Tense and aspect in truth-conditional semantics

Toshiyuki Ogihara

University of Washington, Linguistics, Box 354340, Seattle 98195, USA

Abstract

This article shows in simplest possible terms how the standard truth-conditional semantic framework deals with basic data involving various tense and aspect forms in English. Although I only discuss English examples, the idea is that the overall approach can be applied to any language. I start with a provisional definition of the terms "tense" and "aspect" and some basic terms to be used in the article. I then discuss some differences between an artificial logical language such as tense logic and natural language, but also point out that the former does have lot of contribute to our understanding of natural language tense systems. The next four sections show how the standard formal semantic system, which is a sophisticated descendent of the logical/philosophical tradition in semantics, deals with unembedded tenses, the progressive, the perfect, and embedded tenses. It is hoped that this work also serves the purpose of introducing a formal semantic viewpoint to those who are unfamiliar with it.
© 2005 Elsevier B.V. All rights reserved.

Keywords: Tense; Aspect; Formal semantics; Truth-conditional semantics

1. Introduction

In this article, I will present a formal semantic analysis of a basic data set involving tense and aspect constructions. I will concentrate upon a limited number of leading ideas and proposals and try to convey the essential ideas behind them without emphasizing their technical details.

Let me first introduce some important terms to be used in this article. I start with the terms "tense" and "aspect." Providing a satisfactory characterization of these two terms is already a non-trivial task. Pretheoretically, a tense morpheme specifies the time at which (or during which) the descriptive content of the sentence in question obtains. For example, (1a) and (1b) differ only with regard to tense, and this difference is responsible for placing "John's being happy" at different times.

(1)   a.   John is happy.
        b.   John was happy.

On the other hand, aspect morphemes determine the descriptive content of the sentence itself. Comrie (1976:3) says that aspects are understood to be "different ways of viewing the internal temporal constituency of a situation".[1] In other words, aspect morphemes are more perspectival than tense morphemes. The progressive is an example of aspect.

(2)   a.   John ran.
        b.   John was running.

Both (2a) and (2b) describe past situations containing John's running, so they do not differ with regard to tense. However, they have different descriptive content. Put rather crudely, (2a) describes John's running in its entirety from an external viewpoint, whereas (2b) describes it as on-going (described from within, as it were).

   Dowty (1979) assumes that a tensed sentence is analyzable into a tense morpheme and a tenseless sentence.[2] On this assumption, a tense morpheme is understood to be an expression that specifies the time with respect to which the truth value of a tenseless sentence is determined. An important assumption here is that a tensed sentence conveys something constant regardless of which tense morpheme it contains. For example, (1a) and (1b) differ in tense, but they both talk about the "same state of affairs": the state of John's being happy. The only difference is that this state is located at different times in (1a) and (1b). This viewpoint is perhaps best described by direct discourse paraphrases of (1a, b). When (1a) is true, (3a) is also true. When (1b) is true, (3b) is also true.

(3)   a.   It is now true to say "John is happy."
        b.   There was some past time when it was true to say "John is happy."

In (3a, b), the tenseless sentence part is represented as the same direct discourse sentence. This shows what is shared by them. At the same time, (3a, b) show that they differ with respect to the times at which the same sentence is asserted to be true. It is clear that (1a) and (1b) can have different truth values because *John is happy* is true or false depending upon when it is uttered; John may be happy today but may be unhappy tomorrow. The paraphrase given in (3b) represents what is referred to as **an existential quantifier analysis of past tense**. An existential quantifier approach to tense is generally attributed to Prior (1957, 1967) and is adopted for natural language by Montague (1973) and Dowty (1979). The leading idea here is that a sentence in the past tense is used to claim that there is a past time at which a relevant state of affairs obtains.[3]

   In this connection, it is important to discuss **a referential approach to tense** initiated by Partee (1973) and elaborate by Enç (1987) and others. In this approach, a tense morpheme

---

[1] Comrie attributes this characterization of aspect to Holt (1943:6).

[2] To be more accurate, when a tenseless sentence combines with an adverbial, a tense morpheme is introduced at the same time. This can be taken to mean that an adverbial and a tense morpheme jointly make one semantic contribution.

[3] Montague (1973) adopts an existential quantifier analysis of tense, but he lets his "past tense operator" H (mnemonic for *has*) symbolize the present perfect rather than the simple past.

is a referential expression on a par with a referential pronoun.[4,5] The pronoun *she* in (4a) (Partee (1973)) is an example of a referential pronoun. Similarly, the pronoun *she* as used in (4a) is a referential pronoun involving no pointing action. Its referent is recoverable from the context (i.e., the man's significant other). Partee's claim is that tense can be used in an analogous way. That is, a past tense sentence is used to talk about a particular contextually salient past time although no pointing action is used to indicate it. A possible paraphrase of (4b) in a referential approach would be (4c). (4b) means that John sees his mother at (or within) some contextually salient past time, not just that there was some past time when he saw his mother. Note that the past tense in (4b) plays the role of the adverb *then* in (4c) specifying the time at which John's seeing his mother took place.[6]

(4)   a.   She left me. (uttered by a man sitting alone with his head in his hands)
        b.   I saw my mother.
        c.   I saw my mother then.

The difference between these two approaches is important, but a detailed discussion of their differences would take us too far afield. It is perhaps important to illustrate with examples a fundamental difference between an existential claim about tense and a referential one. (5a) shows how (4b) is interpreted under an existential quantifier approach to past tense. This condition is satisfied as long as a past time is found at which I saw my mother. It is very easy to satisfy this condition. (5b) requires that my seeing my mother obtains at 9 a.m. this morning. No other past time will do. So it is a harder to satisfy the truth condition of (5b) than of (5a). In my own work (Ogihara, 1996), I argue for a mixed approach in which both existential quantification over past times and its contextual restriction are necessary to account for the meaning of past tense. (5c) illustrates how this approach is put to use. The condition (5c) is verified by my seeing my mother at any time within this morning. This condition is more stringent than (5a) but is not as hard as (5b) to satisfy.

(5)   a.   I saw my mother **at some time in the past**. (existential)
        b.   I saw my mother **at 9 a.m. this morning**. (referential)
        c.   I saw my mother at **some time this morning**. (referential + existential)

Regardless of which particular proposal about tense is adopted, the fact remains that tense is understood to specify the time at (or during) which the situation described by the sentence obtains. The choice among the three approaches to tense introduced above will not affect the discussion in the rest of the article.

Let me now turn to aspect. Aspectual morphemes/constructions include inchoative, progressive, perfective, etc. Syntactically or morphologically, aspectual constructions are distributionally independent of tense morphemes in that a tense and an aspect can co-occur in the same clause and the choices of tense and aspect morphemes are made independently of each

---

[4] In fact, even if one assumes that the main predicate requires a temporal argument, one could still let an existential quantifier bind the time variable. For simplicity, I shall not consider this possibility, but this idea was adopted by many researchers (e.g., Ogihara, 1996). For our purposes, this can be assumed to be equivalent to the first account in which a tense provides a time of evaluation.

[5] Those who are unfamiliar with such concepts as referential and bound-variable pronouns are referred to Heim and Kratzer (1998).

[6] In a referential approach to tense, the condition that the time in question must be a past time is usually understood to be a presupposition, rather than an assertion.

other. Compare (6a) and (6b). (6a) is in the simple past tense, and (6b) is in the past progressive. Note that they are both in the past tense.

(6)   a.   Mary smiled.
        b.   Mary was smiling.

Intuitively, (6a) and (6b) are appropriate in different contexts and are not interchangeable. However, it is not easy to pinpoint the exact difference between them in terms of truth conditions. Both sentences indicate the existence of Mary's smiling in the past, but they differ from each other in some subtle ways. (6a) and (6b) appear to depict the "same situation" from different perspectives. To demonstrate the difference between them, let us compare (7a) and (7b). One important difference between (6a) and (6b) is clarified in (7a) and (7b). In (7a), Mary's smiling is understood to follow John's opening his eyes. On the other hand, in (7b) indicates that Mary was already smiling when John opened his eyes. This shows that two event sentences in the simple past used in sequence (e.g., (7a)) describe two relevant events that occur in this order, whereas an event sentence in the simple past followed by a sentence in the past progressive (e.g., (7b)) indicates that the situation described by the latter overlaps the situation described by the first sentence. Note that stative sentences usually behave like progressives in this respect as indicated by (7c).[7]

(7)   a.   John opened his eyes. Mary smiled.
        b.   John opened his eyes. Mary was smiling.
        c.   John opened his eyes. Mary was in the room.

