich.

We included the tense's restrictor 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 our morphologist colleagues would want it. Tense gets spelled out on the copula after all, not on the adjective. We won't fret over this here.[37]

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[38]. 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 (in section 1.2, when we considered frame adverbs, cf. footnote 8). So the analysis of *John likes Mary* might be either (27) or (28). We go with (27) for simplicity, but need not commit.

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[37] A boring fix would be to give some meaning to the copula after all, just enough to let it take a world-time argument but effectively pass it on to its complement. (You can write this as an exercise.) But it may make more sense to put off the issue until we have integrated aspect, another functional head between tense and VP that we are so far ignoring. Bjorkman's 2011 MIT thesis will be relevant here.

[38] 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.

(27) John like-*OP* Mary
move operator: *OP*$_2$ [John like-**t**$_2$ Mary]]
spell out: John likes Mary.

(28) [**PRES-***OP* C] [John like-*OP* Mary]
move operators: *OP*$_1$ [[**PRES-t**$_1$ C] *OP*$_2$ [John like-**t**$_2$ Mary]]
percolate: *OP*$_1$ [[**PRES-t**$_1$ C]-*PRES* *OP*$_2$ [John like-**t**$_2$ Mary]]
transmit: *OP*$_1$ [[**PRES-t**$_1$ C]-*PRES* *OP*$_2$ [John like-[**t**$_2$-*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.[39]

(29)(a) base-generate:
PAST-*OP* [John *be* married-*OP to* [some *one* [*who be* famous-**pro**$_1$]]]

(b) move operators:
OP$_1$ PAST-**t**$_1$
OP$_2$ [John *be* married-**t**$_2$ *to* some *one who*$_6$[t$_6$ *be* famous-**pro**$_1$]]]

(c) from (b), by percolation and transmission:
OP$_1$ [PAST-**t**$_1$]-*PAST*
OP$_2$ [John *be* married-**t**$_2$-*PAST to* some *one who*$_6$[t$_6$ *be* famous-**pro**$_1$]]]

(d) from (b), by QR:
OP$_1$ PAST-**t**$_1$
OP$_2$ [[some *one who*$_6$[t$_6$ *be* famous-**pro**$_1$]] 7[John *be* married-**t**$_2$ *to* t$_7$]]

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 (30).

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[39] Throughout the following discussion, we simplify the structures by pretending that the head noun *one* is semantically vacuous. This means that the determiner *some* combines directly with the denotation of the relative clause. Notice that the types still fit, since the type of a relative clause is the same as what PM puts out. The argument that we gave above – namely that a relative clause must never contain an *OP* in its topmost type-s slot, but always a **pro** – is likewise unaffected by this simplification.

We should eventually undo the simplification, of course, and also look at examples with real lexical head nouns. This raises a number of additional empirical and theoretical issues, as already hinted in footnote 29 of section 2.3.2 above.

(30) *OP*$_{\mathbf{1}}$ PAST-$\mathbf{t_1}$
OP$_{\mathbf{2}}$ [[some *one who*$_6$[t$_6$ *be* famous-**pro**$_{\mathbf{2}}$]] 7[John *be* married-$\mathbf{t_2}$ *to* t$_7$]]

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".[40]

The system makes further predictions. One (closely related to the above) pertains to sentences with embedded future (which we set aside when we restricted our attention to the six configurations in (1) of section 2.1). 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 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 inner 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 or future. 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

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[40] Our system transmits a second uninterpreted *PAST* feature onto the pronoun that is the argument of the head noun *one* ('person'). Evidently this one has no morphological reflex. No past tense morphology appears on nouns. Let's just say that is a matter of morphology. These features may be there but never spelled out. (For a different view, see e.g. Kusumoto 2005. This relates to the discussion I referenced in footnote 27 of section 2.3.2.)

