The Semantics of Tense in Embedded Clauses

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1. Preliminaries

Enç (1987) proposes anchoring conditions for tense based on the assumption that tense is a referential expression. This article is intended as a response to her proposal. Before discussing tense morphemes which occur in embedded clauses, with which Enç is mainly concerned, I will briefly consider what tensed simple sentences mean. They clearly convey some information about time, but it is open to debate what specific temporal information they provide. Previous proposals regarding this question fall into two major groups: those that assume that a tensed sentence without an adverbial *always* exhibits quantificational force and those that do not.

In the tradition of formal semantics, the interpretation of a sentence in the past or future tense was assumed to involve existential quantification over times. Consider (1):

(1) John coughed.

Montague's PTQ system (1973)[1] predicts that (1) is true if and only if there is some past time *t* such that John coughs at *t*.[2] Dowty (1979) extends this proposal to deal with temporal adverbials.[3] Consider the following example:

(2) John coughed yesterday.

Assuming that a simple sentence in the past tense involves existential quantification over

past times, we can describe the truth conditions of (2) in the following way: there is a past time *t* such that *t* is part of yesterday and John's coughing obtains at *t*. That is, an existential assertion about a time is made by the entire sentence and the contribution of the adverb is to restrict the temporal location of the event in question, as in (3):

(3) $\exists t$ [*t* lies before now & *t* is part of yesterday & John coughs at *t*]

There are further complications associated with the interpretation of tensed sentences. Bäuerle (1979: 66-69) discusses some German sentences that contain two types of adverbials at the same time: temporal adverbials like *gestern* 'yesterday' and frequency adverbials like *einmal* 'once'. I will illustrate the point Bäuerle makes using the following English example:

(4) John coughed twice yesterday.

(4) says that there are two past times such that they fall within yesterday, and John's coughing obtains at each of these two times. It is clear that the existential assertion about *two times* is induced by the frequency adverbial *twice*. Examples like (4) lead Bäuerle to claim that frequency adverbials are responsible for existential quantification over times.[4] When a sentence has no overt frequency adverbial, a silent adverbial (*at least*) *once* is assumed to be there, supplying the quantificational force.[5] The proposals made by Montague, Dowty, and Bäuerle differ from each other in details, but they all agree that tensed simple sentences exert an existential quantificational force over times in one way or another. They are subsumed under a common denominator: the quantificational theory of tensed sentences.

Partee (1973) was the first to draw an analogy between pronouns and tenses. For instance, she points to the similarity between the so-called deictic use of pronouns (or "referential" pronouns) and some occurrences of the English tense morphemes. If (5) is uttered by a man sitting alone with his head in his hands, *she* is said to be used deictically (Partee 1973: 603):

(5) She left me.

The analysis assumed here is that the pronoun *she* translates into a free variable at the logical representation level and receives as its value an individual that is salient in the context. In other words, no quantification is involved in the interpretation of the pronoun. As Partee points out, (5) shows that it is not necessary for deictic pronouns to be accompanied by gestures. She goes on to claim that some occurrences of the English tense morphemes are similar to the use of *she* in (5) in that they refer to particular intervals without being accompanied by gestures. Thus, they should likewise translate into free variables and receive contextually salient intervals as their values. For example, such an analysis turns (6a) into a logical representation that is informally given here as (6b), where *t* is a time variable.

(6) a. (A: What happened then?) B: John coughed.

b. *t* lies before the speech time & John coughs at *t*.

A certain specific value, which can be thought of as a contextually salient interval, is assigned to the free occurrences of the time variable in the process of semantic interpretation. Just as in the case of deictic pronouns, no quantification over times is involved here. Partee (1973) does not claim that all uses of English tenses are like

referential pronouns; she presents other parallels between pronouns and tenses. Thus, for the purpose of this paper, the theory that assumes that there are *some* uses of English tenses that are analogous to referential pronouns will be referred to as the "referential theory of tensed sentences."

In what follows, I will defend the quantificational theory of tensed sentences and show that the referential theory of tensed sentences, in particular the version advocated by Enç (1987) and applied to the sequence-of-tense (SOT) phenomenon in English, is inadequate. I will propose a syntactic rule that serves to delete a past tense morpheme locally c-commanded by another past tense at LF. In the semantic component, I propose a *de se* analysis of so-called propositional attitudes following Lewis (1979), which accounts for the semantics of tense in verb complement clauses. My proposal will be discussed in detail in section 3.3.

2. Tensed Sentences without Adverbials

The above discussion shows that sentences with accompanying adverbials generally involve some type of existential quantification over times. Therefore, I would like to investigate in this section which of the two theories presented above best accounts for the interpretation of sentences with no accompanying adverbials.

For the purpose of this article, I will employ a logical representational language that has the following properties: (i) English sentences are translated into a version of IL (intensional logic), and IL formulas are model-theoretically interpreted; (ii) this framework is similar to Montague's PTQ (1973), except that predicates have an "extra" argument position filled by a temporal term. For example, *wake up* translates into *wake-up'*, which is a two-place predicate requiring a "normal" term (denoting an individual) and a temporal

term (denoting a time interval) as its arguments. The overall system works in the following way: the extension of a constant is determined with respect to a model and a world, whereas the extension of a variable is determined by a context-sensitive value assignment *c*.[6] It is context-sensitive in that it assigns to a time variable *t* some time interval which is salient in the context.[7] For example, $[\![\text{wake-up}']\!]_{w,c}$ (the denotation of *wake-up'* with respect to a world *w* and a value assignment *c*) is the following set of time-individual pairs: {<*t*,*x*> | *x* wakes up at *t* in *w*}.[8, 9] $[\![t]\!]_{w,c}$ (the denotation of the variable *t* with respect to *w* and *c*) is *c*(*t*), that is, the interval the context assigns to *t*. According to this notational system, the difference between the quantificational theory of tense and the referential theory of tense is represented in the following way:

