

# A Semantics of Sequence of Tense without a Sequence-of-tense Rule

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**Mean-Young Song. 2000. A Semantics of Sequence of Tense without a Sequence-of-tense Rule.** *Language and Information* 4.2, 93–105. I argue in this paper that the sequence-of-tense (SOT) phenomenon can be accounted for without positing a SOT rule, focusing on the contrast between the past-under-past sentences which lead to ambiguity and those sentences which do not. The different interpretation of past-under-past sentences depends on whether the stative or the non-stative predicates occur in the complement clauses in the propositional attitude verbs. Based on this, I also argue that the embedded past tense does not contribute to the semantics of past-under-past sentences; hence the contrast is not due to the presence of the past tense in the complement clause. Instead, it is due to the occurrence of the stative or non-stative predicates in the complement clauses. The stative predicates are associated with the temporal precedence or the overlap relation, whereas the non-stative predicates the precedence relation only. This fact triggers the contrast in past-under-past sentences. (Korea University)

## 1. Introduction

Sentences like (1a-b) below where the past tense occurs under the matrix past tense, or past-under-past sentences, have traditionally been referred to as a sequence of tense (henceforth SOT) in the literature.

- (1) a. John believed that Mary was tired  
b. John believed that Mary walked to school

What is common in (1a) and (1b) is that they are both “past-under-past” sentences. However, (1a) is not interpreted in the same way as (1b) is. The embedded tense in a sentence like (1a) may have a temporal precedence or overlap relation to the matrix tense, while the embedded tense in a sentence like (1b) has only a temporal precedence relation to the matrix tense. Given this, (1a) is ambiguous between a simultaneous reading in which John believed that Mary was tired at the time of John’s believing and a shifted reading in which John believed that Susan was tired prior to the time of John’s belief. In contrast, (1b) is not ambiguous, i.e., it receives only a shifted reading in which John said that Mary walked to school before Mary’s believing time. Given what I have discussed so

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far, the question arises as to what triggers the semantic difference between (1a) and (1b), even though they both have a syntactically identical structure, i.e., past under past. My purpose in this paper is, thus, to come up with a satisfactory answer to the question, along with an attempt to capture the difference within semantic theory.

This paper is structured as follows: in section 2, I will survey previous treatments of the SOT phenomenon, along with their problems. Section 3 is devoted to addressing the semantic relation established by the occurrence of the stative or the non-stative predicates in the complement clauses, and then discussing what factor is responsible for the contrast in (1a-b). Finally, section 4 aims at presenting a semantic analysis of sentences like (1a-b).

## 2. Previous Treatments

In this section, I will give a brief survey of some previous proposals which account for the semantic interpretation of "past-under-past sentences, as exemplified in (2a-b):

- (2) a. John believed that Mary was sick
- b. John believed that Susan walked to school

In a sentence like (2a), the past tense is embedded under the matrix past tense. Remember that (2a) is ambiguous between a simultaneous reading and a shifted reading. In contrast, a sentence like (2b), which is also a past-under-past sentence, is not ambiguous; it only allows a shifted reading where the time of Susan's walking to school is earlier than John's believing time.

In order to account for sentences like (2a-b), a transformational rule called the SOT rule has been introduced according to which the past tense in the embedding clause is copied onto the present tense in the embedded clause (Comrie, 1985; Comrie, 1986; Ladusaw, 1977; Ross, 1967). According to this, a sentence like (2a) has a D-structure like (3):

- (3) John PAST believe that Mary PRES be sick

After the application of the SOT rule, the embedded PRES in (3) is converted to PAST at S-structure, resulting in its surface form (2a).

The SOT rule runs into troubles when it applies to the embedded tense in sentences like (4):

- (4) John believed that Mary is a hard worker

In (4), the present tense is embedded in the matrix past tense which is called double access sentences. The matrix past tense commands the embedded present tense and not vice versa. Therefore, the SOT rule mentioned above would predict that the embedded present tense should be converted to a past tense, which is contrary to fact. Overall, the SOT rule cannot account for sentences where tenses other than the past tense occur under the matrix past tense.

Another problem with the SOT rule is that it cannot account for the difference between the semantic representation of "past under past" and that of "present under past", as has been noted by Enc (1987). Consider the following sentences:

- (5) John knew that Mary was pregnant
- (6) John knew that Mary is pregnant

According to the SOT theory, the underlying structures of (5) and (6) are like (7a) and (7b), respectively:

- (7) a. John PAST know that Mary PRES be pregnant  
 b. John PAST know that Mary PRES be pregnant

The meaning of (5) is obviously different from that of (6)-that is, the former has a simultaneous reading, whereas the latter has a double-access reading in which the time at which Mary is allegedly pregnant overlaps both the time of John's knowing and the utterance time. Since the SOT rule is optional, it applies to (7a), deriving the S-structure like (5) from the D-structure like (7a). On the other hand, the SOT rule doesn't apply to (7b), obtaining (6) as its S-structure. As is seen in (7a) and (7b), the two sentences (5) and (6) should have the identical representation at DS which is later fed into the semantic interpretation: hence, the SOT rule fails to capture the difference between the semantic representations of (5) and (6).