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 that's not 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. (Implicit or explicit 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-[$\mathbf{pro_2}$-*PAST*]]-*PAST* *OP*$_{\mathbf{3}}$ [t$_6$ *be* famous-[$\mathbf{t_3}$-*PAST*]]]

The left-most *PAST* (the one on $\mathbf{pro_2}$) has been transmitted from the higher clause. The second *PAST*, the one attached to the complex phrase [PAST-[$\mathbf{pro_2}$-*PAST*]], got there by percolation from the PAST-head of that phrase. And the third *PAST* (on $\mathbf{t_3}$) 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 at the beginning of section 2) 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.[41] 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*. (The copula then surfaces as a past participle form, but this is among the further morphological details that we are not attending to here.)

3. 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 ch. 6, 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.[42]

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

3.1 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-**t$_1$** *OP***$_2$**[Mary have-**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

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

[42] There is another natural way to go, which is what you find in practically all 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.

here to percolate and transmit. Recall that verbs with no tense feature are spelled out (in finite environments) as present tense.

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

(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) λi. ∃t [$t > t_i$ &
∀w [w compatible with J's beliefs in w_i at t → M has the key in w at t]]
(b) morphology: [woll-$\mathbf{t_1}$] → *will*, [have-$\mathbf{t_2}$] → *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, which we considered in the previous section, 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.

3.2. 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*$_1$[PAST-**t**$_1$ *OP*$_2$[John think-**t**$_2$ *OP*$_3$[PAST-**t**$_3$ *OP*$_4$[Mary have-**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.

(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-**t**$_1$]-*PAST* *OP*$_2$[J think-**t**$_2$-*PAST* *OP*$_3$[[PAST-**t**$_3$]-*PAST* *OP*$_4$[M have-**t**$_4$-*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-**t**$_1$ *OP*$_2$[John think-**t**$_2$ *OP*$_3$[Mary have-**t**$_3$ 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-**t**$_1$]-*PAST* *OP*$_2$[John think-[**t**$_2$-*PAST*] *OP*$_3$[Mary have-**t**$_3$ 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:[43]
[V [arg F]] becomes [V [arg F]]-F

[43] For this to work as intended, it is actually crucial that the index-argument be the innermost argument of

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-**t**$_1$]-*PAST OP*$_2$[John [think-[**t**$_2$-*PAST*]]-*PAST OP*$_3$[Mary have-**t**$_3$-*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, 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.

3.3. 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

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the verb – a decision which up to now was an arbitrary matter of exposition.

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 recent paper by from Altshuler & Schwarzschild[44], from which we will also take the key idea for our formal analysis:

"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.

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 similar idea[45], but without actually departing from our assumption that the present tense is vacuous and therefore does not shift evaluation time at all. We draw a parallel to a phenomenon with personal plural pronouns known as 'split antecedents' or 'split

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[44] (2013, Amsterdam Colloquium)

[45] 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.

binding'.[46] 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.

(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 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.

(21) $[\![\mathbf{+}]\!] = \lambda i \in D_s.\, \lambda j \in D_s.\, \langle w_i, [t_i,t_j]\rangle$,
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 $OP\mathbf{3}$.[47] 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).

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[46] refs

[47] 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.

(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 $[\![+]\!](i)(i) = i$.) 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.

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* **+** $\mathbf{pro_3}$-*PAST*]]]]
(b) .... *OP*$_{\mathbf{3}}$[Mary *be* at-home-[$\mathbf{t_3}$-*PAST* **+** $\mathbf{pro_2}$-*PAST*]]]]
(c) ... *OP*$_{\mathbf{3}}$[Mary *be* at-home-[$\mathbf{t_3}$-*PAST* **+** $\mathbf{pro_1}$]]]]

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 at all 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.[48]

[48] refs include Podobryaev 2014 MIT PhD

4. A first proposal for perfective and progressive aspect

Throughout our discussion of tense, we have ignored matters of grammatical and lexical aspect, and have mostly stuck to stative predicates. We used examples with eventive verbs occasionally, but did not consider them systematically – particularly not in the environments of present tense and SOT past, where they actually behave differently from the stative predicates that we have focused on (*be famous*, *have the keys*, *be at home*). In the present section, we begin to move towards remedying this limitation. A broader goal of this section is to map out a framework which can integrate insights from Davidsonian event semantics with insights from the traditional intensional semantics for tense and modality.[49]