(7) a. John woke up.
b. John PAST wake up.
c. $\exists t[t < s^* \ \&$ wake-up' $(t, j)]$
d. $t < s^* \ \&$ wake-up' (t, j)

I assume (7b) to be the underlying syntactic structure of (7a). The quantificational theory translates it into (7c), whereas the referential theory turns it into (7d). (7c) reads: there is a time *t* located before the speech time (indicated by the special constant *s**) such that John wakes up at *t*.[10] The model-theoretic interpretation of (7c) is carried out in the usual way, except that *wake-up'* is treated as a two-place predicate requiring a temporal argument as well as a "normal" argument. Unlike (7c), (7d) is an open formula and contains two free occurrences of the time variable *t*. They receive as their value a contextually salient interval from the assignment *c*.

There is evidence that the interpretation of tensed sentences without accompanying adverbials involves existential quantification over times. Assume that John, Bill and Mary are colleagues working in the same office, and consider (8):

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

John's question cannot be taken as a question about the entire past interval; since Bill and Mary are colleagues, it is obvious that Bill saw Mary many times in the past. It should rather be taken as a question that concerns a contextually salient interval, perhaps the day on which the conversation took place. Note that Bill's answer does not assert that his seeing Mary obtained throughout this contextually-salient past interval. Rather, Bill asserts that he saw Mary *sometime within* this interval. Thus, the fact that the temporal information conveyed by (8) is contextually restricted should not lead us to conclude that the referential theory of tense is called for to account for the data. We need both an existential quantifier and a contextual restriction upon its quantificational force to represent the meaning of Bill's italicized statement. In other words, we should adopt a version of the quantificational theory that allows us to restrict the quantificational force of existential quantifiers. Compare (9a) and (9b), which symbolize the predictions made by the quantificational analysis with a contextual restriction on the one hand, and the referential analysis on the other:

(9) a. $\exists t[t < s^* \ \& \ t \subseteq t_{R_1} \ \&$ see' $(t, I, m)]$
(quantificational analysis + contextual restriction)
b. $t < s^* \ \&$ see' (t, I, m) (referential analysis)

In order to represent the desired interpretation, we need to assume that a contextually supplied interval serves to restrict the quantificational force of the existential quantifier. t_{R_1} in (9a) fulfills this function. It is a free time variable whose value is the time interval that is salient in the given context, say, the day in question. The formula $t \subseteq t_{R_1}$ reads "the value of *t falls within* the value of t_{R_1}."[11] The entire formula reads "there is a past time interval *t* that falls within a contextually salient time t_{R_1} such that I see Mary at *t*." This represents the desired interpretation. By contrast, if we pursue the referential theory, as we did in (9b), we predict that the sentence is true if and only if I saw Mary *throughout* some contextually salient past interval. This is not what is conveyed by Bill's answer.

Partee (1984: 276) concedes that there is no perfect analogy between pronouns and tenses. Following Bäuerle (1979), she says that it seems best to acknowledge both the quantificational force of tensed sentences and the contextual restriction imposed on it by items such as adverbials. Even if we find examples in which the time of the event described in a sentence corresponds exactly to the salient interval in the context, this can be handled by the quantificational theory. For example, if we assume that t_R in (9a) denotes an "instant" (technically, a singleton set of times), there is only one temporal object that can satisfy the condition stated by the formula, namely the denotation of t_R itself. This is truthconditionally equivalent to what is predicted by the referential theory. We have so far looked at simple sentences with and without accompanying adverbials and concluded that the quantificational theory is superior to the referential theory regardless of whether accompanying adverbials are present.

3. The Sequence-of-Tense Phenomenon

Despite the problems associated with the referential theory discussed above, Enç (1987) claims that it accounts for the SOT phenomenon in English when accompanied by her "anchoring conditions for tense." Although Enç discusses the SOT phenomenon in relative clauses as well as in verb complement clauses, I will only be concerned with the latter in this article. The SOT phenomenon refers to a situation where a past tense occurs immediately under another past tense, but the lower past tense is interpreted as referring to a time *simultaneous* with the time referred to by the higher past tense. Consider (10a-b):

(10) a. John said that Mary was sick.

b. John-wa [$_S$Mary-ga byooki-da] to it -ta.
TOP NOM be-sick PRES that say PAST
'John said that Mary was sick [simultaneous interpretation only].'

(10a) exemplifies the SOT phenomenon in English. Both the main clause and the verb complement clause are in the past tense, and its default interpretation is that the time at which Mary is allegedly sick is simultaneous with the time of John's utterance. Let us henceforth refer to this type of interpretation as a *simultaneous interpretation*. This phenomenon is indeed remarkable when compared with (10b), which is the Japanese equivalent of the simultaneous interpretation of (10a). Note that (10b) has a present tense morpheme in the verb complement clause. The traditional grammarian's view (e.g., Jespersen, 1909-1949) is that the English fact is unexpected and that a special syntactic rule must be posited in English to account for it: an SOT rule.[12]

(10a) also has a *shifted interpretation*, where the time of Mary's being sick is prior to the time of John's saying. This interpretation is not salient (or impossible, according to some native speakers) unless (10a) is accompanied by an appropriate adverbial, for example, *the day before*.