This difference between the simple past and the past progressive is captured in Discourse Representation Theory, which is designed to describe and explain various discourse phenomena from a formal semantic viewpoint (Kamp and Reyle, 1993).[8] More discussion about the progressive will be presented in section 4. As for the English perfect, I (Ogihara, 1996) contend that it can receive a preterit interpretation as well as an aspectual interpretation. This point will be discussed in detail in Section 5.

   I assume throughout this article Vendler's (1967) four-way classification of verbs (or ultimately sentences) and use the terms states, activities, achievements and accomplishments. They are exemplified by sentences like (8a–d). A state generally describes a stable situation. An activity typically describes a dynamic situation that takes time but does not have a built-in goal. An accomplishment is like an activity except that it has a built in goal such as the existence of a completed house as in (8c). An achievement is an event that is characterized by a change of state that is understood to occur instantaneously. They are very rough intuitive descriptions of the four verb classes, but I believe that this is sufficient for our purposes.[9]

(8)   a.   John loved Mary. (state)
        b.   John swam in the river. (activity)
        c.   John built a house. (accomplishment)
        d.   John found Bill. (achievement)

---

[7] See (42).

[8] This DRT perspective on the behavior of progressives, statives and events is certainly an interesting one, but it is also a controversial one. See Dowty (1986), and Hinrichs (1986). See also Klein (1994).

[9] For a detailed description and analysis of the aspectual distinctions, the reader is referred to Dowty (1979) and the subsequent literature.

These aspectual classes are alternatively referred to as Aktionsarten (action types).[10] When we wish to group together achievements and accomplishments as those that involve built-in changes of states, the term ''telic'' (as opposed to ''atelic'') is used. I will use the following notional convention in this article: for any syntactic expression (a structure or lexical element) α, its meaning is indicated by [[α]].

With these introductory remarks, I shall discuss in what follows how formal semantic tools deal with various natural language data involving tense and aspect morphemes. In section 2, the fact that natural language tense systems only allow for a limited number of tense-like expressions associated with the same predicate will be discussed. Section 3 deals with the semantics of tenses in unembedded clauses. Section 4 discusses the progressive, and section 5 the perfect. Section 6 deals with embedded tenses, i.e. tenses in embedded clauses.

2. Limited complexity of tenses

In the logical tradition, Prior (1957, 1967) is known as the founder of tense logic and his contribution is important in the context of natural language semantics as well. He introduces tense operators into his logical language: **P** for past and **F** for future. Prior paraphrases his tense operators as in (9).

(9)   I shall, to begin with, employ the symbols **P** and **F** to mean respectively 'It has been the case that' and 'It will be the case that'. (Prior, 1957:8)

There are two noteworthy points here. One is that Prior analyzes a tensed sentence into a tense morpheme (or operator) and a tenseless sentence. The other is that Prior lets **P** represent the present perfect rather than the simple past. This shows that it is not Prior's intention to use the operator **P** to represent the meaning associated with the English past tense morpheme *-ed*. Montague (1973) follows Prior and lets the present perfect be translated into the tense operator **H** (mnemonic for *has*) in his logical language. This tense operator has an existential quantifier interpretation. For example, the English sentence in (10a) is symbolized as in (10b) and receives the interpretation given by the paraphrase in (10c).

(10)   a.   Kim has left.
          b.   P [leaves(Kim)]
          c.   There is a past time at which Kim leaves.

This means that Priorian tense logic or its Montagovian descendent does not say anything about the semantics of the English past tense morpheme per se.

It is well-known that tense morphemes in natural language cannot be iterated within the same clause. (11a–d) show the range of possibilities for English. English allows the past tense and the perfect to be used together as in (11b). However, the perfect cannot be iterated as shown in (11c). The same is true of the past tense morpheme *-ed* as indicated in (11d).

---

[10] Krifka (1989) uses a different term: temporal constitution.

(11)   a.   Kim left.
            b.   Kim had left.
            c.   *Kim had had left.
            d.   *Kim walkeded.

One noteworthy syntactic characteristic of Prior's system is that tense operators can be iterated. This means that (12) is well-formed (i.e. grammatical) and meaningful.

(12)   P[P[P[leaves(Kim)]]]

This is often taken to indicate the inadequacy of Tense Logic as a model for natural language tense systems (Hornstein, 1981, 1990). It is true that Prior's operator approach cannot be adopted for natural language as is, but this is not surprising. Tense logic is an artificial language, after all, and it should not be taken to be a complete simulation of how natural language tense morphemes work. Note also that when tense logic is actually introduced in a formal proposal for English as in Montague's (1973) system, tense operators are part of the intermediate language (called Intensional Logic) and not the language to be described (i.e., the object language). Montague (1973) adopts a set of syntactic rules for English that only produce grammatical strings. For example, one of the syntactic rules says that when a term phrase (=NP) α combines with an intransitive verb phrase δ (=VP) via this rule, the resulting string is $\alpha\delta'$, where δ' is the result of changing δ into its present perfect tense form. For example, this rule takes *John* and *walk* and yields *John has walked*. This is then translated as **H**[walks(j)]. There are similar rules for future tense, negated past tense, and negated future tense. There is no way to obtain forms like (11c, d) or an intermediate translation like (12) in this system. Thus, Montague's system never generates unwanted tense combinations that result from iteration of tenses. Thus, one can use tense logic as a tool for a formal semantic analysis of natural language without assuming that the former is exactly like the latter.

    I pointed out above that the iteration of the same tense (or tense-like) morpheme in the same minimal clause is impossible as demonstrated by the ungrammaticality of (11c–d). It is arguable, however, that iteration of tense-like expressions is possible in English to some extent though there is clearly an upper bound on the number of such expressions. The idea here is that multiple tense-like expressions, i.e. expressions that are syntactically distinct but behave semantically like prototypical tenses, do occur in the same minimal clause and convey meanings consistent with the presumed syntactic hierarchy among them. For example, it is arguable that the past perfect construction consists of two nested ''past tenses'' one of which surfaces as a perfect as shown in (13a). It is also arguable that the future perfect has a future tense and a preterit in the same clause with the former having scope over the latter as in (13b). Similarly for the future perfect in the past tense as in (13c).

(13)   a.   John had left $\Rightarrow$ PP[leaves (John)]
            b.   John will have left $\Rightarrow$ FP[leaves (John)]
            c.   John would have left $\Rightarrow$ PFP[leaves (John)]

The foregoing discussion suggests one way in which Prior's program sheds light upon the study of natural language tense systems. Unfortunately, the standard Priorian interpretation of the formulas in (13) would not yield the desired interpretations of the corresponding

English sentences.[11] To accurately describe the truth conditions of the English sentences in (13), we would need to combine the tense logic idea of hierarchically organizing tenses and Partee's (1973) idea that the interpretation of tensed sentences is sensitive to contextually specified times. For example, (13a) is reinterpreted in a system proposed in Ogihara (1996) as in (14). Here, RT_1 and RT_2 are mnemonic for Reichenbach's (1947) reference time, which is a contextually specified salient time. For example, RT_2 in (14) could be the time of the event described by the sentence that precedes (13a) in the discourse.

(14)   There is a time t_1 within RT_1 and there is a time t_2 within RT_2 such that t_1 is earlier than t_2 and t_2 is earlier than the utterance time and John leaves at t_1.

It is clear that we need a syntactic proposal in which each tense-like expression has an independent syntactic slot or projection. I propose one such system in Ogihara (1996). See Guéron (2004) for some recent proposals.

3. Unembedded tenses

In this section, I will discuss simple sentences in English to provide a basic characterization of their semantic properties in relation to Aktionsarten (or action types) of verbs. For the purpose of this article, I ignore generic sentences.[12]

First, let discuss the stative versus non-stative distinction. We will examine the four sentences in (15). (15a) describes one particular occurrence (what you might call a ''state'') of John's being in the office that obtains at the utterance time. When an occurrence of John's being in the office obtains in the past, then this situation is described by a sentence in the past tense as in (15b).[13] (15c, d) contain an event verb *build* and has different semantic properties. Unlike (15a), (15c) is not acceptable when it is used to describe John's building a house that is on-going at the utterance time. On the other hand, (15d) is acceptable when the whole event of John's building a house is located in the past.

(15)   a.   John is in the office (now).
        b.   John was in the office (yesterday).
        c.   ?John builds a house (now).
        d.   John built a house (last year).

In order to describe an on-going event of John's building a house, we must use the progressive as in (16a) instead of (15c). By contrast, the progressive sentence (16b) cannot be used to describe a current state of John's being in the office.

(16)   a.   John is building a house.
        b.   *John is being in the office.

---

[11] For example, **PP**[leaves(John)] and **P**[leaves(John)] have exactly the same truth conditions with the standard semantics of **P** and a dense structure of time. See Ogihara (1996:36).

[12] See Carlson and Pelletier (1995) for generic sentences.