4.1. Event semantics and perfective aspect

Up to now we assumed that verbs take an index (world-time pair) as their argument (in addition to their usual overt arguments expressed by DPs and complement CPs). Now we switch to a Davidsonian semantics, where one of the verb's argument is an event. (We don't review the motivations for this here; see e.g. Roger Schwarzschild's handout for 24.970 Fall 2015.) Concretely, we assume lexical entries such as (1).[50]

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

We posit a new basic semantic type for events, type v. VPs are then of type <v,t> (after all the verb's non-event arguments have been merged).

Do we need an index (world-time) argument in addition, i.e., should we amend (1) to something like (2)?

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

That depends. Here we follow Kratzer and assume an ontology according to which each event exists in just one world. Thus 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. It is also impossible for one and the same *e* to be an event of x laughing at one time and something else at another time. This being so, entries like (2) are uncalled for and we stick with (1).

How then does world and time dependence enter the semantic composition? And how can temporal and modal operators combine with VPs? VPs are now type <v,t>, but temporal and modals operators need complements of type <s,t>. The answer is: that's why we need aspect. An Aspect head intervenes between V and the higher heads along the clausal spine (including M

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[49] We share this goal with Beck & von Stechow (2014), from whom we borrow a number of ideas. See later remarks and footnotes for specific points of overlap and difference.

[50] Many versions 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 an abstract theta-role predicate that combines with the verb in the manner of a modifier. 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.

and T), and its semantic job is to bind the event argument of the VP and introduce an index-argument (which in turn can then be bound by a modal or tense).

Here is our version of a run-of-the-mill semantics for "perfective" aspect.

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

(3) combines the standard semantics of perfective aspect (Krifka 1989, Klein 1994, etc.) with the semantics of Beck & von Stechow's (2014) *Modl* head, so it introduces both a world and a time and locates the event in both. We must clarify at this point that our metalanguage variables for "times" now range over time intervals.[51] Intervals are sets of moments, so relations like subset are well defined. (But an "interval" in this technical sense does not have to be an extended stretch of time. It can also be a singleton set containing just one moment, which we call an "instant".)

Let's analyze a simple example. PFV is morphologically zero in English, and we assume for now that it is generated in every sentence that does not have progressive morphology (*be ...-ing*).

(4) (a) John laughed.
(b) base-generate: $[_{TP}$ [PAST *OP*] $[_{AspP}$ [PFV *OP*] $[_{VP}$John laugh]]]
(c) LF: $OP_{\mathbf{1}}$[PAST-$\mathbf{t_1}$ $OP_{\mathbf{2}}$[PFV-$\mathbf{t_2}$ [John laugh]]]
meaning: $\lambda i.\, \exists t\, [t < t_i \,\&\, \exists e\, [e \leq w_i \,\&\, \tau(e) \subseteq t \,\&\, \text{laugh}(e, \text{John})]\,]$
equivalently: $\lambda i.\, \exists e\, [e \leq w_i \,\&\, \tau(e) < t_i \,\&\, \text{laugh}(e, \text{John})]\,]$
(d) PF: $OP_{\mathbf{1}}$[[PAST-$\mathbf{t_1}$-*PAST*]-*PAST* $OP_{\mathbf{2}}$[PFV-$\mathbf{t_2}$-*PAST* [John laugh]]]

Notice that, even though the verb calls for an argument of type v (event), we never projected one in the syntax. This is because we chose to set up the lexical entry in such a way that the event argument comes last, and therefore all the types fit without adding more covert material. But this was an arbitrary and merely expository decision.[52]

Let's comment on the semantic computation. By mechanical application of the rules and entries,

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[51] Bennett & Partee (1972/78) were the first to show that intervals were needed in the semantics of tense and aspect for natural languages. Previous formal analysis had followed Priorian tense logic, which treated times as moments.