3.1. Arguments for the Traditional Sequence-of-Tense Rule Analysis

The standard argument for the traditional treatment of the SOT phenomenon in English asserts that the simultaneous reading of (10a) can be paraphrased with the following sentence, which is a direct discourse:

(11) John said "Mary is sick."

(11) gives us the following information: (i) John's utterance took place in the past; (ii) the quote repeats his actual utterance verbatim, which is in the present tense; (iii) since sentences in the present tense are normally used to talk about the time of the utterance, the time of Mary's being sick is simultaneous with the time of John's utterance, which is located in the past. That is, John's utterance took place in the past and the state that it describes (i.e., Mary's being sick) is "present" with respect to the time at which it was made. This line of reasoning is attractive from the semantic point of view: tense morphemes are interpreted in relation to other tense morphemes that are located in structurally higher positions. Given that (10a) has an interpretation that (11) entails, the embedded clause of (10a) is expected to be in the present tense. However, it is in the past tense. Therefore, assuming that (11) directly mirrors the semantic structure of (10a), we need a syntactic rule that converts a present tense morpheme into a past tense morpheme if

and only if it is "in the scope of" another past tense.[13] The discussion so far implicitly presupposes a grammatical framework in which the semantic rules apply before this "tense conversion transformational rule" often referred to as an SOT rule does (e.g., the Aspects framework (Chomsky 1965)). In contrast to the English example (10a), the Japanese example (10b) has a present tense morpheme in the verb complement clause and receives a simultaneous interpretation. This means that the above line of reasoning concerning semantics is valid for both English and Japanese; the difference between English and Japanese with respect to tense is restricted to whether they have an SOT rule.

3.2. Enç's Proposal

Enç (1987) proposes "anchoring conditions for tense," which serve to account for the semantics of tense morphemes in general and the SOT phenomenon in English in particular. Enç's account involves the following claims: (i) the referential theory of tense is adopted in place of the quantificational theory of tense; (ii) no SOT rule is posited in the syntax; (iii) the SOT phenomenon is accounted for by tense binding. Enç argues against the traditional SOT theory on several grounds. One is that an SOT rule makes the meaning of tense morphemes opaque and, to that extent, is unmotivated. The traditional SOT analysis, in effect, says that we have two past tense morphemes (i.e., the "real" past tense morpheme and the "dummy" past tense morpheme) that are homophonous. Enç's program is to posit only one past tense morpheme, which receives a constant temporal interpretation: "located in the past of some well-defined interval."

Let us see how this is accomplished in her proposal. Consider (12), which was presented earlier as (10a):

(12) John said that Mary was sick.

(12) has two interpretations: a simultaneous interpretation and a shifted interpretation. Let us first consider the simultaneous interpretation of (12), which is predicted by the following indexed structure:

(13) [$Comp_0$ John $\underline{\underline{PAST_1}}$ say [[$_{Comp}$ that] Mary $\underline{\underline{PAST_1}}$ be sick]]

Enç's proposal dictates that every tense be "anchored," and she goes on to explain when a tense morpheme is anchored. A tense is anchored if it is bound within its governing category.[14,15] A tense α binds another tense β if and only if α c-commands β and they are co-indexed. The matrix tense in (13) has no governing category, so it must be anchored in some other way. A tense can also be anchored if its local Comp is anchored. A Comp β is the local Comp of a tense α if and only if β governs α or β governs a tense γ and γ binds α (Enç 1987: 647). In (13), the matrix Comp is the local Comp of the matrix tense, and Enç stipulates that the matrix Comp, which has no governing category, is anchored if and only if it receives the speech time as its value. (A Comp that has a governing category is anchored if and only if it is bound within its governing category.) The matrix Comp in (13) has index 0, which is interpreted as denoting the speech time. Thus, the matrix clause tense is anchored. When a local Comp of a tense morpheme has a temporal index (i.e., receives as its value a time interval), the tense morpheme must stand in a certain relation to the Comp. For example, a past tense morpheme must denote an interval located earlier than that denoted by its local Comp. The matrix past tense in (13) then must denote a time earlier than the speech time, namely the time denoted by the matrix Comp. This takes care of the fact that the event described in the matrix clause, John's saying, is located in the past of the speech time.

The more important aspect of the interpretation of (13) is that the state of Mary's being sick is understood as being simultaneous with the time of John's saying. The idea here is that this can be explained by a principle similar to the principle A of the Binding Theory: the embedded past tense is anchored because it is bound by the matrix tense within its governing category. Semantically, any two expressions bearing the same temporal index are interpreted as denoting the same time interval. This accounts for the simultaneous interpretation of (12). Under Enç's definition of local Comp, when a past tense α binds another past tense β as in (13), a local Comp of α is also a local Comp of β. Therefore, β must denote a time earlier than what a local Comp of α denotes. This requirement guarantees that β indeed behaves like a "real past tense" because the past tense in the complement clause must denote a time earlier than the speech time. Hence, Enç does not need a special syntactic rule to account for the SOT phenomenon.

Next, I will consider (14), which is another indexed structure of (12):

(14) [Comp_0 John say $\underline{\underline{\text{PAST}_1}}$ [[$_{\text{Comp}_1}$ that] Mary be $\underline{\underline{\text{PAST}_2}}$ sick]]

The matrix past tense is interpreted as denoting a time earlier than the speech time as in (13). (14) differs from (13) in that its embedded past tense is not bound. It is anchored because its local Comp, the Comp in the lower clause, is anchored by being bound by the matrix tense. As mentioned above, when a tense is not bound by another tense, it must stand in a prescribed relation to its local Comp. Thus, the embedded tense must denote an interval located earlier than the interval denoted by its local Comp; the denotation of the index 2 must precede the denotation of index 1. This results in a shifted interpretation: Mary had been sick before the event of John's saying obtained.