[13] It is important to note that John's being in the room does not have to be located wholly in the past in order for (15b) to be true. For example, (15b) could be uttered truthfully when the speaker saw John working in the office yesterday. The sentence remains true even if we find out that John worked all night in the office and is still there.

The data in (15) and (16) show that we must distinguish between those sentences that are well-formed (and meaningful) in the simple present and those that are not. The ability to occur in the simple present tense is often used as a defining criterion for stative sentences. According to this position, (15a) is a stative sentence and the predicate *be in the office* is a stative predicate because of their ability to occur in the simple present. By contrast, (15c) is unacceptable and is therefore a non-stative sentence.

This strategy of sentence classification is useful, but this does not explain why statives and non-statives differ from each other just in this way. In the formal semantics literature, the standard account takes a slightly different tack and provides a plausible explanation of why statives and non-statives behave differently in the simple present tense. This account invokes the notion of ''subinterval property'', which shall be defined below (e.g., Bennett and Partee, 1972; Taylor, 1977; Vlach, 1981). Intuitively, stative sentences describe homogeneous situations. When some object is homogeneous, any proper part of this object has exactly the same make-up as the whole. This idea can be applied to the classification of sentences in question. For example, when John is in the office from 10 to 11, John is in the office at every moment of this one hour interval. On the other hand, non-statives do not have this same property. If John spends the entire month of January to build a house, it does not follow that John builds a house at every moment within January. The relevant intuition is that *John builds a house* does not describe a homogeneous situation and that the entire month of January is the time in relation to which John is in the extension of the VP *build a house*. The semantic intuitions described here are formalized (e.g., Bennett and Partee, 1972; Taylor, 1977; Vlach, 1981) in terms of the concept of **subinterval property** defined in (17).[14]

(17)   A tenseless sentence ϕ has the **subinterval property** iff the truth of ϕ with regard to some interval t guarantees the truth of ϕ with regard to all the subintervals of t.

An important idea that is preliminary to (17) (Bennett and Partee, 1972) is to take the truth value of a sentence ''at'' an interval to be basic.[15] In this system if John is in the office from 10 to 11, the tenseless sentence *John be in the office* is true with regard to this one hour interval. In the same way, when John builds a house in an month, the tenseless sentence *John build a house* is true with regard to the month of January. Given these assumptions, the question is whether each sentence is true with respect to proper sub-intervals of the relevant maximal interval. This is where (17) becomes important. We can now define a stative sentence as one that has the subinterval property as defined in (17) (Taylor, 1977; Dowty, 1979). I shall show below why this account is preferable to an alternative in which statives are defined as those that do occur in the simple present tense felicitously.

Let me add a parenthetical note about the idea that the truth value of a sentence can be evaluated with regard to extended intervals. Unlike instants, there is no convenient syntactic or morphological diagnostic to verify the truth of a sentence with respect to (non-instantaneous)

[14] Bennett and Partee (1972) introduce the idea that the extension of expressions should be determined in relation to an interval rather than an instant. On the basis of this idea, they define so-called activities (e.g., walk) as subinterval verb phrases and so-called achievements and accomplishments as non-stative non-subinterval verb phrases. Bennett and Partee define stative verb phrases as those that fail to occur in the progressive form. Taylor (1977:206) is the one who first defines stative predicates in terms of the subinterval property, though he does not use this term. The term ''subinterval property'' is used by Vlach (1981).

[15] More formally, this means that the extension of each constant is given in terms of its intension and an interval. See Dowty (1979) for one possible formalization.

intervals. In English, we cannot say *at January* or *at 1995* as shown in (18a). Instead, we depend upon constructions like "It took John X to . . ." or "John did . . . in X" as exemplified by (18b–c). With instants (or very short intervals), we can use PPs like *at 3 p.m.* as in (18d). It seems reasonable to say that if (18d) is true, John is in the extension of *leave* at 3 p.m.

(18)   a.   *John built a house at January.
        b.   John built a house in January.
        c.   It took John the entire month of January to build a house.
        d.   John left at 3 p.m.

(18a) shows that *at*-adverbials cannot be used to indicate an extended interval. We must use *in*-adverbials as in (18b). But the problem with *in*-adverbials is that they do not specify the exact interval throughout which the event or state described in the sentence obtains. Rather, they indicate temporal frames within which relevant events or states obtain. (18b) means that a part of January (and usually a proper part) is used by John to build a house. The best possible diagnostic would be the one used in (18c). When (18c) is true, we understand this to mean that *John build a house* is true with regard to (or "at") January.

Let us now go back to the main story line. The standard formal semantic account of the behavior of statives and non-statives in the simple present tense is based upon the subinterval property defined in (17) and can be briefly described as follows. It seems natural to assume that when a stative sentence (i.e., a sentence that has the subinterval property) of the form NP VP in the simple present tense is true, the denotation of NP is in the extension of VP at the utterance time. But what is the utterance time? The default answer is that it is the time used to utter the sentence in question. Since it takes time to utter any sentence, an utterance time is necessarily a non-instantaneous interval. Normally, when we utter a stative sentence in the simple present tense, we first observe a stable situation, and then decide to describe it in terms of this sentence. The idea is that this time delay is not crucial as long as it is short. What we assume or hope is that the same state continues to hold *throughout* the utterance of the sentence in question. Here, the term *throughout* is important. We do not claim that a simple present sentence we utter is true *at* the utterance time; we claim instead that it is true *throughout* the utterance time. This idea is given in a slightly more formal fashion in (19).

(19)   For any sentence in the simple present sentence **NP VP**, **NP VP** uttered at I
        (i.e., I is the entire interval needed to utter the sentence) is true iff for all
        subintervals I' of I, $[[NP]]^{I'} \in [[VP]]^{I'}$. Here $[[\alpha]]^{I'}$ indicates for any expression α,
        its extension at I'.

Given this hypothesis, it follows that only those sentences that have the subinterval property can be true in the simple present tense. Consider (15a), for example. Suppose that John is in the office from 10 to 11. Then John is in the extension of *be in the office* at the interval $\{t|\ 10 \le t \le 11\}$.[16] This in turn guarantees that John is in the extension of *be in the office* at every subinterval of $\{t|\ 10 \le t \le 11\}$. On this scenario, if (15a) is uttered at 10:30, the interval that is needed for the utterance (say a two second interval) is clearly a subinterval of $\{t|\ 10 \le t \le 11\}$. Finally, all of the subintervals of the utterance time are also subintervals of $\{t|\ 10 \le t \le 11\}$ due to the transitivity

---

[16] The question of whether the interval in question should contain 10 and/or 11 cannot be settled on an empirical basis. So the interval in question could be $\{t|\ 10 < t < 11\}$, for example. But this point is irrelevant for our purposes.

of the subset relation: if A ⊆ B and B ⊆ C, then A ⊆ C. This means that (15a) is true in the circumstance just described.

By contrast, (15c) cannot be true as we assume that the tenseless sentence *John build a house* does not have the subinterval property. Suppose that John builds a house using the entire month of January, (15c) cannot be true if it is uttered on January 15th because John is in the extension of build a house "at" January as a whole, but not at all subintervals of January. In fact, it is normally assumed that an accomplishment like *John build a house* has what you might call the non-subinterval property described in (20).[17]

(20)   ϕ is an accomplishment only if the truth of ϕ at *t* guarantees the falsity of ϕ at all proper subintervals of *t*.

Given (20), one can show formally that (15c) cannot be true given that an utterance time cannot be long enough to cover a time at which John is in the extension of *build a house*.

I now turn to some apparent problems with the above semantic account of Aktionsarten (action types). In some exceptional cases, a non-stative non-generic event (=achievement or accomplishment) sentence can be used felicitously in the simple present tense. This happens when an utterance of a sentence is used to describe an instantaneous (or near-instantaneous) event. (21) is the case in point. (21) could be used to describe the very action of Jones' passing the ball to Smith as it actually occurs in a basketball game.

(21)   Jones passes the ball to Smith.

The use of the simple present observed in (21) is called "reportive present" (Bennett and Partee, 1972; Kratzer, 1998). (21) is acceptable when the speaker utters it to describe a short event as it occurs. Since instances of reportive present are often found in radio sports commentaries, this could be referred to as a "live sports broadcaster use" of the simple present. Sentences like (22a, b) simply cannot be used in the reportive present in normal circumstances.

(22)   a.   ? John builds a house.
         b.   ? John writes a book.

Apart from this uncommon use of the simple present, event sentences do not occur felicitously in the simple present tense as exemplified by the oddness of (22a, b).[18]

Let us now turn to another potential problem with the above proposal, which is that activities generally do not occur felicitously in the simple present tense for a reportive meaning as shown in (23).

(23)   ? John runs.

---

[17] Bennett and Partee (1972) group accomplishments and achievements together and call them non-stative non-subinterval verb phrases.