As a way to account for the contrast between (2a) and (2b), Abusch (1988) proposes that there are two past tenses: Past1 and Past2. Past-1 which usually occurs in any context means the temporal precedence, and Past2 which is licensed within transposing context (which is the same meaning as intensional context) has the temporal overlapping relation as its meaning. To illustrate this, consider the following sentence:

- (8) a. John said<sub>[CP</sub> that Mary was sick]  
 b. John PAST say<sub>[CP</sub> that Mary PAST be sick]

According to Abusch, the embedded past tense in (8) is within an intensional context, and thus, it may be either Past1 or Past2. When the embedded past tense is Past1, the shifted reading is the one available in (8a). When the embedded past tense is Past2, on the other hand, (8a) gets a simultaneous reading.

However, Abusch's proposal runs into trouble as soon as it deals with a sentence like (2b), which is repeated below as (9) for convenience' sake:

- (9) John believed that Susan walked to school

As in (8a), the embedded past is also within the scope of an intensional context. Thus, her analysis would predict that either of the two past tenses are licensed in (9). As a result, we would have to say that (9) is ambiguous in the same way as (8a) is, which is contrary to fact-i.e. (9) is not ambiguous. Thus, her proposal fails to account for why (9) is not ambiguous.

More recently, Ogihara (1992; 1996) attempts to account for the SOT phenomenon in (2a-b) by positing a sequence-of-tense rule which says that the embedded tense is deleted under identity to its matrix tense, as in (10):

- (10) If a tense A is locally commanded by another tense B at LF and A and B are occurrence of the same tense, A is optionally deleted. (Ogihara, 1996, 124).

According to (10), the embedded PAST in sentences like (8a) is optionally deleted at LF since it is locally commanded by the matrix PAST, and furthermore the embedded tense is the same as the matrix tense; hence (8a) has two different LF's, as in (11a-b):

- (11) a. John PAST believe that Mary  $\emptyset$  be sick  
 b. John PAST believe that Mary PAST be sick

Notice that (11a) is the result of the application of the SOT rule to (8a), while this is not the case with (11b). According to Ogihara, when the embedded tense is deleted, a simultaneous reading is obtained, while when the embedded tense is not deleted, a non-simultaneous reading is obtained. Thus, (11a) is an LF for a simultaneous interpretation, whereas (11b) is an LF for a shifted reading.

Ogihara's proposal has the same problem as Abusch's. Consider the following sentence:

- (12) John said that Mary walked to school

One should remember that unlike (8a), a sentence like (12) is not ambiguous. The sentence in (7) has only a shifted reading in which the time of John's saying is earlier than the time of Mary's walking to school. The problem with his SOT rule in dealing with (12) is that his rule would predict that (12) should be ambiguous in the same way as (8a) is, since according to (10), the embedded past tense is deleted optionally. That is, it would have to predict that a simultaneous interpretation should be available in (12), contrary to fact. The reasoning is as follows. Because Ogihara's SOT rule is optional, we have to consider two possibilities: one is that the embedded past tense is deleted, as in (13a), and the other is that it is not, as in (13b):

- (13) a. John PAST say that Mary  $\emptyset$  walk to school  
b. John PAST say that Mary PAST walk to school

(13a) where the embedded past tense is deleted is an LF for the simultaneous interpretation, whereas (13b) where it is not deleted is an LF for the shifted interpretation. As we saw above, (12) has only a shifted reading, indicating that the embedded past tense in (12) must not be deleted. Thus, the LF like (13a) which is intended to represent the simultaneous reading of (12) should be ruled out as ill-formed. However, both of the LF's in (13a-b) are well-formed within his analysis, which indicates that (12) should be ambiguous between a shifted reading and a simultaneous reading. This is contrary to fact, hence, Ogihara's SOT rule cannot account for why a simultaneous reading is not available in (12). As we saw above, neither of the two approaches — i.e., Abusch's and Ogihara's — is sufficient to account for the contrast in (2a) and (2b) since they both fail to explain why (2b) is unambiguous. In what follows, I will elaborate on the account of the contrast.

### 3. Stative and Non-Stative Predicates in SOT

This section is devoted to discussing what causes the contrast in (2a) and (2b), along with a possible way out to account for it. For convenience's sake, I will repeat (2a) and (2b) below as (14a) and (14b), respectively:

- (14) a. John believed that Mary was sick  
b. John believed that Susan walked to school

Albeit the fact that (14a) and (14b) have in common that they are both past-under-past sentences, a close look at them reveals that there is a difference between them. The difference between (14a) and (14b) lies in the fact that in (14a), the embedded predicate is stative, while in (14b), it is non-stative, or dynamic.