So far I have assumed that Enç's indexed syntactic structures are semantically interpretable and have discussed their interpretation in informal terms. Since my primary

purpose is to discuss semantics in truth-conditional terms, it is necessary to make explicit the interpretations that Enç has in mind. Since Enç does not say explicitly how the indices are model-theoretically interpreted, I will propose a formal semantic mechanism that interprets the indexed syntactic structures generated by Enç's system. I believe that this makes Enç's proposal not only formally explicit but also amenable to comparison with alternative proposals, such as my own to be presented later. Given Enç's own remark that it is a referential theory of tense, I trust that the following rendition of her theory does justice to her theory.

Let us first consider (13). I make several assumptions here: (i) instances of the same index translate into instances of the same variable in the logical representation; (ii) verbs like *say*, which take a sentential complement, denote a relation between agents and propositions;[16] (iii) no existential quantifier binds time variables that represent the interpretation of tense, and the context assigns appropriate values to the free time variables; (iv) propositions are assumed to be sets of worlds. (i) and (ii) are standard in formal semantics. (iii) comes from Enç's own description of her proposal, and the standard formal semantic interpretation of referential expressions explained above. (iv) is not adopted in PTQ but is a natural proposal to adopt when the time of the event/state described in the embedded clause is specified by a referential expression.[17] Given these assumptions, (13) translates into (15):[18]

(15) $t_1 < s^*$ & say' (t_1, j, ^ [$t_1 < s^*$ & be-sick' (t_1, m)])

In my notational system, *say'* denotes in any world a three-place relation involving an interval, an agent, and a proposition.[19] Unlike PTQ, the "^" symbol is used in this system to construct an expression whose denotation is a function from worlds, not from world-time pairs, to truth values. Thus, a proposition is denoted by an expression of the form

$\hat{}\varphi$ (where φ is a formula), which denotes a set of worlds. In (15), the proposition to which John stands in the saying relation is denoted by $\hat{}[t_1 < s^* \ \&$ *be-sick'* $(t_1, m)]$. The proposition in question, then, is $\{w \mid c(t_1)$ is located before the speech time and Mary is sick at $c(t_1)$ in $w\}$.[20] Note that the time of John's saying and the time of Mary's being sick are both represented by the free occurrences of the same variable t_1. As we assumed above, the context assigns an appropriate time interval to these two free occurrences of t_1. In this way, Enç's proposal accounts for the simultaneous interpretation associated with (12).

Let me turn to the interpretation of the other indexing possibility. (14) translates into the following open formula:[21]

(16) $t_1 < s^*$ & say' $(t_1, j, \hat{} [t_2 < t_1$ & be-sick' $(t_2, m)])$

The time of Mary's being sick is not simultaneous with the time of John's saying under the shifted interpretation of (12); the former must be located earlier than the latter. Thus, two different time variables occur in the translation of the embedded clause. As (16) shows, both of these two time variables, t_1 and t_2, are free in the translation of the embedded clause. (16) says that $c(t_1)$ lies before the speech time and that John stands in the saying relation at $c(t_1)$ to the proposition $\{w \mid c(t_2)$ is located before $c(t_1)$ and Mary is sick at $c(t_2)$ in $w\}$. Note that the values of t_1 and t_2 are both fixed by the context. As the time of John's saying is simultaneous with the time prior to which Mary's sickness is located (i.e., $c(t_1)$), it follows that the time of Mary's sickness precedes the time of John's saying. Thus, Enç's proposal accounts for the shifted reading associated with (12) as well.

(15) and (16) incorporate the three ingredients of Enç's proposal, which I touched upon above. First, neither (15) nor (16) has existential quantifiers. Thus, no quantification over times is involved. The free time variables occurring in them receive

values from the context. As mentioned earlier, this is analogous to the standard formal semantic interpretation of referential pronouns. Second, no SOT rule is posited in the syntax to account for the SOT phenomenon. And third, the anchoring conditions for tense account for the SOT facts. By accounting for the SOT phenomenon without positing an SOT rule, Enç was able to say that past tense has one constant interpretation. We shall see later that a closer scrutiny of Enç's proposal discloses that it has some shortcomings. However, before starting a critical examination of Enç's proposal, let me present my own.

3.3. A New Proposal

I will adopt the traditional view that a special syntactic rule (an SOT rule) is needed to account for the SOT phenomenon. There are several ways of implementing the SOT rule in a contemporary framework. I will offer one possible implementation in the so-called upside-down Y model proposed by Chomsky and Lasnik (1977). One feature of this theory that is important for our purposes is that all syntactic operations, including such transformational operations as an SOT rule, must have been applied to the syntactic structure before it can be semantically interpreted. For simplicity, I will only discuss SOT examples in which the SOT phenomenon is triggered by a tense morpheme.[22] Assume that English tense nodes expand as in (17) and that present and past tense morphemes are inserted freely at D-structure:

(17) Tns → PRES
PAST

The SOT rule optionally applies at LF before the syntactic structure is model-theoretically interpreted. The rule is defined as follows:

(18) A tense morpheme α can be deleted if and only if α is locally c-commanded by a tense morpheme β (i.e., there is no intervening tense morpheme between α and β), and α and β are occurrences of the past tense morpheme.[23, 24]

The SOT rule turns (19a) into (19b):

(19) a. John PAST say that Mary PAST be sick

b. John PAST say that Mary Ø be sick[25]