[18] Karen Zagona (personal communication) correctly points out that newspaper headlines also occur in the simple present tense even when they contain event predicates. This is a different phenomenon since the simple present tense is not used to talk about an event or state that obtains now.

That is, (23) cannot mean that John is running. Bennett and Partee assume that activities are homogenous and have the subinterval property. That is, if John runs from 10 to 11, his running is claimed to obtain at any point within this one hour interval. If so, it is puzzling why (23) cannot occur in the simple present tense for a non-generic non-repetitive sense. One can offer the following explanation of this fact. Running is a complex act and is not really a homogeneous event, and one needs to observe the individual to determine whether she is simply moving her feet, is walking, or running. This means that when John runs from 10 to 11, he does not strictly speaking run at all proper subintervals of this one hour interval. This means that (23) does not have the subinterval property as defined in (17); it only has the subinterval property if subintervals are restricted to reasonably large intervals.[19] This then explains why (23) is unacceptable.[20] In this way, the subinterval property defined in (17) accounts for the distribution of different Aktionsarten (action types) in the simple present tense.[21]

As for future time reference by means of the simple present tense, this has a very restricted distribution. It occurs only when an event is certain to happen (Dowty, 1979) as exemplified by (24a, b). On the other hand, no sentence in the simple present tense can describe what happened in the past as indicated by (24c–d). It seems reasonable then to dichotomize time into past and non-past given that the present tense morpheme can describe a current situation or a future situation, whereas the past tense can only describe a past situation.[22]

(24)   a.   The Yankees play the Red Sox tomorrow.
         b.   The sun rises at 6:15 a.m. tomorrow.
         c.   *The Yankees play the Red Sox yesterday.
         d.   *The sun rises at 6:15 a.m. yesterday.

In a language like Japanese, the claim that the present and the future are grouped together can be substantiated more easily since a non-generic sentence in the present tense that contains a non-stative verb describes a future situation. For example, (25a) contains a non-stative verb and is in the simple present tense. It has future time reference. This is because an eventive sentence cannot be used in the simple present tense (except for some exceptional cases) to make reference to an on-going process due to the lack of the subinterval property (17). On the other hand, (25b) is normally understood to refer to a situation that holds at the utterance time.

---

[19] To my knowledge, Taylor (1977) was the first to discuss this fact in a formal setting. See also Krifka (1989).

[20] This account has difficulty accounting for examples like (i) if the unidentified object was constantly moving during the event in question. That is, it is unclear why (i) cannot describe a situation where the object is moving. Perhaps, we must stipulate that all events have the property (20) after all.

(i)   ? The unidentified object moves.

[21] The fact that progressives occur in the present tense can be explained if progressives are statives. Dowty (1986:44) shows that this is indeed the case if the subinterval property is taken to be the defining criterion for statives. See (42) for details.

[22] We should not ignore the historical present. But this may be a totally different phenomenon since a sentence in the present tense could describe a past situation but cannot have a co-occurring adverbial that clearly denotes a past interval. For example, (i) is unacceptable.

(i)   *John is in Seattle two months ago.

(25)   a.   Taroo-wa Tokyo-e iki-masu.
              Taro-TOP Tokyo-to go-PRES
              'Taro will go to Tokyo.'
        b.   Taroo-wa heya-ni i-masu.
              Taro-TOP room-at be-PRES
              'Taro is in the room.' (or 'Taro will be in the room.' — less preferred)

It is premature to group together the present and the future just in terms of the English and Japanese data presented here. Matthewson (2002) points out that some Salish languages do not distinguish between the past and the present, but the future is marked by some modal expression. Thus, more research is needed to say anything definitive about the behavior of the present tense making reference to future situations.

Let us now turn to the future tense (i.e., the future auxiliary *will*). This form is used to indicate a future situation as in (26).

(26)   Kim will leave tomorrow.

Traditionally, future tense is understood simply as a mirror image of past tense (Dowty, 1979). That is, (26) is true in w_0 at t_0 iff there is a future time (i.e., a time later than t_0) at which Kim leaves (and this time falls within tomorrow) in w_0 (Montague, 1973). This position was challenged by some researchers such as Enç (1985).[23] Enç (1985) claims that a future is a modal and is not a tense; it is a future-oriented modal. Abusch (1997) adopts Enç's idea and formalizes it. The idea is that (26) is true iff in all worlds accessible from the actual world via some relevant relation there is a future time within tomorrow at which Kim leaves. Obviously, it is not easy to characterize the relation in question exactly, but one possibility might be (27) (specified by means of an example for simplicity).

(27)   *Kim will leave tomorrow* is true in w_0 at t_0 iff in all worlds w in which events and
            states develop in a way compatible with how they have been developing in w_0 up
            until t_0, Kim leaves at some time within tomorrow.

The truth condition specified by (27) seems to be too weak, however, because by uttering a sentence containing *will* virtually forces the speaker to guarantee that the state of affairs in question obtains in the future. For example, suppose that Kim's landlord asks her to vacate her apartment, and Kim says (28a). Then she is committed to do so. If she fails to leave the premises tomorrow, she cannot say that that was merely her plan.

(28)   I will move out of my apartment tomorrow.

The idea that "future tense" has a modal ingredient may work better with examples like (29a, b), which contain the construction *be going to*. Both (29a) and (29b) describe a future situation, but the speaker is allowed to be less responsible for the truth of the sentence in question since discourses like (30a, b) are acceptable (Wulf, 2000). Note that (30c) sounds odd.

---

[23] See also Heim (1994).

(29) a. Kim is going to leave tomorrow.
      b. Kim is to leave tomorrow.

(30) a. Kim was going to leave the following day, but the bad weather prevented her from doing so.
      b. Kim was to leave the following day, but the bad weather prevented her from doing so.
      c. ?Kim would leave the following day, but the bad weather prevented her from doing so.

It is arguable then that *be going to* has a future modal meaning, whereas *will* has a non-modal future meaning despite their syntactic properties.

I now turn to the discussion of examples involving modal verbs (other than *will*).

(31) a. Terri may/should study (*now/tomorrow).
      b. Terri may/should like coffee (now/tomorrow).
      c. Leave (tomorrow)!

The fact that the adverb *now* cannot occur in (31a) but can in (31b) is easily accounted for by the subinterval property (17) combined with the idea that modal verbs are quantifiers over a restricted set of worlds as suggested by Kratzer (1981). Assuming that *may* and *should* have non-temporal character (i.e., non-future or non-past interpretation), one can paraphrase (31a, b) as in (32a, b).

(32) a. It is possible/necessary that Terri studies (tomorrow).
      b. It is possible/necessary that Terri likes coffee (now).

Since the time in relation to which each embedded clause is evaluated is the utterance time, the stative sentence *Terri likes coffee* can receive a coherent reading, but the event sentence *Terri studies* cannot since it does not have the subinterval property. We can then assume that it is reanalyzed as having a future time reference just like the Japanese present tense sentence (25a). If (32a) is rather stilted as an English sentence, a paraphrase with an infinitive in (33) perhaps makes the point more clearly; a future reading of the embedded clause is brought out more easily here.

(33) It is possible/necessary for Terri to study (tomorrow).

Regarding the imperative sentence (31c), it is sufficient to paraphrase it as in (34a) and to argue that ordering is inherently future oriented.

(34) a. I order you to leave.
      b. Be quiet!

(31c) has future time reference because it is an imperative sentence, not because it contains an event verb. Note that (34b) also must have future time reference despite the fact that it contains a stative verb phrase *be quiet*.

4. The progressive

The English progressive has been studied extensively in the formal semantics literature (Bennett and Partee, 1972; Dowty, 1979; Vlach, 1981; Landman, 1992). Bennett and Partee (1972) propose (35) to account for the semantics of the progressive.[24]

(35)   A progressive sentence PROG φ is true at t_0 (the utterance time if the sentence is in the present tense) iff there is an interval t_1 such that t_0 is a non final subinterval of t_1 and φ is true at t_1.

For example, (36a) indicates that the utterance time is contained within a more extended interval at which Lee is in the extension of *walk*. It appears that this is all we need to account for the semantics of the progressive. But it turns out that there are many difficulties with this simple account. Note also that any account of the progressive must also account for ungrammatical (or unacceptable) progressive sentences such as (36b).

(36)   a.   Lee is walking.
         b.   *Lee is resembling Terri.

Researchers generally agree that the utterance time of (36a) must contain a more extended interval at which the sentence without the progressive morpheme is true, but this account faces many counterexamples. Let us discuss some representative examples.

When a progressive sentence is true at *t,* the relevant situation does not continue beyond *t*. It simply is terminated at (the end of) *t*. (37a, b) show that the relevant event is terminated at the time indicated by the *when*-clause. Both examples show that (35) does not describe the truth conditions of progressives accurately.