[52] One dubious consequence of this decision concerns morphology. You see in (4d) that the lowest transmitted *PAST* feature now no longer is on an argument of the verb, but in the Aspect head. This may may still be good enough for the morphology to deal correctly with examples like (4). That depends on one's morphosyntactic theory – see again Bjorkman 2011 for a recent proposal). But it will create a problem in conjunction with the specific analysis of SOT in complement clauses that we developed in section 3.2, because of the crucial role that "percolation in the verbal complex" played in that analysis. To solve that problem, we must project event-arguments in the syntax and moreover treat them as the *inner*most argument of the verb. But we will gloss over this here and won't in fact pay detailed attention to morphology for the remainder of this section.

There may also be other reasons to project event arguments in the syntax, for example, in order to be able to interpret indefinite quantifiers with VP-internal scope without type-shifting them.

we arrive at something with two existential quantifiers, one over times and one over events. These truth-conditions require the existence of an interval which precedes t_u (the utterance time) and which contains the run-time of a laughing-event (with agent John). Given the logic of temporal precedence and containment, this entails that the event itself (wholly) precedes t_u. In fact, it says nothing more than that. Whenever there is an event which is (entirely) before t_u, there must be some interval that contains that event and precedes t_u. Therefore we can rewrite the truth-conditions as in the last line of (c), where the existential quantifier over past times has completely dropped out.[53]

The truth-conditions we derived for (4a) look unexceptional. Obvious questions arise at this point. What about combining PFV with tenses other than PAST? What about aspects other than PFV? We postpose the first question for a while and introduce another aspect in the next section.

4.2. Imperfective aspect

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.[54] English has an imperfective aspect known as the "progressive", with an overt morphology that consists of a copula that 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.[55]

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 locates the evaluation time within the event time, or equivalently, locates the event at a super-interval of the evaluation time. If we formalize this intuition directly, without introducing any further difference from the perfective, we get (5).[56]

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[53] Mitya Privoznov asks whether this is still the case when add a frame adverb (or pay attention to the covert contextual restrictor). Let's work through that case. Suppose the sentence is *John laughed on April 1st*. Using our official entry for PAST, we compute a presupposition and an assertion.

(i) presupposition: $\lambda i.\ \exists t\ [t < t_i\ \&\ t \subseteq \text{April 1}]$

(ii) assertion: $\lambda i.\ \exists t\ [t < t_i\ \&\ t \subseteq \text{April 1st} \ \&\ \exists e\ [e \leq w_i\ \&\ \tau(e) \subseteq t\ \&\ \text{laugh}(e, \text{John})]\ ]$
equivalently: $\lambda i.\ \exists e\ [e \leq w_i\ \&\ \tau(e) < t_i\ \&\ \tau(e) \subseteq \text{April 1st} \ \&\ \text{laugh}(e, \text{John})]\ ]$

An event e is contained in a time that's both past and within April 1st iff e itself is both past and within April 1st. So at least the assertion can still be expressed without an existential quantifier over times.

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

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

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

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

It is well-known, however, that there is also a difference in how the event is related to the evaluation *world*. Perfective places the event within this world, but imperfective 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 (6).

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

We don't infer from this sentence that John actually made it, or will ever make it, to the store.[57] Maybe, maybe not. Perhaps he just said 'hi' without stopping in his tracks. Perhaps they got into a conversation, went to a café together, ... The truth-conditions of the sentence (6) are in fact compatible with these and many other scenarios. (5), on the other hand, requires 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 (5) can't be 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 in progress get interrupted ("inertia worlds"). The idea is, very roughly, that the sentence tells us that, if John didn't actually go the store, he at least *would have* gone there if he hadn't been interrupted. Since the publication of Dowty's paper, there has been an endless succession of sophisticated counterexamples and refinements to his original proposal, but this is beyond the scope of this introduction.[58] Here is a version based on Dowty.[59]

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

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[57] 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.