Portner (1998) notes that if a predicate is stative, the eventuality picked out by the predicate is understood as either preceding or overlapping the reference time, whereas if a predicate is non-stative, the eventuality depicted by the predicate always precedes the reference time. This also has been elaborated upon within the discourse representation theory (DRT) framework Hinrichs (1986) and Partee (1984)<sup>1</sup>. Within the DRT framework, it has generally been observed that the state sentences overlaps the reference time

1. Partee's observation is based on Hinrichs's (1982) which is an earlier version of Hinrichs (1986)

in subsequent discourse, while the event sentences locate the reference time right after the event. To illustrate this, consider the following sentences:

- (15) John woke up in the morning. He got back to sleep. He felt he was tired.

The utterance of the first event sentence introduces a reference time R1 which is right after the time of John's waking up. When the subsequent event sentence (i.e., he got back to sleep) is uttered, the event of his getting back to sleep is understood as being an event taking place at R1; hence the event described by the second event sentence follows the one depicted by the first event sentence. When the state sentence is uttered, the state of John's feeling that he is tired is interpreted as overlapping the event time of John's getting back to sleep which is simultaneous with R1. What I have discussed so far indicates that the event sentences move the reference time forward, while the state sentences do not.

Hinrichs (1986) further notes that the state sentences need not always overlap the preceding event, as exemplified in (16):

- (16) Jameson entered the room, shut the door carefully and switched off the light. It was pitch-dark around him because the Venetian blinds were closed. (Hinrichs, 1986, 68)

In (16), the state of the room's being dark cannot overlap the event of Jameson's switching off the light, but rather follows the reference time which is established right after the time of his switching off the light. As we saw in (15) and (16), the reference time for the state sentences may have either the overlap or the precedence relation, whereas for the event sentences it is located right after the event—that is, it has only the temporal precedence relation.

Portner (1998) observation may provide a clue as to accounting for the contrast in (14a) and (14b). In the SOT theory, sentences like (14a-b) have been claimed to have (17a) and (17b) as their D-structures.

- (17) a. John PAST believe that Mary PAST be sick  
b. John PAST believe that Susan PAST walk to school

In the SOT theory, the embedded past tense morpheme functions as a semantic operator shifting the evaluation time. What we have seen in (15) and (16), however, suggests that the fact that (17a) is interpreted differently from (17b) is not due to the embedded PAST tense, but to what type of predicates, stative or non-stative, occurs in the complement of the attitudes verbs. In other words, (17a) where a stative predicate occurs has to have either the precedence or the overlap relation, and thus it leads to the ambiguity between a shifted reading and a simultaneous reading. By contrast, (17b) where a non-stative predicate occurs has to have only the precedence relation, which leads to a shifted reading.<sup>2</sup> In the next section, I will incorporate this into the semantic analysis of (14a-b).

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2. The reader may wonder why (17a) cannot receive a forward shifted reading in which the time of Mary's being sick is later than the time of John's belief. As a matter of fact, this kind of reading is impossible in sentences like (17a) because the complement clause in (17a) is within an intensional context, as Abusch (1988) notes. If the embedded clauses occur in an extensional context, such a reading may be possible. For more details, see Abusch (1988).

#### 4. Semantic Analysis

In the previous section, I have discussed what factor is involved in the contrast in (14a) and (14b), repeated below as (18a) and (18b) for convenience's sake:

- (18) a. John believed that Mary was sick  
 b. John believed that Mary walked to school

One should remember from the previous section that the past tense embedded in the complement does not contribute to the interpretation of (18a) and (18b). Instead, the presence of the stative or the non-stative predicates in the complement clauses determines what interpretations (18a-b) should have. This indicates that the embedded past tense is semantically vacuous.<sup>3</sup>

If this is correct, one might ask how sentences like (18a-b) are interpreted. The strategy for the interpretation of (18a-b) is as follows. In (18a), the reference time for the embedded stative sentence is the time of John's belief which is in the past. Since the stative sentences have the property of preceding or overlapping the reference time (or the local evaluation time), (18a) can be understood to mean that the time of Mary's sickness either precedes or coincides with the time of John's belief. In contrast, in (18b), the reference time for the embedded event sentence is also the time of John's belief. Since the event sentences describe an event preceding the reference time, (18b) is interpreted as the time of Mary's walking to school being earlier than the time of John's belief. In what follows, I will discuss how to incorporate what we saw above into the semantic analysis without positing a sequence-of-tense rule.