(37)   a.   John was watching TV when he fell asleep.
         b.   John was building a house when he was struck by lightning.

Dowty (1979) and Landman (1992) agree that it is necessary to appeal to modal concepts to account for the behavior of the progressive. That is, the truth of (38) does not require that John finish building a house in the actual world; rather it requires that this take place in ''inertia worlds'' (Dowty, 1979).

(38)   John is building a house.

Dowty's proposal (1979:149) is formalized as in (39).[25] Inr (inertia function) is characterized as in (40).

(39)   [PROG φ] is true in *w* at *t* iff for some interval t_1 such that t is a non-initial and non-final proper subinterval of t_1, and for every world w_1 such w_1 $\in$ Inr($<w, t>$), φ is true in w_1 at t_1.

---

[24] (35) slightly paraphrases Bennett and Partee's original proposal.
[25] This slightly paraphrases Dowty's original (1979:149) but no essential change is made here.

(40)   Inr is a function that maps a world-time pair <w, t> to a set of worlds which are
            exactly the same as w up to t and in which the future course of events after this
            time develops in ways most compatible with the past course of events.
            (Dowty, 1979:148)

This brings possible worlds into the picture, and hence modal concepts. Parsons (1990)
disagrees with Dowty's proposal and claims that the truth conditions for progressives can
be stated without invoking modal notions. The debate is still on-going, but I think it is fair to say
that it is nearly impossible to account for the semantics of the progressive without invoking
modal notions.

Regarding the interaction between the progressive and action types (Aktionsarten) of verbs or
sentences, the research dates back at least to Vendler (1967). Vendler contends that the
progressive occurs with activities and accomplishments, but not with states or achievements. On
closer inspection, we find that achievements often occur in the progressive form as shown in (41)
(Dowty, 1979). When the "preparatory stage" of the relevant event described by the main
predicate obtains and it looks as though the event itself will obtains in the immediate future,
sentences such as (41a, b) are acceptable. An achievement typically does not have a clear
starting point as indicated by the oddness of sentences like (41c) and is regarded as an
instantaneous event as shown by the use of the adverbial *at 11 a.m.* in (41d). Thus, (39) does not
seem to account for (41a, b) in a straightforward fashion. See Ogihara (1998) for one possible
solution to this problem.

(41)   a.   John was reaching the top of the mountain.
            b.   John was dying.
            c.   ?John started to reach the top of the mountain at 10 a.m.
            d.   John reached the top of the mountain at 11 a.m.

We also need to account for the fact that states generally do not occur in the progressive
form. It is undesirable to define stative sentences as those that cannot be progressivized. It is
better to account for this fact in pragmatic terms. Dowty (1986:44) shows that a progressive
sentence has the subinterval property. This can be proven assuming an account of the
progressive along the lines of (35) or (39). (42) shows that given (35), a progressive has the
subinterval property (hence a stative if the subinterval property is used as the defining criterion
for stativity).

(42)   For any non-stative sentence ϕ and any time t such that PROG ϕ is true at t_1,
            there is a time t_2 such that $t_1 \subseteq t_2$ and ϕ is true at t_2 (from (35)). This means that
            for any time $t_3 \subseteq t_1$ PROG ϕ is true at t_3 given the transitivity of the subset relation.

The idea is this: stative sentences already have the subinterval property by definition, it is not
necessary to "stativize" it further since this operation is semantically vacuous. This explains why
(36b) is unacceptable. I believe that this account is essentially correct. The fact that (43a) is an
apparent problem for this account since *be nice* is has the subinterval property and occurs in the
simple present tense as in (43b). This problem is more apparent than real because *be nice* in (43a)
clearly has an eventive reading: to act nice. If *be nice* is used as an event predicate, then it is
natural for it to occur in the progressive form to obtain the subinterval property. Similarly, *stand*

can be used as an eventive predicate as in (43c) or as a stative predicate as in (43d), which is consistent with the above discussion.[26]

(43)   a.   John is being nice.
        b.   John is nice.
        c.   John is standing at the corner of the street.
        d.   The statue stands at the corner of the street.

Another type of present tense progressive that needs to be discussed here is futurate progressive. (44a) is a present progressive, but it contains an adverb that denotes a future time (i.e., *tomorrow*) and talks about a future time. Thus, (44a) is not truthconditionally distinct from (44b).

(44)   a.   Terri is walking tomorrow.
        b.   Terri will walk tomorrow.

Dowty (1979) attempts to provide a comprehensive account of the progressive that "futurate" progressives. But a lot of questions still remain. Interested readers are referred to Landman (1992) for an account of the progressive that attempts to incorporate the insights of many previous proposals.

5. The perfect

I now turn to the semantics of the English perfect. The difficulty of dealing with this construction is well demonstrated by McCoard (1978). McCoard presents many different accounts of the English perfect such as current relevance theory, indefinite past theory, extended now theory, and embedded past theory. They all have advantages and disadvantages. Dowty (1979) formalizes extended now theory. Dowty's (1979) account based upon extended now theory of the perfect is stated as follows. A present perfect presupposes the existence of an "extended now", an extended interval that contains the utterance time as a final subinterval, and locates an event or state described by the sentence within this interval. Dowty's proposal (1979:342) is paraphrased in (45).

(45)   [PRES PERF ϕ] is true in w at t iff there is an interval t_1 such that t is a proper final subinterval of t_1 and there is a time t_2 falling within t_1 such that ϕ is true in w at t_2.

The theory is so called because the denotation of *now* is extended into the past and provides a long interval as a contextually salient time. Support for this view comes from the fact

---

[26] An anonymous reviewer points out that examples like (i) are possible.

(i)   That statue of Paul Revere is still standing at the corner of East and Main, as it has been for as long as
        I can remember.

Note here the use of the adverbial *still*, which strongly suggests that the state in question is terminable, and this seems to license the progressive form in (i). Since it is hard to contend that what (i) describes does not have the subinterval property, we may need to invoke a different idea such as "temporary property" to account for some progressives.

that a temporal adverbial that can occur in a present perfect refers to an interval that contains the utterance time. This is shown by the data in (46). (46a) contains the adverb *today,* which clearly includes the utterance time, and is acceptable. On the other hand, (46b) contains the adverb *yesterday,* which completely precedes the utterance time, and is unacceptable. Dowty's idea is to account for this co-occurrence restriction in semantic terms. That is, the English perfect requires that there be an event located within an extended now.

(46)   a.   John has been working today.
          b.   *John has been working yesterday.

When there is no co-occurring adverb, this idea does not produce a significant semantic difference between a preterit and a perfect. A preterit locates an event or state at or within a contextually salient past interval; a perfect locates one within an extended now. Since the only truth-conditional difference between them is the possibility that a perfect can locate a relevant event or state at an interval that contains the utterance time, the difference between them is almost nil.

Intuitively, there is a subtle but important meaning conveyed by the perfect that is not captured by the extended now analysis as formalized by Dowty (1979). To capture this intuition, some researchers turn to what may be called a resultant state analysis of the perfect. Parsons (1990) distinguishes between target states (concrete results that can be undone) and resultant states (abstract states that cannot be undone). Using Parsons' terminology, result states described by perfects are perhaps better referred to as ''target states'' rather than ''resultant states''. The idea is that the perfect locates a relevant event in the past but requires also that a target state in the sense of Parsons (1990) be located at an extended now. For example, (47a) requires that the passport have not turned up as of now; (47b) that the mess made by the spilled coffee has not been cleaned up.

(47)   a.   John has lost his passport.
          b.   John has spilled his coffee.

This type of approach is adopted by Kamp and Reyle (1993) and is intuitively appealing. However, since the target state associated with a perfect is not always obvious, the resultant state analysis does not make the truth conditions of the perfect substantially different from the preterit. For example, there is no truth-conditional difference between (48a) and (48b). Perhaps (48a) is used when John died very recently, whereas (48b) has no such constraint. But there does not seem to be a target state associated with (48a) that is crucial for its truth.

(48)   a.   John has died.
          b.   John died.

Nevertheless, it is undeniable that the English present perfect makes a claim about an extended now, and this needs to be accounted for in some way.

Let me now turn to the past perfect. The past perfect is clearly ambiguous between an aspectual meaning and a past tense meaning (embedded in the scope of the preterit). This can be seen in the following fact: when a present perfect and a simple past are reported later by means

of an indirect discourse verb such as *say,* their semantic difference cannot be represented by means of distinct morphological forms. For example, both (49a) and (49b) can be reported by (49c) at a later time. One could obviously use the simple past in the verb complement clause as in (49d) to report a past tense utterance. However, this is by no means obligatory (Ogihara, 1996).

(49)   a.   John: Bill has lost his wallet.
        b.   John: Bill lost his wallet.
        c.   John said that Bill had lost his wallet.
        d.   John said that Bill lost his wallet.