The embedded clause with a null tense node can be thought of as a tenseless sentence. For my own proposal, I will assume with Montague (1973), Dowty (1979) and others that a proposition is a set of world-time pairs. Then the intension of a tenseless sentence is simply a set of world-time pairs at which the sentence is true. Thus, assuming that *say'* is a three-place predicate requiring an interval, an individual term, and a proposition, (19b) translates into (20):[26]

(20) $\exists t_1[t_1 < s^* \ \& \ t_1 \subseteq t_{R_1} \ \&$ say' $(t_1, j, \hat{}[$be-sick' $(m)])]$

Note that the embedded clause translates into the expression $\hat{}$[*be-sick'* (*m*)], which denotes the following set of world-time pairs: {<*w*,*t*> | Mary is sick in *w* at *t*}.[27] Recall that in my rendition of Enç's proposal given above, the time of John's saying and the time of Mary's being sick are represented by two occurrences of the same (free) time variable,

which receive the same value from the context. In my proposal, by contrast, the variable indicating the time of John's saying, t_1, does not occur in the translation of the embedded proposition. In fact, the embedded proposition is simply the above set of world-time pairs.

I adopt Lewis's (1979) *de se* analysis of so-called propositional attitudes to show that we can give the right semantic treatment to tenses in verb complements on the basis of structures like (20). *De se* attitudes were first introduced by Castan)ada (1968). They should be understood as special attitudes that are directed toward attitude bearers themselves. Adopting this idea, Lewis (1979) analyzes attitudes in terms of self-ascription of properties by the attitude bearer. He argues persuasively that the object of an attitude must be a property (a set of individual-world-time triples, in our terms), rather than a set of worlds.[28] Our proposal takes the object of an attitude to be a "property of times" (a set of world-time pairs) and, therefore, is a simplified version of Lewis's claim that specializes for temporal examples. Remaining in the spirit of Lewis's proposal, we define the lexical meaning of *say'* as in (21):

(21) For any world w, time t, "property of times" p (= a set of world-time pairs), and individual e, $[\![\text{say}']\!]_w$ (p)(e)(t) = true iff in w at t, e talks as if s/he self-ascribes the property of being located at a time at which p is true.[29, 30]

According to (21), (20) reads: there is a past time at which John talked as if he self-ascribed the property of being located at a time at which Mary is sick. Now, suppose that (19a) is true on its simultaneous reading and that John happens to speak the truth at the time of his saying. This can be interpreted as follows: let w_0 be the actual world and t_0 be the time of John's saying, and assume that in w_0 at t_0 John has the property he talks as if he self-ascribes at that time. Then it follows that $<w_0,t_0>$ is an element of {<w, t> | Mary is sick

in w at t}. That is, Mary is sick in w_0 at t_0. This accounts for the simultaneous reading associated with (20).

When the tense deletion rule does not apply to the structure given in (19a), a shifted interpretation results. It is arrived at via the formula (22):[31]

(22) $\exists t_1[t_1 < s^* \ \& \ t_1 \subseteq t_{R_1} \ \&$ say' $(t_1, j, \wedge \lambda t_2[\exists t_3\ [t_3 < t_2 \ \&\ t_3 \subseteq t_{R3} \ \&$ be-sick' $(t_3, m)]])]$

As in the above example, we can conclude from this that John talked as if he self-ascribed the property of being located at a time t such that Mary is sick at some $t' < t$. If John in fact speaks the truth, it follows that there is a time t' earlier than the actual time of John's saying such that Mary is in fact sick at t'. This accounts for the so-called shifted interpretation of (20).[32]

One additional advantage of my proposal is that it accounts for Japanese examples such as (23a-b) with no difficulty:

(23) a. Jon -wa [Mearii-ga byooki -da] to it -ta.
John TOP Mary NOM be-sick PRES that say PAST
John said that Mary was sick. [simultaneous reading only]

b. Jon -wa [Mearii-ga byooki -datta] to it -ta.
John TOP Mary NOM be-sick PAST that say PAST
John said that Mary had been sick. [shifted reading only]

If we assume that Japanese sentences in the present tense are tenseless sentences and that Japanese lacks a tense deletion rule unlike English, we can employ exactly the same semantic mechanism for both English and Japanese. (23a-b) translate into (24a-b):

(24) a. $\exists t_1[t_1 < s^* \ \& \ t_1 \subseteq t_{R_1} \ \&$ say' $(t_1, j, \hat{}[$be-sick' $(m)])]$

b. $\exists t_1[t_1 < s^* \ \& \ t_1 \subseteq t_{R_1} \ \&$ say' $(t_1, j, \hat{} \lambda t_2[\exists t_3 \ [t_3 < t_2 \ \& \ t_3 \subseteq t_{R3} \ \&$ be-sick' $(t_3, m)]])]$

3.4. Enç's Proposal vs. The New Proposal

In this sub-section, I will compare Enç's system with my proposal by examining some additional data. My discussion in this sub-section owes a great deal to Abusch (1988) and Baker (1989, personal communication). I will show that Enç's system has problems accounting for the data and that any attempt to correct them would result in a system that no longer espouses her basic idea, that past tense has one constant interpretation. One crucial problem is detected when we try to deal with future tense. Enç chooses not to consider examples involving the future tense auxiliary because "the temporal properties of *will* pattern with other modals, rather than with tenses" (Enç 1987: 634). However, in some cases a plain past tense is located in a position locally c-commanded by a future auxiliary, and the semantics of the former is clearly related to the semantics of the latter. Thus, we cannot ignore future tense. Some crucial data, which involve two embedded clauses as well as *would*, have been discussed by Abusch (1988) and also by Baker (1989: 457). Consider the following example, which is due to Abusch (1988):

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

The reading that we want to predict is the one in which all of the following conditions hold:

(i) the time of John's deciding is in the past of the speech time of (25); (ii) the time of his saying to his mother is in the future of the time of his deciding and also of the speech time of (25); (iii) the time of their last meal is simultaneous with the time of his saying to his mother. If Enç is to maintain that past tense is unambiguous and always refers to a time earlier than some other well-defined time, she must show that the value of the lowest past tense is located prior to some other interval referred to elsewhere in the sentence.