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3. An anonymous reviewer points out to me that the following sentences suggest that the embedded past tense might not be semantically vacuous (i.e. it might make a contribution to the temporal interpretation):

- (i) a. John said that Mary would be pregnant  
 b. John said that Mary will be pregnant

As a matter of fact, (ia) seems to make a point in favor of what I have mainly argued in this paper. A sentence like (ia) receives only a forward shifted reading in which the time of Mary's pregnancy is located between the time after the time of John's saying and the time before the utterance time. What is it that makes (ia) have the forward shifted reading? If it were the embedded past tense, we would have to expect at least that a simultaneous or a shifted reading is available in (ia). However, such kinds of readings are not available in (ia). This indicates that it is not the embedded past tense but the modal verb "would" that locates the time of Mary's pregnancy after the time of John's saying. A similar argument is made for sentences like (ib). The stem underlying the modal verbs "will" and "would" is "Woll" (Ogihara, 1996; von Stechow, 1995). Thus, the underlying forms for sentences like (ia) and (ib) can be represented as (iia) and (iib), respectively:

- (ii) a. John PAST say that Mary PAST Woll be pregnant  
 b. John PAST say that Mary PRES Woll be pregnant

As far as semantics is concerned, the modal verbs in the complement clause play a role in locating the eventuality in question, whether it occurs in the main clause or in the subordinate clause, after the local evaluation time. For example, in (iia), the local evaluation time for Woll is the time referred to by the matrix tense which is in the past, hence the time of the embedded clause should be after the time of John's saying. In (iib), the local evaluation time for Woll is the utterance time, hence the time of Mary's pregnancy follows the utterance time. Thus, "Woll" is interpreted as locating the eventuality in question after the reference time (or its local evaluation time), and for this reason, "Woll" is translated as  $\lambda P \exists t' [t < t' \wedge P(t')]$ . Notice that  $t$  in the translation is referred to as the local evaluation time whose value is determined by the context of use. What I have discussed so far suggests that the readings available in (iia) and (iib) are due to the existence of "Woll" in the complement clauses, rather than due to the existence of the embedded PAST or PRES.

What I have argued above is that the interpretation of the sequence-of-tense sentences depends on the presence of the stative or the non-stative predicates and that the embedded past tense is semantically vacuous in the sequence-of-tense phenomenon. I postulate that since the stative predicates establish the precedence or the overlap relation, they have either of the features: [ $<$ ] or [=], where [ $<$ ] and [=] refer to the former and the latter, respectively, whereas since the non-stative predicates establish the precedence relation, they have the feature [ $<$ ] only. Given this, what I'd like to claim is that either of the features should be transmitted to the embedded past tense morpheme in order for the embedded clauses in sequence-of-tense sentences to get interpretable. Thus, we can state the principle for the assignment of the feature to the embedded past tense morpheme as follows:

- (19) Principle for the Assignment of the Feature to the Embedded Past Tense  
 In the construal [ $_{CP} \dots \alpha V_{Att} \dots [_{CP} \dots \beta \gamma \dots ]$ ], where  $\alpha$  and  $\beta$  are past tenses,  $V_{Att}$  is an attitude verb associated with  $\alpha$ , and  $\gamma$  is the head of XP which is a sister of INFL immediately dominating  $\beta$ ,
- i. either [ $<$ ] or [=] is assigned to  $\beta$  iff  $\gamma$  is a stative predicate, and
  - ii. the feature [ $<$ ] is assigned to  $\beta$  elsewhere.

According to (19), (18a) and (18b) have (20a-b) and (21), respectively, as their tentative LF:

- (20) a. [ $_{CP}$  John PAST believe $_{[CP}$  that Mary PAST[ $<$ ] be sick]]  
 b. [ $_{CP}$  John PAST believe $_{[CP}$  that Mary PAST[=] be sick]]
- (21) [ $_{CP}$  John PAST believe $_{[CP}$  that Mary PAST[ $<$ ] walk to school]]

Remember that (18a) is ambiguous between the shifted reading and the simultaneous reading, while (18b) receives only a simultaneous reading. (20a-b) are the LF's for the shifted reading and the simultaneous reading, respectively. (21) is the LF for (18b). In what follows, I will discuss how we can derive the available readings in (18a-b).