This shows that the past perfect is at least two-way ambiguous. The interpretation of temporal adverbials also suggests the ambiguity of the past perfect. For example, (50a) is ambiguous between two readings. One indicates that the event of Terri's finishing has already taken place by 1 p.m. The other indicates that the event took place at 1 p.m. There is no such ambiguity in (50b); 1 p.m. can only indicate the finishing time.

(50)   a.   Terri had finished at 1 p.m.
        b.   Terri finished at 1 p.m.

The ambiguity of the past perfect is also suggested by the fact that a past perfect sentence can contain an adverbial that indicates the time of the ''previous event'' but a present perfect sentence cannot. For example, (51a) is acceptable, whereas (51b) is ruled out.

(51)   a.   Terri had finished her paper the day before.
        b.   *Terri has finished her paper yesterday.

Stump (1985) contends that the perfect is inherently ambiguous between a preterit interpretation and a perfective interpretation. He shows that the perfect exhibits ambiguity in all forms with the exception of the present perfect. Consider examples like those in (52).

(52)   a.   Having finished her paper yesterday, Terri is now relaxed.
        b.   Terri must have finished her paper yesterday.

Examples like (52a, b) show that the perfect is capable of expressing anteriority in all forms except in the (finite) present perfect form. This leads Stump to hypothesize that the non-ambiguity of the present perfect is an anomaly that needs to be explained. Stump's account goes like this. The present perfect in English is in principle capable of expressing a preterit meaning but its preterit interpretation is ''suppressed'' because there is another form (V-ed) that specializes in expressing a preterit interpretation. This restriction is grammaticized in English, and (51b) is therefore ungrammatical. This account is plausible given that in many European languages (such as German and French), the present perfect (*have* or *be* plus a past participle) is used to indicate a preterit meaning. This is shown by the fact that past oriented adverbials freely occur in the present perfect in these languages.

When the perfect is combined with different tense morphemes, examples like those in (53) are obtained. Most data are accounted for by the proposal made in Ogihara (1996), but the fact that *by*

now can occur in (53a) is problematic. If the future auxiliary *will* is always future oriented, this is unexpected.

(53)   a.   Kim will have finished the project (by now/by next May/*by last May).
         b.   Kim has finished the project (by now/*by next May/*by last May).
         c.   Kim had finished the project (*by now/*by next May/by last May).

(53a) shows that *will* can receive a purely modal (i.e., non-temporal) interpretation in some cases, in which case it has a meaning of epistemic necessity stronger than that conveyed by epistemic *must*.

6. Embedded tenses

The behavior of tense morphemes in embedded clauses requires careful treatment. First of all, complement clauses and other types of clauses (relative clauses in particular) must be distinguished. In English, complement clauses and relative clauses are clearly distinguished in terms of the ways in which tense morphemes are used there. Put simply, tense morphemes in relative clauses behave as if they are independent of structurally higher tenses, whereas those in verb complement clauses are clearly ''affected'' by structurally higher tenses.[27] This is shown by the examples in (54). (54a) does not allow the time of Sam's sickness to be after the time of Marty's hearing; (54b) allows any time relationships between Mary's meeting the man and the man's being sick.

(54)   a.   Marty heard [that Sam was sick (the previous day/that day/*the next day).]
         b.   Marty met the man [who was sick (the previous day/that day/the next day).]

In my own work (Ogihara, 1996) I explained the difference in terms of a sequence-of-tense rule (a tense deletion rule in my proposal), *de se* attitudes (Lewis, 1979; Cresswell and von Stechow, 1982) and quantifier raising. Technical details aside, the idea is that the interpretation of (55a) is accounted for by assuming that the embedded tense is deleted before LF (where the structure is semantically interpreted) (Ogihara, 1995a, 1996). That is, the embedded past tense is deleted

---

[27] An anonymous reviewer points out that verbs like *dream* produce counterexamples to this generalization as in (i-a) (see also Giorgi and Pianesi, 1997). However, *dream* does not represent an attitude in this context, and this is not a standard use verb complements from a cross-linguistic point of view. For example, Japanese cannot express the content of a dream or fantasy with a verb complement clause as shown in (i-b). Instead a sentence like (i-c) must be used to indicate the meaning conveyed by (i-a). The Japanese nominalizer *-no* is glossed as 'fact' here. Although this is not accurate, it was used because there is no better English word for it.

(i)   a.   Thursday night, Marty dreamt [that Sam was sick on Friday].
         b.   *Mokuyoo-ni Taroo-wa Hanako-ga kinyoo-ni ki-ta to kuusoosi-ta. Thursday-on Taro-TOP
                   Hanako-NOM Friday-on come-PAST that fantasize-PAST
                   Lit. 'On Thursday, Taro fantasized that Hanako came on Friday.'
         c.   Mokuyoo-ni Taroo-wa Hanako-ga
                   Thursday-on Taro-TOP Hanako-NOM
                   kinyoo-ni kuru koto-o kuusoosi-ta.
                   Friday-on come-PRES NOM ACC that fantasize-PAST
                   Lit. 'On Thursday, Taro fantasized the fact that Hanako comes on Friday.'

under identity with the local tense, i.e. the matrix past tense. As a result, the LF structure (55b) of (55a) has a tenseless embedded clause.

(55)   a.   Sam thought that Terri was in Boston.
         b.   Sam PAST think that Terri $\varnothing$ be in Boston

The semantic interpretation based upon the structure in (55b) is obtained on the basis of the idea that the embedded clause is interpreted in relation to the time referred to by the matrix past tense (rather than in relation to the utterance time). Thus, the tenseless verb complement clause is understood to describe Terri's being in Boston as a situation co-temporaneous with Sam's thinking, which is located in the past. This is the so-called simultaneous reading associated with (55a). The same line of reasoning accounts for the so-called shifted reading associated with (55b). This reading is not the default reading associated with (55b), but could be made salient by adding an adverbial like *the day before* as in (56a). This reading is based upon the LF structure in (56b). The embedded past tense is interpreted in relation to the matrix past tense. Thus, the time of Terri's being in Boston is understood to be prior to Sam's thinking, which itself obtains in the past.

(56)   a.   Sam thought that Terri was in Boston the day before.
         b.   Sam PAST think that Terri PAST be in Boston the day before

The sequence-of-tense rule could be encoded without positing a tense deletion rule. Kratzer (1998) presents an alternative model in which she posits a D-structure that is suited for semantic interpretation. That is, (55b) can be regarded as the D-structure of (55a). This null tense then assumes the phonetic value of the higher tense, which is Kratzer's sequence-of-tense rule. Kratzer justifies her approach by drawing an analogy between pronouns and tenses.

Before providing a formal semantic analysis verb complements, one must realize that the truth value of a sentence of the form NP V S, where S is the complement clause of V, cannot be determined compositionally if the meaning provided by the S is its extension (i.e., truth value). This type of compositionality problem with a purely extensional semantic system was originally noted by Frege (1892). For example, it is conceivable that (57a) is false while (57b) is true even though both complement clauses (*Japan has a president* and *the U.S. has a prime minister*) are actually false.

(57)   a.   [John [believes [that Japan has a president]]]
         b.   [John [believes [that the U.S. has a prime minister]]].

That this is problematic for a compositional semantic theory can be shown in the following way: (i) Assuming that the meaning of a constituent is a function of the meanings of the parts, (57a) and (57b) must have the same meaning if they have exactly the same set of ''semantic ingredients''; (ii) The same subject (i.e., *John*) is used in (57a, b). Since the interpretation function[[]][28] by definition maps one and the same expression to one and the same individual, the subject NPs denote the same individual; (iii) The same main verb (i.e., *believe*) is used in (57a, b). Thus, their verbs have the same meaning; (iv) (57a) and (57b) have different complement clauses. However, since they are both false, their denotations are the same; (v) since the three constituents in (57a) and those in (57b) indeed have the same meanings respectively, (57a) and (57b) must also have the same meaning.

---

[28] It is a function from object language expressions to their semantic values (=meanings).

That is, (57a) and (57b) must be either both true or both false. To be more specific, let us assume that the truth value of (57a) is determined as in (58a), whereas that of (57b) is obtained as in (58b).

Assume here that [[]] is a function (called valuation function) from expressions to their meanings. Given the condition in (58c), the condition in (58d) obtains because [[believes]] (i.e., the meaning of *believes*) is a function. It is now clear that (58a) is equivalent to (58b).

(58)   a.   [[[believes]]([[that Japan has a president]])] ([[John]])
        b.   [[[believes]]([[that the U.S. has a prime minister]])] ([[John]])
        c.   [[that Japan has a president]] = [[that the U.S. has a prime minister]]
        d.   [[[believes]]([[that Japan has a president]])] = [[[believes]] ([[that the U.S. has a prime minister]])]

This result clearly goes against our intuition because it is conceivable that (57a) and (57b) have different truth values (in the actual world at a particular time).