Let us assume the following syntactic and morphological analysis of (25) with the indicated indexing:

(26) $Comp_0$ John $\underline{PAST}_1$ decide a week ago [$Comp_1$ that] in ten days at breakfast he $\underline{PAST}$ $woll_2$ say to his mother [Comp that] they $\underline{PAST}_2$ be having their last meal together.

It is assumed here that the expression *would* is morphologically analyzed into the future auxiliary *woll* (the tenseless form of *will* and *would*) and a past tense morpheme.[33] Note that the intermediate Comp is co-indexed with the matrix past tense. Following earlier examples involving past and present tense morphemes, I assume here that the intermediate Comp serves as a local Comp of *woll*. As *woll* is a future tense, it seems prima facie reasonable to require that it denote an interval later than what its local Comp denotes. Finally, *woll* binds the past tense morpheme in the lowest clause, thereby predicting correctly that the time of John's saying to his mother and the time of their having their last meal coincide. Unfortunately, there is a problem with this account. According to Enç's definition of local Comp, the intermediate Comp is not only a local Comp of *woll* but also a local Comp of the past tense in the lowest clause. Thus, the past tense morpheme must denote a time *earlier* than the time denoted by the intermediate Comp. However, this is impossible as *woll* must denote a time *later* than what the intermediate Comp denotes. In

other words, in order for the above indexing to be sanctioned by the anchoring conditions, the following contradictory conditions must be satisfied: $c(1) < c(2)$ *and* $c(2) < c(1)$. Since this is impossible, some special provision must be made to account for the behavior of the future tense auxiliary.

One possibility is to make the future tense an exception to the requirement regarding local Comps and to let it bind any tense. Note that even if this revised theory were to make correct empirical predictions, the modification just proposed would be a significant blow to Enç's theory: since the lowest past tense now has no local Comp with a temporal index, it is not required to behave like a "real" past tense morpheme anymore. In other words, there is no interval prior to which the value of the past tense morpheme must be located. It turns out that this modified proposal is not even descriptively adequate. Consider (27a-b), which are identical except for the tense form in the intermediate clause:

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

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

The question is whether they can receive an interpretation in which the time of his saying to his mother is simultaneous with the time of their having their last meal together. (27a) can receive a simultaneous reading, whereas (27b) cannot; the only possible interpretation of (27b) is that the time of their having their last meal is earlier than the time of John's saying to his mother. This shows that the availability of the tense binding option is controlled by the morphological form of the binder, *not* by its semantic properties. This leads to the following descriptively adequate, but ad hoc, generalization:

(28) The future tense *woll* can bind a past tense iff *woll* surfaces as *would*.

The above discussion shows that Enç's thesis that the English past tense is unambiguous has intrinsic problems.

By contrast, my proposal predicts the desired interpretation of (25) straightforwardly. The D-structure of (25) is assumed to be (29a). It is subject to the SOT rule, and (29b) results:

(29) a. John *PAST* decide a week ago that in ten days at breakfast he *PAST* *woll* say to his mother that they *PAST* be having their last meal together.

b. John *PAST* decide a week ago that in ten days at breakfast he *Ø woll* say to his mother that they *Ø be* having their last meal together.

(29a) translates into (30):

(30) $\exists t[t < s^* \ \& \ t \subseteq t_{R_1} \ \&$ decide' $(t, j, \wedge \lambda t_2 \exists t_1[t_2 < t_1 \ \& \ t_1 \subseteq t_{R2}$ & say' $(t_1, x, \wedge \lambda t_3$[they-be-having-their-last-meal' $(t_3)])])]$

When model-theoretically interpreted, (30) represents the desired interpretation.

4. Conclusion

In this article, I defended a theory of tense that has the following properties: (i) the interpretation of tensed sentences involves existential quantification over times; (ii) the SOT phenomenon in English should be accounted for by positing an SOT rule (more

specifically, a tense deletion rule) in the syntax; (iii) the interpretation of tense in verb complement clauses is accounted for by assuming that so-called propositional attitudes actually involve the subject's self-ascribing properties (*de se* attitudes). I first discussed simple sentences with and without adverbials and concluded that the temporal interpretations associated with tensed sentences are best captured by the quantificational theory of tense accompanied by a contextual restriction upon the quantificational force of quantifiers. Regarding the SOT phenomenon, I argued against Enç's idea that tense morphemes in English are unambiguous by demonstrating that it cannot account for examples involving *would* and multiple embedded clauses. I also showed that a SOT rule and a quantificational analysis of tense most naturally combine with a *de se* analysis of attitude verbs to yield the right truth conditions.

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[1] PTQ stands for Montague's paper "The Proper Treatment of Quantification in Ordinary English."

[2] This is a simplification of Montague's proposal. His proposal involves the present perfect, not the simple past tense.

[3] By "temporal adverbials," I mean what Dowty calls "main tense temporal adverbials," which include *yesterday* and *today*.