I will start with the LF for (18a) where a simultaneous reading is available.<sup>4</sup> The LF for (18a) I have in mind would be like this:

- (22) [ $_{CP}$  John<sub>7</sub> PAST [ $_{VP}$  e<sub>7</sub> believe  $\lambda t$  [ $_{CP}$  that [ $_{IP}$  Mary<sub>8</sub> PAST[=] [ $_{VP}$  e<sub>8</sub> be sick]]]]]]

Let me give brief comments on the LF in (22). In the course of the derivation of LF, I adopt the VP-internal hypothesis which says that the subject is base-generated within the SPEC of VP. Notice also in (22) that " $\lambda t$ " is adjoined to CP in the complement clause. This is a result of what I call " $\lambda$ -abstractor closure". I will consider the object of propositional attitudes to be a property, rather than a proposition, following Lewis (1979). In order to incorporate this into the IL translation, we need a special rule for the CP which is in the complement of the attitude verb.  $\lambda$ -abstractor closure is the rule and it can be stated as follows:

- (23)  $\lambda$ -abstractor Closure<sup>5</sup>

4. Here, I will only discuss the case where (18a) receives the simultaneous reading. That is, I will leave out the shifted reading because the shifted reading of (18a) is derived exactly in the same way as that of (18b). I will discuss the semantic derivation of (18b) later in this section. Thus, the reader can refer to that part for the detailed account of how the shifted reading of (18a) is derived.

5. For the sake of convenience, no  $\lambda$ -abstraction over anything but intervals will be considered throughout this paper since the present study concerns tense.

Insert a  $\lambda$ -abstractor over intervals, i.e.,  $\lambda t$ , to the SPEC of  $CP_{[+Comp]}$  in the derivation of LF, where [+Comp] is the complement of the propositional attitude verb.

The use of the feature [+Comp] indicates that the  $\lambda$ -abstractor closure must apply not to the matrix CP, but rather to the complement CP. In the course of IL translations,  $\lambda$ -abstractor closure is intended to operate on CP which is of type  $t$  to make a CP which is type of  $\langle i, t \rangle$  with the denotation of a set of intervals. When it combines with a propositional attitude verb as an argument, its type  $\langle i, t \rangle$  is converted to an intensional type  $\langle s, \langle i, t \rangle \rangle$  which denotes properties of interval. Thus, this intensional type enables us to treat the object of the propositional attitude as denoting a property, rather than a proposition. I will get back to this in more detail later in this section.

Given this, the LF (22) for the simultaneous reading of (18a) can be translated as (24).

(24) IL Translation

1.  $VP'$ :  $e_8$  be sick  $\Rightarrow$  be-sick  $\mu\ell\lambda x_8$
2.  $I'$ : PAST[=]  $\Rightarrow$   $\lambda P\exists t_1[t = t_1 \wedge P\{t_1\}]$
3.  $\bar{I}'$ :  $\lambda P\exists t_1[t = t_1 \wedge P\{t_1\}](\wedge$ be-sick'(x<sub>8</sub>)  
 $\Rightarrow \exists t_1[t = t_1 \wedge$ be-sick(x<sub>8</sub>, t<sub>1</sub>))
4.  $IP'$ :  $\lambda PP\{m\}(\wedge\lambda x_8[\exists t_1[t = t_1 \wedge$ be-sick'(x<sub>8</sub>, t<sub>1</sub>))]  
 $\Rightarrow \exists t_1[t = t_1 \wedge$ be-sick(m, t<sub>1</sub>))
5.  $CP'_{[+Comp]}$ :  $\lambda t\exists t_1[t = t_1 \wedge$ be-sick'(m, t<sub>1</sub>))
6.  $\bar{V}'$ : believe'( $\wedge\lambda t\exists t_1[t = t_1 \wedge$ be-sick'(m, t<sub>1</sub>))
7.  $VP'$ : believe'(x<sub>7</sub>,  $\wedge\lambda t\exists t_1[t = t_1 \wedge$ be-sick'(m, t<sub>1</sub>))
8.  $I'$ : Past  $\Rightarrow$   $\lambda P\exists t[\text{past}(t) \wedge t \in R \wedge P\{t\}]$
9.  $\bar{I}'$ :  $\lambda P\exists t[\text{past}(t) \wedge t \in R \wedge P\{t\}](\wedge$ believe'(x<sub>7</sub>,  $\wedge\lambda t\exists t_1[t = t_1 \wedge$ be-sick'(m, t<sub>1</sub>))]  
 $\Rightarrow \exists t[\text{past}(t) \wedge t \in R \wedge$ believe'(x<sub>7</sub>, t,  $\wedge\lambda t\exists t_1[t = t_1 \wedge$ be-sick'(m, t<sub>1</sub>))]
10.  $IP'$ :  $\lambda PP\{j\}(\wedge\lambda x_7[\exists t[\text{past}(t) \wedge t \in R \wedge$ believe'(x<sub>7</sub>, t,  $\wedge\lambda t\exists t_1[t = t_1 \wedge$ be-sick'(m, t<sub>1</sub>))]]]  
 $\Rightarrow \exists t[\text{past}(t) \wedge t \in R \wedge$ believe'(j, t,  $\wedge\lambda t\exists t_1[t = t_1 \wedge$ be-sick'(m, t<sub>1</sub>))]