Factive verbs such as *know* require that the complement clause be true in order for the entire sentence to have a truth value.[29] But note that (59a) and (59b) can have different truth values on a par with (57a, b). Thus, (59a) and (59b) also lead us to conclude that the truth value of the complement clause is not sufficient to determine the truth value of a sentence like (59a, b).

(59)   a.   John knows that Japan has a prime minister.
        b.   John knows that the U.S. has a president.

These observations led Frege to propose that each expression is associated with ''two layers of meaning'' so to speak in order to maintain compositionality. These two semantic layers or levels are referred to as **reference** and **sense.** Put crudely, reference is concrete meaning, and sense abstract meaning. The assumption is that for any expression α, its sense is more particularized and informative than its reference. Given this distinction, one can argue that in (57a, b), the two complement clauses have different senses, which can contribute to the fact that they have different truth conditions. After this revision, (57a, b) are distinguished as in (60a, b). Just for the purpose of this article, the intension of any expression α is indicated by $\ll\alpha\gg$.[30] Since the senses of the two complement clauses are assumed to be distinct as indicated in (60c), it is possible for the two VPs to have different values. That is, the state of affairs given in (60d) is possible. This in turn means that it is possible for (60a) and (60b) to have different truth values.

(60)   a.   [[[believes]]($\ll$that Japan has a president$\gg$)] ([[John]])
        b.   [[[believes]]($\ll$that the U.S. has a prime minister$\gg$)] ([[John]])
        c. $\ll$that Japan has a president$\gg \neq \ll$that the U.S. has a prime minister$\gg$
        d.   [[[believes]]($\ll$that Japan has a president$\gg$)] $\neq$ [[[believes]]($\ll$that the U.S. has a prime minister$\gg$)]

---

[29] Technically, this is a presupposition rather than an assertion because when the embedded clause is false, the entire sentence is anomalous rather than false, (i) is one such example.
(i)   John knows that the U.S. has a prime minister.
[30] Note that $\ll\gg$ is not a standard notation at all. I am using it just for the purpose of simplifying and clarifying the concept of sense (or intension).

This system allows us to accommodate the fact that (57a) and (57b) can have different truth values even when the verb complement clauses in (57a, b) have the same truth value.

The sense of a sentence is generally called ''proposition'' and is normally encoded by a function from world-time pairs (or worlds) into truth values. Montague (1973) adopts the view that a proposition is a function from world-time pairs into truth values. Given this definition of proposition, it is now technically possible to distinguish semantically between the verb complement clauses in (57a, b). For example, even though both *Japan has a president* and *the U.S. has a prime minister* are false in the actual world now, it is conceivable that only one of them is false at a different time and/or in a different world. For example, in determining the truth value of (61), one must imagine a ''world'' (call it w_1) that is closest to the current one among those in which Japan has presidency. In so doing, it is not necessary to assume that the U.S. has no president in w_1. In fact, we assume that in w_1 the U.S. *does* have a president as in the real world. This means that in w_1 *Japan has a president* is false, but *the U.S. has a prime minister* is true.

(61)   If Japan had a president instead of a prime minister, it would be a better country.

In this way, (60c) is substantiated. This in turn shows that (60d) is possible and that (60a) and (60b) can be distinct.[31]

Let us assume with Montague (1973) that a proposition is a set of world-time pairs. I can then provide the semantic rule for complement-taking verbs as in (62). To simplify our discussion, the semantics is given in terms of a concrete example sentence: *Kim claims that Marty is sick.*

(62) $[[\text{Kim claims that Marty is Sick}]]^{w_0, t_0} = [[\text{Claim}]]^{w_0, t_0}$ ($\ll$Mary is sick$\gg$)
        ($[[\text{Kim}]]^{w_0, t_0}$ = true in w_0 at t_0 iff every $<w,t>$ that is compatible with what
        Kim claims in w_0 at t_0 is such that $\ll$Mary is sick$\gg(<w,t>)$ = true.

A different way of looking at the same proposal is to think of a set of world-time pairs as a property of times, i.e., the intension associated with a set of times. This is in line with Lewis's idea that we need a property rather than a proposition as the object of belief (so-called *de se* beliefs) (Lewis, 1979) and can be given as in (63). The basic idea is that a verb like *believe* denotes a relation between individuals and properties, rather than propositions. Put another way, when John believes S, John self-ascribes the property associated with S (Cresswell and von Stechow's 1982; Ogihara, 1996).

(63) $[[\text{Kim claims that Marty is sick}]]^{w_0, t_0} = [[\text{claim}]]^{w_0, t_0}$ ($\ll$Marty is sick$\gg$)
        ($[[\text{Kim}]]^{w_0, t_0}$ = true iff Kim talks as if she self ascribes the property of being located
        at a world time pair $<w,t>$ such that $\ll$Marty is *sick*$\gg$ $(<w,t>)$ = true.[32]
        (Put another way, every doxastic alternative $<w,t>$ of Kim in w_0 at t_0 is an element
        of {$<w,t>$ | Mary is sick in w at t}.)

Since a proposition is understood to be a set of world-time pairs and the sentence is in the present tense, it is natural to assume that $\ll$Marty is sick$\gg$ in (62) and (63) is that function F that maps

---

[31] This proposal works only if the embedded clause is not a tautology or contradiction. For cases involving tautologies and contradictions, we should adopt a *de se* analysis (Lewis, 1979) of propositional attitude verbs.

[32] $[[\text{Kim claims that Marty is sick}]]^{w_0, t_0}$ reads the meaning of ''Kim claims that Marty is sick'' in w_0 at t_0. Similarly for other expressions.

every element of $\{<w,t>|$ Mary is sick in w at $t\}$ and nothing else to true (or 1). According to (62), the sentence *Kim claims that Mary is sick* is true in w_0 at t_0 iff every pair $<w,t>$ that is compatible with What Kim claims in w_0 at t_0 is where Marty is sick. According to (63), the sentence is true iff every world-time location that Kim accepts as her location is one in which Marty is sick. In either case, if what Kim claims is true, then Marty is indeed sick in the world and at the time Kim makes the claim, namely in the actual world at the utterance time.[33]

Given this preliminary, I now turn to the present case, namely the semantics of tense in complement clauses. The point that should be clear from the foregoing discussion is that (64a) can be true even if Terri has never been in Boson and never will be. There could be many circumstances in which (64a) is true without the complement clause being true. If there is no time when Terri is actually in Boston, how could we talk about a "simultaneous reading" or "shifted reading" associated with sentences like (64a)? We pretend that Sam spoke the truth, and then examine our intuitions as to when Sam would be sick in order for the sentence to be true. Thus, the semantics of verb complements inevitably involves modal notions. As stated earlier, my proposal represents the simultaneous reading of (64a) as in (64b) at LF, and its shifted reading as in (64c).

(64) a. Sam thought that Terri was in Boston.
      b. Sam PAST think that Terri $\varnothing$ be in Boston
      c. Sam PAST think that Terri PAST be in Boston

Let us assume that there is a past time of Sam's thinking that is relevant for the interpretation of (64b), and let us refer to this time as t_1. Then (64b) is true if [[Sam think that Terri $\varnothing$ be in Boston]] = true in w_0 at t_1. (Assume that w_0 is the real world.) This condition holds iff Sam self-ascribes at t_1 the property of being located at a world-time pair $<w,t>$ at which [[Terri $\varnothing$ be in Boston]] is true. Suppose that Sam indeed has at t_1 the property he self-ascribes, then [[Terri $\varnothing$ be in Boston]] is true at t_1 (in the actual world). Assuming that *Terri $\varnothing$ be in Boston* is a tenseless sentence, we can conclude that Terri is in Boston at t_1. This is an account of the "simultaneous reading" of (64a) based upon the idea that the embedded tense gets deleted before the sentence is subject to semantic interpretation rules.

The "shifted reading" is obtained on the basis of (64c). Assume that t_2 is a past time and is the time of Sam's thinking in question. We can then say that (64c) is true iff [[Sam think that Terri PAST be in Boston]] = true in w_0 at t_2. This condition holds iff Sam self-ascribes at $<w_0, t_2>$ the property of being located at $<w, t>$ at which [[Sam think that Terri PAST be in Boston]] = true. Here we assume that the embedded clause has the following intension: that function F that maps any element of $\{<w_4, t_4>|$ there is a time t_5 earlier than t_4 such that Terri is in Boston at t_5 in $w_4\}$

---

[33] Lewis's idea that a complement-taking verb like *believe* denotes a relation between individuals and properties is fully generalized when the object of belief (or some other concept described by the verb) is a function that involves worlds, times and individuals. A property (=the intension of an intransitive verb or VP) is such a semantic entity. For example, in analyzing the semantics of (i), it is useful to understand the embedded clause as providing the following property: that function F from world-time pairs into sets of individuals such that for any world w and time t, F($<w,t>$) = $\{x|$ x is Hume in w at t$\}$. (i) is then understood in such a way that it is true iff Heimson self-ascribes the property of being Hume.