[4] PTQ (Montague, 1973) has a syntactic rule that turns a tenseless (or present tense) English sentence α into its past tense counterpart β. The translation rules say that if α translates into α', β translates into $P\alpha'$, where P is a past tense operator. As the introduction of a past tense morpheme correlates with the introduction of P, we could say that past tense morphemes are responsible for quantification over past times in PTQ. In

Dowty's (1979) system, an existential quantifier is introduced as part of the translation of a temporal adverbial. This could be taken to mean that a temporal adverbial is responsible for quantification over times in Dowty's proposal. As the question of compositionality is quite complex, I will not discuss it further in this article.

[5] Krifka (1989) analyzes adverbials like *once* and *twice* as modifiers of event predicates, instead of as quantifiers. As this approach is not possible with adverbs of quantification (See Lewis 1975) such as *always* and *often*, it is better for us to distinguish between two types of frequency adverbs: (i) those that merely count the number of events involved (e.g., *once* and *twice*), and (ii) adverbs of quantification.

[6] The model employed here is the one associated with the actual interpretation of English sentences. For example, the denotation of *person'* at any index $\langle w,t \rangle$ is (the characteristic function of) the set of all persons at $\langle w,t \rangle$. Thus, I will not use any subscript for model when representing the denotation of an IL expression.

[7] I assume that an interval is technically a set of instants with no "gaps," following Bennett and Partee (1972) and others.

[8] The set of types *T* for the logical language (IL) adopted in this paper can be recursively defined as follows: (i) *T* contains *e*, *t*, and *i*. (They are intuitively associated with entities, truth values, and intervals, respectively.); (ii) if *a* and *b* are elements of *T*, so is $\langle a,b \rangle$; (iii) if a is an element of *T*, so is $\langle s, a \rangle$. (Intuitively, *s* represents worlds.); (iv) nothing else is in *T*.

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[9] More precisely, the semantic mechanism of my proposal is as follows: let *F* be the interpretation function furnished by the model. *F* (wake-up'), the intension of *wake-up'*, is that function *k* such that for any world *w*, *k* (*w*) yields the extension of *wake-up'* in *w*. *k*(*w*) is an element of $D_{<e,<i,t>>}$, given the following notational convention and definitions: In general, D_a is the set of possible denotations for expressions of type *a*, for any type *a*. More specifically, D_e is the domain of "normal" individuals, D_t {0,1}, D_i the set of intervals. For any types *a* and *b*, $D_{<a,b>}$ is {*f* | *f* is a function from D_a to D_b}.

[10] That is, for any *w* and *c*, $[\![s^*]\!]_{w,c}$ = the speech time; $[\![\alpha < \beta]\!]_{w,c} = 1$ if and only if every element of $[\![\alpha]\!]_{w,c}$ precedes every element of $[\![\beta]\!]_{w,c}$.

[11] For any *w* and *c*, and for any temporal terms α and β, $[\![\alpha \subseteq \beta]\!]_{w,c} = 1$ if and only if $[\![\alpha]\!]_{w,c} \subseteq [\![\beta]\!]_{w,c}$.

[12] Jespersen (1909-1949) calls the rule back-shifting. Quirk et al. (1972) call it back-shift.

[13] The notion "be in the scope of" will be defined in syntactic terms below. Enç's effort to define the locality condition that triggers the ST phenomenon is definitely on the right track in this respect, though I disagree with her as to what rule is subject to this locality condition.

[14] Government is defined in terms of head-government here (Belletti and Rizzi 1981). That is, the head of a certain maximal projection governs its complement and the head of that complement. For example, the Comp of a verb complement clause governs the

Infl phrase (= the complement clause) and its head (i.e., Infl). If we assume that Infl is a tense morpheme, we can conclude that a tense is governed by the Comp of the immediately higher sentence.

[15] Enç assumes Chomsky's recent approach (Chomsky 1986), where the governing category is defined as the Complete Functional Complex containing the governor. Enç claims that this allows her to define the governing category as a domain where the governor of tense (i.e., Comp) is in the scope of the subject. Consider the following schematic example:

(i) $[_{S1}$ ... that $[_{S2}$ ...]]

According to Enç, S_1 is the governing category for the tense in S_2.

[16] In my notational system, *say'* is a three-place predicate requiring a time variable, an individual term, and a proposition.

[17] It is a natural proposal in the following sense: if we adopt the view that a proposition is a set of world-time pairs, the embedded proposition is the set {<*w*,*t*> | Mary is sick in *w* at $c(t_1)$}. Note that *t* has no role to play in defining the proposition. In particular, *t* is not the time of Mary's being sick. The latter is instead provided by the context $c(t_1)$. This means that if Mary is sick in some world *w'* at $c(t_1)$, for every *t*, <*w'*,*t*> is an element of this set. On the other hand, if Mary is not sick in some world *w"* at $c(t_1)$, then for no *t*, <*w"*,*t*> is an element of this set. The above proposition is an example of a timeless proposition in that time plays no role in characterizing it. Because the referential

analysis of tense as I understand it systematically yields this result (i.e., the embedded proposition is timeless), times are superfluous when it comes to defining propositions. Thus, it is better to assume that a proposition is a set of worlds (instead of world-time pairs) in a referential theory of tense.

[18] The translation proceeds compositionally as follows:

1. Mary Past_1 be sick $\Rightarrow$ $t_1 < s^*$ & be-sick' (t_1, m)

2. say that Mary Past_1 be sick $\Rightarrow$

say' ($\hat{}$ [$t_1 < s^*$ & be-sick' (t_1, m)])

3. John Past_1 say that Mary Past_1 be sick $\Rightarrow$

$t_1 < s^*$ & say' (t_1, j, $\hat{}$ [$t_1 < s^*$ & be-sick' (t_1, m)])

[19] *say'* is assumed to be an expression of type $\langle\langle s,t\rangle,\langle e,\langle i,t\rangle\rangle\rangle$ in the referential theory of tense.