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

[59] This is the same as Beck & von Stechow's (37), modulo correction of a typo. In their (37), $\subseteq$ should be $=$. (Otherwise no substantive constraint would be placed on the temporal location of the event at all.) With this, their (37) simplifies to (i).

(i) $\lambda w.\ \lambda t.\ \lambda P_{<s,vt>}.\ \forall w'\ [w\ \text{INERT}_t\ w' \rightarrow \exists e\ [t \text{ is a non-final part of } \tau(e)\ \&\ e \leq w'\ \&\ P(w')(e) = 1]\ ]$

Apart from notation and details due to their slightly different framework (separate world and time variables instead of index-variables, use of a Modl head), (i) is the same as (7).

Apart from introducing quantification over other worlds, (7) also differs from (5) 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. (6) is not appropriate if John already reaches the store at or during his encounter with Mary; see Dowty (1977) for discussion.

(8) 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 (7) come very close to those predicted by the simpler (5). But examples like (6) show that this must not always hold.

Let's do a simple example.

(9) (a) John is laughing.
(b) base-generate: $[_{TP}\ [_{AspP}\ [\text{bePROG}\ OP]\ [_{VP}\text{John laugh}]\ ]\ ]$
(c) LF: $OP_{\mathbf{1}}[\ \text{bePROG-}\mathbf{t_1}\ [\text{John laugh}]\ ]$
$\lambda i.\ \forall w\ [w \in \text{Inert}(i) \rightarrow \exists e\ [t_i \subseteq \tau(e)\ \&\ \text{RB}(\tau(e)) > t_i\ \&\ e \leq w\ \&\ \text{laugh}(e, \text{John})]\ ]$

Just as it stands, (9c) does not logically entail that any laughing happens in the world w_i, i.e., in the utterance world w_u if (9a) 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 $\text{Inert}(w_u, t_u)$, say w. If (9c) is true in w_u at t_u, it follows that w_u 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.[60] 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 (9a) that there is *actual* laughing at the utterance time.

This is the kind of example for which (7) and the earlier extensional entry (5) predict almost identical truth conditions. (7) 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 $w \in \text{Inert}(i)$ contains an event of John going to the store which happens at 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*

[60] 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.

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 ((4) in the previous section), but a *present* tense example, (9), for the progressive in the current section. Indeed, it is incumbent upon us to examine what the current theory predicts for every possible combination of a tense and an aspect.

4.3. 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 (10) are spontaneously judged as odd by speakers of English.

(10) (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 denote a proposition, so the aspect must be PFV. With present tense semantically vacuous, we then have derivations like (11) for (10c).

(11) base-generate: $[_{TP}\ [_{AspP}\ [PFV\ OP]\ [_{VP}$John go to the store$]\ ]\ ]$
LF: $OP_{\mathbf{1}}[$ PFV-$\mathbf{t_1}$ [John laugh$]\ ]$
meaning: $\lambda i.\ \exists e\ [\tau(e) \subseteq t_i\ \&\ e \preceq w_i\ \&$ 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 a lot longer than the production of such a short sentence. One may be tempted to attribute the strangeness of (10c) to this fact. But upon reflection, that doesn't look like the right kind of 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 (10c) is not really affected by such manipulations in the way we would expect it to be if pragmatic plausibility were all that mattered. And the pragmatic explanation looks even less promising when we consider the other examples in (10). Waking-up events are very short, if not instantaneous, so such events should have no problem fitting inside the utterance time and (10b) should be just fine. As regards (10a), 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 a laughing event within the utterance time, and (10a) should be true and acceptable.