Notice that in (24) the matrix past tense is translated as  $\lambda P\exists t[\text{past}(t) \wedge t \in R \wedge P\{t\}]$ , where  $P$  is a variable of type  $\langle s, \langle i, t \rangle \rangle$  and  $R$  is the reference time.<sup>6</sup> The local evaluation time of the matrix past tense is the utterance time. Thus, "past( $t$ )" is true iff the interval denoted by  $t$  precedes the utterance time, as defined in (25):

- (25) If  $t \in ME_i$ , then  $\|\text{past}(t)\|^{M,w,g,u} = 1$  iff  $\|\text{past}(t)\|^{M,w,g,u} < u$ . (N.B.  $ME_i$  refers to a meaningful expression of type  $i$ ,  $g$  is a value assignment function, and  $u$  the utterance time).

6. The motivation to introduce the free variable  $R$  in the formula is to incorporate the determinacy (or indefiniteness) or the indeterminacy (definiteness) of tense which has been an issue in the semantics of tense. As Song (1999) notes, the more satisfactory semantic analysis of tense would be one which can provide a semantic representation handling the determinacy and the indeterminacy of tense. In order to achieve this, I'd like to incorporate the notion of determinacy into our object-language style of translation although this treatment is not an ultimate way to give semantic treatment of tense. To save space, I will not go into more details of this. The reader is referred to Song (1999).



Recall that unlike the matrix past tense, the embedded past tense morpheme is semantically vacuous. It becomes semantically visible only when it is associated with either features. According to (19), since it gets the feature [=] from the embedded stative predicate and thus has the overlap relation, the embedded past tense PAST[=] is translated as  $\lambda P\exists t_1[t = t_1 \wedge P\{t\}]$ , as illustrated in (24-2). This indicates that the semantics of the matrix past tense is different from that of the embedded past tense with either features. Notice that the free variable  $R$  is introduced in the IL translation. When a free variable occurs in a formula, its value is determined not by semantics but by pragmatics, i.e., the context of use.  $R$  denotes a most salient reference time which is given by the context of use. As the translation of PAST[=] shows, it is intended to generate a simultaneous reading. (24-8) is the result of applying the  $\lambda$ -abstractor closure to the translation of the complement CP of the attitude verb *believe*. This operation is necessary since we take the object of the propositional attitude to be a property, along the lines of Lewis (1979). Thanks to this, we have the final translation for (18a), which is repeated below:

$$(26) \exists t[\text{past}(t) \wedge t \in R \wedge \text{believe}'(j, t, \wedge \lambda t\exists t_1[t = t_1 \wedge \text{be-sick}'(m, t_1)])]$$

(26) can be simplified as (27):

$$(27) \exists t[\text{past}(t) \wedge t \in R \wedge \text{believe}'(j, t, \wedge \lambda t[\text{be-sick}'(m, t)])]$$

(27) says that there is a past time interval  $t$  which is an element of the set of contextually salient times  $R$  such that at  $t$  John ascribes to himself the property of being located at a time  $t$  such that Mary was sick at  $t$ . In (27), the object of John's belief is denoted by the expression  $\wedge \lambda t[\text{be-sick}'(m, t)]$  which is of type  $\langle s, \langle i, t \rangle \rangle$  whose denotation is a property. This indicates that the propositional attitude does not denote a relation between an individual and a proposition, which is the traditional view of the denotation of the propositional attitude in formal semantics. Instead, it denotes a relation between an individual and a property, as in (27). Given this, we are in a position to discuss the semantics of propositional attitudes. In what follows, I will elaborate on this and get back to the main line of discussion.

Hintikka's doxastic alternative for an individual is simply a set of or propositions. However, his analysis is not sufficient to deal with the semantics of belief-sentences, as is illustrated in Quine's (1956) Orcutt example and the Heimson example (Lewis, 1979). Thus, Lewis (1979) argues that the object of the propositional attitudes is taken to be a property, rather than a proposition (i.e., a set of possible worlds).<sup>7</sup> To incorporate this, we need two notions: centered possible worlds first introduced by Quine (1969) and self-ascribed properties (Lewis, 1979). The introduction of centered possible worlds indicates that the object of the propositional attitude is a set of centered possible worlds, rather than a set of possible worlds, namely propositions. The view of the object of the attitude as a set of centered possible worlds amounts to taking the object of the attitude to denote a property. I will take centered possible worlds to be world-interval pairs, as in  $\langle w, t \rangle$ .<sup>8</sup>

The introduction of self-ascribed properties first proposed by Lewis (1979) amounts to saying that the object of proposition attitudes is taken to denote self-ascribed properties, which is what he calls *de se* attitudes. Given that the object of propositional

7. I will not go into the details of this to save space. The reader can consult Lewis (1979) for the motivation to take the object of the propositional attitudes to be a property.