[20] To be more precise, the lambda expression denotes (at any index) that function h such that for any world w, $h(w) = 1$ if and only if $c(t_1)$ is located earlier than the speech time and Mary is sick in w at $c(t_1)$ where $c(t_1)$ is the value the context assigns to t_1. Here, c is a function from variables to appropriate set-theoretic entities.

[21] The translation proceeds as follows:

1. that_1 Mary Past_2 be sick $\Rightarrow$ $t_2 < t_1$ & be-sick' (t_2, m)

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2. say that$_1$ Mary Past$_2$ be sick ⇒

say' (^ [$t_2 < t_1$ & be-sick' (t_2, m)])

3. John Past$_1$ say that Mary Past$_1$ be sick ⇒

$t_1 < s^*$ & say' (t_1, j, ^ [$t_2 < t_1$ & be-sick' (t_2, m)])

[22] There are cases in which the SOT phenomenon is triggered without the presence of a tense morpheme. See Ogihara (1989) for such examples.

[23] α locally c-commands β if and only if α c-commands β and there is no tense node which is c-commanded by α and which c-commands β.

[24] The rule (18) is given as a modalized statement (i.e., the modal verb "can" is used in the definition) because the rule is an optional rule. When the condition is satisfied and when the rule does not apply, we obtain a shifted reading.

[25] The symbol Ø is used to indicate a null tense node.

[26] As propositions are sets of world-time pairs in my proposal, the type of *say'* is <<*s*,<*i*,*t*>>,<*e*,<*i*,*t*>>>.

The translation proceeds as follows:

1. Mary Ø be sick ⇒ be-sick' (m)

2. say that Mary Ø be sick ⇒ say' (^ [be-sick' (m)])

3. John Past say that Mary Ø be sick ⇒

$\lambda t_2 \exists t_1[t_1 < t_2 \ \& \ t_1 \subseteq t_{R_1} \ \&$ say' $(t_1, j, \hat{}$ [be-sick' $(m)]))$

At this point, I assume a truth definition that says the following:

(i) A matrix sentence S is true if and only if S' (s*) is true, where S' is the IL translation of S.

This means that 3 is true if and only if the following is true:

4. $\exists t_1[t_1 < s^* \ \& \ t_1 \subseteq t_{R_1} \ \&$ say' $(t_1, j, \hat{}$ [be-sick' $(m)]))$

[27] The expression $\hat{}$*[be-sick' (m)]* is syntactically identical to what we expect under the original PTQ analysis of propositions, but it is different from the PTQ analysis in that its type is <s, <i,t>>. The "$\hat{}$" symbol designates abstraction over worlds, and the expression *be-sick' (m)* is semantically equivalent to λt *[be-sick' (t, m)]* and denotes the set of times at which Mary is sick.

[28] See Ogihara (in press) for this type of approach to attitudes.

[29] The expression "talks as if" is needed to cover cases where the speaker lies when he makes a statement.

[30] To be more precise, we posit an accessibility relation R between individual-world-time triples and world-time pairs. Intuitively, for any $e_0 \in$ A, w_0, $w_1 \in$ W, and t_0, $t_1 \in$ T,

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$<e_0, w_0,t_0>$ bears R to $<w_1,t_1>$ iff $<w_1,t_1>$ is not ruled out as a world-time pair of the kind where e_0 believes himself in w_0 at t_0 to be located. This is an extension of Hintikka's (1962) proposal. Borrowing Hintikka's (1962: 49) term "doxastic alternative", we say that when $<w_1, t_1>$ is accessible from $<e_0, w_0, t_0>$, $<w_1, t_1>$ is a doxastic alternative of $<e_0, w_0, t_0>$. Given these assumptions, we can say the following: in w at t, e self-ascribes the property of being located at a time at which p is true iff every doxastic alternative of e in w at t is an element of $\{<w,t> \mid p(w)(t) = 1\}$.

[31] The translation proceeds as follows:

1. Mary Past be-sick $\Rightarrow \lambda t_2[\exists t_3\ [t_3 < t_2$ & be-sick' $(t_3, m)]]$

2. say that Mary Past be-sick $\Rightarrow$ say' $(\hat{}\ \lambda t_2[\exists t_3\ [t_3 < t_2$ & be-sick' $(t_3, m)]])$

3. John Past say that Mary Past be sick $\Rightarrow\ \lambda t_4 \exists t_1[t_1 < t_4$ & $t_1 \subseteq t_{R_1}$ & say' $(t_1, j, \hat{}\ \lambda t_2[\exists t_3\ [t_3 < t_2$ & be-sick' $(t_3, m)]])]$

At this point, the truth definition (see note 26) is employed. That is, 3 is true if and only if the following condition holds:

4. $\lambda t_4 \exists t_1[t_1 < t_4$ & $t_1 \subseteq t_{R_1}$ & say' $(t_1, j, \hat{}\ \lambda t_2[\exists t_3\ [t_3 < t_2$ & be-sick' $(t_3, m)]])]\ (s^*)$

5. $\exists t_1[t_1 < s^*$ & $t_1 \subseteq t_{R_1}$ & say' $(t_1, j, \hat{}\ \lambda t_2[\exists t_3\ [t_3 < t_2$ & be-sick' $(t_3, m)]])]$

[32] The proposed analysis also accounts for the interaction of tense interpretation and NP scope. The interested reader is referred to Ogihara (1989).

[33] Strictly speaking, then, we must make sure that the past tense that is suffixed to *woll* must also be anchored, but I will not be concerned with this problem in this paper.