Friends of pragmatic approaches like to remind us that the examples in (10) are not ungrammatical. Sentences of this kind 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.[61] It is appealing to say that the essence of (at least some of) these special uses amounts to a pretense that the utterance 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.[62] At any rate, it does not directly address the question why (10a - c) are unacceptable *outside* of these special registers or contexts. One needs 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)[63], 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.[64] To get the desired mileage out of this assumption, we must also sharpen some specifics regarding the lexical meanings of verbs.[65] These assumptions are not uncontroversial, but widely accepted in the literature: None of the VPs in (10) 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

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[61] 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. Either way, the question whether PFV could apply to the output of this operator either doesn't arise in the first place (beacuse there already is an aspect), or else it falls together with the broader question of whether PFV can combine with stative VPs, which we turn to shortly. (Some kind 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.)

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

[63] 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).

[64] As Milo Philipps-Brown pointed out, one worry abour 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.

[65] 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.

for clauses with PFV (as computed in (11)) 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 (10) to stative ones, of course, the simple present tense becomes perfectly fine.

(12) (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 (12) have the exact same parses as those in (10), with a perfective aspect head, and yet they have truth-conditions which can be satisfied by an instant.

(13) LF: $OP_{\mathbf{1}}$[PFV-$\mathbf{t_1}$ [John *be* tired]]
meaning: $\lambda i.\ \exists e\ [\tau(e) \subseteq t_i\ \&\ e \leq w_i\ \&$ tired(e, 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 (?) 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.[66]

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 tense. These environments include the infinitival complements of verbs like *believe* and *claim*, as well as tensed complements of attitude and speech verbs which exhibit an SOT past.[67]

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[66] 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.)

[67] The stativity effect in SOT and infinitival environments was first discussed by S. Gennari (1999, Brown U PhD, also in Corblin, F., Dobrovie-Sorin, C., and Mandarin, J. (eds.) *Empirical issues in*

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

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

(16) (a) John believed that Mary laughed/ went home.
(*simultaneous reading, ok back-shifted reading)
(b) John believed that Mary was at home/ was laughing.
(ok simultaneous reading, ok back-shifted reading)

(17) (a) John said that Mary laughed/ went home.
(*simultaneous reading, ok back-shifted reading)
(b) John said that Mary was at home/ was laughing.
(ok simultaneous reading, ok back-shifted reading)

The pattern here is just the same as in matrix presents. Whatever explains the latter should generalize to the former. It evidently will not be sufficient here to say something about the nature of utterance times. The relevant predicates in (14) - (17) are not interpreted at the utterance time of the sentence.

Let us focus on the finite complements in (16) and (17), since these are what we were dealing with in previous sections of this chapter.[68] As we try to integrate our earlier analysis of attitude and speech verbs with the current event-based framework, we must first rewrite their lexical entries. Recall the pre-Davidsonian versions.

(18) $[\![\text{believe}]\!] = \lambda i_s.\ \lambda p_{\langle s,t\rangle}.\ \lambda x_e.\ \forall w[w \text{ is compatible with x's beliefs in } w_i \text{ at } t_i \rightarrow p(w,t_i) = 1]$
$[\![\text{say}]\!] = \lambda i_s.\ \lambda p_{\langle s,t\rangle}.\ \lambda x_e.\ \forall w[w \text{ is compatible with what x says in } w_i \text{ at } t_i \rightarrow p(w,t_i) = 1]$

Now we need to write something of the form "$\lambda p_{\langle s,t\rangle}.\ \lambda x_e.\ \lambda e_v.$ ....", where *e* ranges over eventualities – presumably events in the narrow sense for *say* and states for *believe*. Here is how this is done.

(19) $[\![\text{believe}]\!] = \lambda p_{\langle s,t\rangle}.\ \lambda x_e.\ \lambda e_v.\ [e \text{ is a state of x believing something } \&$
$\forall w[w \text{ is compatible with what x believes in } e \rightarrow p(w, \tau(e)) = 1]]$

(20) $[\![\text{say}]\!] = \lambda p_{\langle s,t\rangle}.\ \lambda x_e.\ \lambda e_v.\ [e \text{ is an event of x saying something } \&$
$\forall w[w \text{ is compatible with what x says in } e \rightarrow p(w, \tau(e)) = 1]]$

Notice that we refer to $\tau(e)$, the run-time of the belief-state or saying-event, in the argument of the complement proposition p. In (18), we had mentioned t_i twice, once as the time at which the believing/saying takes place and once as the time in the argument of p. Now there is no index-argument from which we could pick out a time-coordinate. But fortunately there is a uniquely determined run-time for each eventuality.