8. A centered possible world can be taken to be a triple  $\langle w, t, a \rangle$ , where  $w$  is a world,  $t$  an interval, and  $a$  an individual. This is a slightly extended version of a centered possible worlds proposed by Cresswell and von Stechow (1982). Abusch (1992; 1997) and Ogihara (1996) are in the lines of this. Since our primary goal of this paper is to deal with temporal expressions, and dealing with an individual in the attitude is beyond the present study, I only focus on the interval in the centered possible world I have in my mind in order to make it as simple as possible.

attitudes is a self-ascribed property, the propositional attitude should be interpreted not as a relation between individuals and propositions (i.e., a set of possible worlds), but as a relation between individuals and self-ascribed properties.

On the basis of what I have discussed in the last two paragraphs, we can give the semantics of a propositional attitude verb like believe as follows:

- (28)  $\| \text{believe}' \|^{M,w,g,u}$  is that function  $f \in D_{\langle\langle s, \langle i, t \rangle \rangle, \langle e, \langle i, t \rangle \rangle \rangle}$  such that for any  $p \in D_{\langle s, \langle i, t \rangle \rangle}$ , for any  $\alpha \in D_e$  and  $t \in D_i$ ,  $f(p)(\alpha)(t) = 1$  iff  $\{ \langle w', t' \rangle : \langle w, t \rangle H_j(\alpha) \langle w', t' \rangle \} \subseteq p$ .

Armed with what we have discussed about the semantics of the propositional attitude, we are now in a position to discuss how a sentence like (18a) leads to a simultaneous reading. I will repeat the translation (27) of (18a) below as (29):

- (29)  $\exists t[\text{past}(t) \wedge t \in R \wedge \text{believe}'(j, t, \wedge \lambda t[\text{be-sick}'(m, t)])]$

(29) says that there is a past time interval  $t$  which is a member of the set of contextually salient times  $R$  such that at  $t$  John self-ascribes the property of being located at a time  $t$  such that Mary was sick at  $t$ . According to (28), (29) is true in  $w$  at  $u$  iff for some  $g \langle a/t \rangle g'$ ,<sup>9</sup>  $g'(a)$  precedes  $u$  and  $g'(a)$  is a member of  $R$  and every doxastic alternative for John in  $w$  at  $g'(a)$  is a subset of  $\{ \langle w, t \rangle : \text{Mary is sick in } w \text{ at } t \}$ . Notice that the set of world-interval pair  $\{ \langle w, t \rangle : \text{Mary is sick in } w \text{ at } t \}$  denotes a property of Mary's being sick in  $w$  at  $t$ . If John has this property in  $w$  at  $g'(a)$  (notice that  $g'(a)$  is his believing time), then the whole sentence in (29) is true, which indicates that Mary is sick in  $w$  at  $g'(a)$ . In this way, the simultaneous reading of (29) is obtained.

Let us get back to (18b), repeated as (30) below and see what its LF representation looks like.

- (30) John believed that Mary walked to school

Recall that (30) is not ambiguous, namely it only receives a shifted reading. Since the predicate in the complement clause is not stative, the feature [ $\langle$ ] is transmitted to the embedded past tense. Thus, the LF for a sentence like (30) is something like this:

- (31)  $[_{CP} \text{John}_7 \text{PAST} [_{VP} e_7 \text{believe} \lambda t [_{CP} \text{that} [_{IP} \text{Mary}_8 \text{PAST}[\langle] [_{VP} e_8 \text{walk to school}]]]]]$

Recall that  $\text{PAST}[\langle]$  always precedes its local evaluation time which is the time denoted by the matrix past tense. Thus, the embedded past tense  $\text{PAST}[\langle]$  in (31) can be translated as  $\lambda P \exists t_1 [t_1 < t \wedge P\{t\}]$ , where  $P$  is a variable of type  $\langle s, \langle i, t \rangle \rangle$ . The LF (31) for the sentence in (30) is translated as (32):<sup>10</sup>

- (32)  $\exists t[\text{past}(t) \wedge t \in R \wedge \text{believe}'(j, t, \wedge \lambda t \exists t_1 [t_1 < t \wedge \text{walk-to-school}'(m, t_1)])]$

(32) is true in  $w$  at  $t$  iff there is a past time interval  $t$  which is an element of the set of contextually salient times  $R$  such that  $\{ \langle w', t' \rangle : \langle w, t \rangle H_j \langle w', t' \rangle \} \in \{ \langle w, t \rangle : \text{there is a time } t_1 \text{ such that } t_1 < t \text{ and Mary walks to school in } w \text{ at } t_1 \}$ . This interpretation shows us that if John has the self-ascribed property in question in  $w$  at  $t$  (note that  $t$  is John's believing time), then Mary walks to school in  $w$  at  $t_1$  which precedes  $t$ . This is how the shifted reading of (30) is accounted for.