So what about the stativity effect for simultaneous readings that we observed in (16) - (17)?

Formal Syntax and Semantics 2, Berne, France, Peter Lang.)

[68] But what we will say carries over to (14) - (15), once we make the assumption that the infinitives lack T and M projections and are therefore just AspPs. (This is not a tenable analysis for all infinitival complements to all attitude and speech verbs, but it may be essentially correct for the infinitives that are selected by these particular verbs.)

What does our current set of assumptions have to say about this? Let's start with the *say*-sentences. For a simultaneous reading (which morphology spells out as past under past[69]), we have no semantic tense in the complement. The highest interpreted head in the lower clause is the aspect head. If that head is PFV, the LF and interpretation come out as in (21).

(21) OP_1[PAST-$\mathbf{t_1}$ OP_2[PFV-$\mathbf{t_2}$ John say OP_3[PFV-$\mathbf{t_3}$ VP]]]
$\lambda i. \exists e [\tau(e) \subseteq t_i \ \& \ e \leq w_i \ \& \ e$ is an event of John saying something $\&$
$\forall w [w$ is compatible with what John says in e
$\rightarrow \exists e' [\underline{\tau(e') \subseteq \tau(e)} \ \& \ e' \leq w \ \& \ [\![VP]\!](e') = 1]]]$

The crucial part is underlined. This is the contribution of the embedded perfective, which says that the event described by the lower VP is temporally located inside the run-time of the saying event. Under what conditions is this possible? By the assumptions we laid out in the discussion of (10) vs. (12), it should be *im*possible only when [[VP]] is not stative and τ(e) is an instant. So if we wanted to rule out the bad cases in (17) by the same logic as the bad matrix sentences in (10), we would have to assume that the τ(e), the event-time of the matrix verb, is necessarily an instant.

This sounds like a natural generalization of the idea that the utterance time is an instant. Here, after all, we are dealing with the time of another utterance – not the speaker's own, but the utterance of John's that the speaker is reporting. Why not say then that all utterance times, both of utterances being performed and of utterances being talked about, are conceptualized as instants? Yet, this gives rise to something of a contradiction in the theory. If the time of John's saying is or can be an instant, shouldn't the matrix *say*-VP itself show the behavior of a stative predicate? This does not seem to be so. The matter is a bit complicated, because verbs like *say*, *tell*, etc. do allow an apparently stative use of some sort, which makes them usable in the simple present tense. (*Danny says that you have a new paper on SOT. Can I see it?*) But we can force an eventive reading, e.g. with modifiers (*in a loud voice*, *slowly*), or we can switch to a more consistently eventive verb like *announce*. But we still get the stativity effect for simultaneous readings of the complement.

(22) John announced/ said in a loud voice that he #got up/^{ok}was getting up from the chair.
(# = *simultaneous reading)

Next let's turn to stative attitude verbs like *believe*. We have said that stative predicates are true of eventualities (states) whose run-times are instants. But we have *not* said that they are true *only* of states that occupy instants. So for example the matrix VP of one of the ungrammatical simultaneous readings in (16) has the LF-representation in (24a) and denotes the function of type <v,t> computed in (24b).

[69] See earlier footnote re how feature traffic has to work for this to get the SOT morphology. (As noted, one needs to project event-arguments in the syntax and as sisters to the verb.)

(24) (a) John believe OP_3[PFV-$\mathbf{t_3}$ Mary laugh]

(b) λe [e is a state of John believing something &
$\forall w$ [w is compatible with what John believes in e
$\rightarrow \exists e'$ [$\underline{\tau(e') \subseteq \tau(e)}$ & $e' \leq w$ & laugh(e', Mary)]]]

For all we have said, the predicate in (24b) can be true of belief-states of various durations, including some that are certainly long enough to contain a laughing event (as required by the underlined part of (24b)). So we fail to predict the stativity effect here as well.[70]

We haven't looked at double access sentences, and these too pose a problem, maybe even the most dramatic one. The empirical fact seems to be that double access readings require stative or progressive complements as well. But the embedded evaluation time in this case is *always* a lengthy interval (regardless of the duration of the reported thought or speech event), because it is defined as stretching from the reported thought-speech to the utterance time. Such an interval should easily contain within it run-times of events like laughing, waking up, and even going to the store. It remains a mystery why a stativity effect should obtain in this environment.

In summary, our discussion in this section has not come to a satisfying conclusion. We first laid out an approach to the stativity effect in matrix present-tense sentences and then asked whether this approach would naturally extend to parallel data in embedded environments. The answer seemed to be no. Perhaps this was due to inadequacies in our analysis of the relevant embedding constructions. Or perhaps it was because we were not on the right track in the first place with the idea of treating utterance times as instants. Ogihara (2005), for example, avoids that assumption and suggests a very different approach. Letting utterance times be the extended intervals that they seem to be, he builds universal quantification over instants into the meaning of the present tense. That doesn't help us much, of course, if it is literally just about present tense in the morphological sense. But maybe the idea can be recast in terms of a kind of imperfective aspect which obligatorily appears whenever there is no temporal operator in the clause? More work is required.

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[70] In class (and in the previous version of these notes) I claimed that the effect was explained by the fact that *believe* is stative and therefore, like all stative predicates, creates a "strict subinterval" predicate. As Kai pointed out to me afterwards, however, this was getting it backwards. What I had shown was that, *if* the *believe*-VP is a strict subinterval predicate, then the embedded proposition cannot be a perfective non-stative. But the proper conclusion to draw from this observation is simply that our lexical entry for *believe* does not guarantee that *believe*-VPs are always strict subinterval predicates. It predicts instead that some of them are and some of them aren't, depending on the content of the embedded proposition. Putting it another way, if we insist that every VP headed by *believe* is a strict subinterval predicate, we are in fact making a claim about the meaning of *believe* which does not follow from the lexical entry in (19). We would have to amend to lexical entry in order to make it follow. There are ways of doing this, but if we go that route, we haven't really *explained* anything. As Maša Močnik pointed out in class, once we allow ourselves to rewrite the entries of *say* and *believe*, it is not difficult to do this in a way which will force the propositional argument (p) to be evaluated at an instant. I replied to her that this amounted to stipulating the stativity effect into the entries of the verbs. But as Kai convinced me, that criticism applies with equal force to my "explanation" in terms of the subinterval property.

4.4. Referential tense after all?

Having enriched the system with aspect, we must revisit Partee's stove and the prospects of a "referential" theory of tense. Our earlier discussion of Partee's example converged on the conclusion that we did need an existential quantifier over times, albeit a contextually restricted one. The stove-example was interpreted as about a particular contextually relevant interval. But the speaker's claim was not 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 subinterval of the contextually relevant interval. Her claim was stronger: she did not turn off the stove at *any* time *within* this interval. That is a negative existential claim. So there needs to be an existential quantifier in the LF, and we concluded that past tense does not simply refer to an interval.

But that whole discussion (as well as its historical precedents from Partee and Stalnaker in 1973 through Ogihara 1996) was premised on the assumption that tense combined directly with the VP. Aspect was not in the picture, and in particular the presence of a covert perfective aspect between the past tense and the verb was not entertained as a possibility. Now that we posit this more complex structure, the earlier argument for an existential-quantifier analysis of tense is no longer valid in this form. In section 4.1. we saw, in fact, that the truth-conditions of a sentence with PAST and PFV boil down to a statement with a single existential quantifier, over events. This suggests that we may be able to redesign our compositional semantics in such a way that only one layer of quantification is derived in the first place. Let's spell this out ...

.... another time.