9.  $g \langle a/t \rangle g'$  is a value assignment function, which is exactly like  $g$  except that it possibly assigns a to  $t$ .

10. I will not give a full derivation of the translation of (31) since it is very similar to what we saw in (27).

## 5. Closing Remarks and Further Research

Several attempts have been made in the literature to account for the SOT phenomenon, yet, as was mentioned in this paper, none of them provides a satisfactory account of it; specifically, recent works of Abusch (1988) and Ogihara (1996) provide no account whatsoever of the contrast between the past-under-past sentences which lead to ambiguity and those sentences which do not. Such attempts except Abusch's (1988) have in common that the SOT rules are proposed to account for the SOT phenomenon. In this paper, however, I have proposed an approach which takes account of the contrast without positing any SOT rule. Based on what is addressed in Hinrichs (1986), Partee (1984) and Portner (1998), I have argued that the contrast is caused not by the existence of the past tense embedded in the complement of the attitude verbs but by the stative or the non-stative predicates occurring in the complement. This indicates that what is crucial in the interpretation of past-under-past sentences is the presence of a stative or non-stative predicate in the complement clauses. More precisely, the stative predicates embedded in the complement trigger the precedence or the overlap relation to the reference time (or the local evaluation time) denoted by the matrix past tense, while this is not the case with the non-stative predicates. This may assist in allowing an improved understanding of the nature of the contrast in past-under-past sentences more accurately than has previously been suggested.

I will conclude this section by addressing the need of extended research on the approach which has been proposed in this paper. In this paper, my argument focuses on what is called the sequence-of-tense phenomenon, i.e., past-under-past sentences. If we extend what is proposed here to other cases such as past-under-present sentences or present-under-present sentences, as illustrated in (33a) and (33b), respectively:

- (33) a. John believes that Mary was sick  
 b. John believes that Mary is sick

A sentence like (33a) is interpreted to mean that John believes that Mary was sick at John's believing time, while (33b) is understood to mean that the time of Mary's sickness coincides with John's believing time. Notice that the stative predicate occurs both in (33a) and (33b), but they seem not to respect the principle in (19) which has been discussed in section 4. To put it differently, the embedded stative predicate in past-under-present sentences like (33a) is claimed to have nothing but the precedence relation, whereas the embedded stative predicate in present-under-present sentences like (33b) has nothing but the overlap relation. These sentences contrast with past-under-past sentences.

As a possible way out, we might think that as far as the temporal interpretation is concerned, there are two different past tenses: PAST without any features whose evaluation time is the utterance time, and PAST with either features [=] or [<] inherited from the type of embedded predicates whose evaluation time is the time denoted by the matrix tense. Notice that the embedded past tense is evaluated by the matrix present tense which in turn coincides with the utterance time, and thus its evaluation time is also the utterance time. As a result, the embedded past tense in (33a) is a real (or semantically visible) past tense with no features assigned to it.

Let's get back to (33b). Both the embedding present tense and the embedded present tense are evaluated by the utterance time, since they are both in the present tense. Heim (1994) claims that the present tense presupposes that the time referred to by that present tense overlaps the utterance time. Given this, the matrix and the embedded present tense in (33b) presupposes that they overlap the utterance time which is the local evaluation

time for the two present tenses. This indicates that the two present tenses overlap each other after all. If we assume that there might be the precedence relation available in (33b) (i.e., the time of Mary's sickness is prior to John's believing time), this is infelicitous since this kind of interpretation contradicts with the presupposition triggered by the present tense. What is common in (33a) and (33b) is that the embedded tenses associated with the stative predicates are evaluated by the utterance time. Thus, we might need to come up with some device which prevents the embedded stative predicates from having either the precedence or the overlap relation, just in case the evaluation time for the embedded tenses is the utterance time.<sup>11</sup>

A sentence like (iii) is understood to mean that the time of Mary's being allegedly pregnant overlaps both the time of John's belief and the utterance time. This suggests that the utterance time is at least involved in the interpretation of (iii). As was mentioned above, the tenses in the complement clauses are not semantically vacuous as far as their evaluation time is the utterance time. In contrast to the embedded past tense in past-under-past sentences like *John believed that Mary was sick*, the embedded present tense in (iii) does contribute to the semantic interpretation. As long as the embedded tense is semantically vacuous, the existence of stative or non-stative predicates in the complement affects meaning, as in past-under-past sentences, while this is not the case if the embedded tense is not semantically vacuous. I will leave it for further research.

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11. This may go for the double-access sentences in which the present tense in the complement occurs under the matrix past tense, as exemplified as in (iii):

(iii) John believed that Mary is pregnant

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