(i)   Heimson believes that he is Hume.

This solves the problem associated with tautologies and contradictions. For details, see Ogihara (1996).

and nothing else to true.[34] If at $<w_0, t_2>$ Sam indeed has the property he self-ascribes, then there is a time t_5 earlier than t_2 and Terri is in Boston in w_0 at t_5. This corresponds to the shifted interpretation of (64a).

Enç (1987) espouses a referential theory of tense and proposes a different approach to tense morphemes in verb complement clauses. A major difference between Enç's approach and my proposal presented above (Ogihara, 1996) is that the former analyzes the simultaneous reading of (64a) in terms of the surface tense forms (essentially of the form given in (65)). The idea here is that the embedded past tense is co-indexed with the matrix past tense, and this indicates simultaneity of their denotations.

(65)   Sam PAST$_1$ think that Terri PAST$_1$ be in Boston

For reasons of space, I shall not go into the details of how this syntactic configuration is mapped to an acceptable semantic interpretation.[35] It suffices to say for our purposes that at least in the simultaneous reading of (64a), the two occurrences of the past tense morpheme do indicate past time reference, and coindexing them makes sense intuitively. In this account, any occurrence of past tense indicates a time earlier than the utterance time. It would be nice if we could account for all occurrences of past tense without positing a rule that allows for a discrepancy between the surface morphological forms and the forms used for semantic interpretation. However, I argue (Ogihara, 1995a, 1996) with Abusch (1988) that Enç's proposal cannot deal with more complex examples involving multiple embedded clauses such as (66a). The crucial point made with (66a) is that the lowest past tense morpheme (i.e., *were*) can be interpreted in such a way that it does not denote a time earlier than the utterance time; in fact, it does not even denote a time earlier than any other relevant time mentioned in the sentence. To be more specific, the meal time can be simultaneous with his saying time, which is clearly a future time. But the meal time is indicated by past tense. If all three occurrences of past tense are there at LF as in (66b), it is not clear how the index 3 on the lowest past can indicate a future time co-temporaneous with his saying time, which is indicated by future tense.[36] On the other hand, if my proposal is adopted, the two embedded occurrences of past tense get deleted by the tense deletion rule before LF as in (66c) and the interpretation proceeds in a straightforward fashion.

(66)   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 PAST$_1$ decide a week ago that in ten days at breakfast he PAST$_1$ woll say to his mother that they PAST$_2$ be having their last meal together.
         c.   John PAST decide a week ago that in ten days at breakfast he $\emptyset$ woll say to his mother that they $\emptyset$ be having their last meal together.

---

[34] This is a rendition of past tense in terms of a quantificational theory of tense. A rendition based upon a referential theory of tense would be slightly different, but this difference is irrelevant to the point being made.

[35] We can assume that the embedded tense receives a *de re* interpretation. Cresswell and von Stechow (1982) present one analysis of *de re* attitudes that is based upon the *de se* analysis of attitudes originally proposed by Lewis (1979) and is empirically accurate.

[36] The future tense is indicated by woll, which is understood to be a morpheme that is the tenseless form of *will* and *would* (Abusch, 1988).

In this way, a proposal based upon tense deletion, a *de se* analysis of attitudes (e.g., beliefs, claims, etc.) provides an empirically satisfying account of tense morphemes in verb complement clauses.

An important exception to the generalizations obtained so far is the structure that came to be referred to as the ''double-access sentence'' and is exemplified by (67). (67) shows that the state described by the complement clause must hold throughout an extended interval that spans both the original time of Kim's saying and the utterance time of the entire sentence (if what Kim said is true, that is). The adverbial *two years ago* is unacceptable in (67) because a human pregnancy could not possibly last two years. This construction was discussed at length by Ogihara (1996) and Abusch (1997). Ogihara and Abusch agree that it is an instance of *de re* attitude report and adopt a variant of Cresswell and von Stechow's (1982) proposal. According to Ogihara (1995b, 1996), (67) means that there is some state s at the utterance time of (67) and at the relevant past time Kim ascribes to s the property $\{<w,t,s>|\ s$ is a state of Terri's being pregnant and s exists at t in w$\}$. The point is that since the state must be a current state from the viewpoint of the attitude holder (i.e., Kim), the state must be extensive enough to overlap the time of Kim's saying. Moreover, since Kim merely ascribes to this state the property of (being a state of) Terri's being pregnant, the truth of (67) does not require that Terri be pregnant at any time. Perhaps Terri got a big stomach as a result of overeating, but Kim mistook it for a sign of pregnancy. Abusch's (1997) account is similar except that her solution involves a *de re* attitude about an interval rather than a state.

(67)   Kim said (*two years ago) that Terri is pregnant.

Ogihara (1995b, 1996) also discusses examples like (68a) (as opposed to (68b)) and says that (68a) is an instance of a *de re* attitude report (or double-access sentence) on a par with (67).

(68)   a.   Kim said that Marty will leave (tomorrow/*last May).
         b.   Kim said that Marty would leave (tomorrow/last May).

Kim's original statement locates Marty's leaving in the future relative to the time of Kim's statement. But (68a) locates Marty's leaving in relation to the utterance time of (68a). Thus, one and the same event (i.e., Marty's leaving) is described from two different temporal perspectives. The perspective adopted in the report is not the same as the one used by the original speaker. (68a) means that there is a future time t (in relation to its utterance time) such that Kim ascribes (at the time of her saying) to t the property of being a time at which Marty leaves and t lies in the future of the time of Kim's saying. Since the same time (i.e., the time of Marty's leaving) is described from two different times (the utterance time and the time of Kim's saying), (68a) is also claimed to be an instance of ''a double-access sentence''.

7. Conclusion

I have discussed a basic set of examples involving various tense and aspect constructions in English and have presented representative formal semantic analyses of the data. Although many problems remain, it is clear that the precise nature of formal semantic analyses allows us to accrue many interesting findings about natural language tense and aspect constructions.

It is hoped that this article will further stimulate discussion among researchers who are interested in the same empirical problems but subscribe to different theoretical persuasions.

Acknowledgements

References

Abusch, D., 1988. Sequence of tense, intensionality and scope. In: Borer, H. (Ed.), Proceedings of the West Coast Conference on Formal Linguistics, vol. 7. Stanford Linguistics Association, Stanford, CA, pp. 1–14.

Abusch, D., 1997. Sequence of tense and temporal *de re*. Linguistics and Philosophy 20, 1–50.

Bennett, M., Partee, B., 1972. Toward the Logic of Tense and Aspect in English. Indiana University Linguistics Club, Bloomington, IN.

Carlson, G., Pelletier, F.J., 1995. The Generic Book. The University of Chicago Press, Chicago, IL.

Comrie, B., 1976. Aspect. Cambridge University Press, Cambridge.

Cresswell, M.J., von Stechow, A., 1982. *De re* belief generalized. Linguistics and Philosophy 5, 503–535.

Dowty, D., 1979. Word Meaning and Montague Grammar: The Semantics of Verbs and Times in Generative Semantics and in Montague's PTQ. D. Reidel, Dordrecht.

Dowty, D., 1986. The effects of aspectual class on the temporal structure of discourse: semantics or pragmatics? Linguistics and Philosophy 9, 37–61.

Enç, M., 1985. Temporal Interpretation. Ms., University of Southern California, Los Angeles.

Enç, M., 1987. Anchoring conditions for tense. Linguistic Inquiry 18, 633–657.

Frege, G., 1892. On sense and reference. In: Geach, P., Black, M. (Eds.), Translations from the Philosophical Writings of Gottlob Frege. Blackwell, Oxford, p. 1960.

Giorgi, A., Pianesi, F., 1997. Tense and Aspect: From Semantics to Morphosyntax. Oxford University Press, Oxford.

Guéron, J., 2004. The Syntax of Time. MIT Press, Cambridge, MA.

Heim, I., 1994. Comments on Abusch's theory of tense. In: Kamp, H. (Ed.), Ellipsis, Tense and questions. DYANA Administrator, Centre for Cognitive Science, University of Edinburgh, Edinburgh, UK, pp. 143–170.

Heim, I., Kratzer, A., 1998. Semantics in Generative Grammar. Blackwell, Malden, MA.

Hinrichs, E., 1986. Temporal anaphora in discourse. Linguistics and Philosophy 9, 63–82.

Holt, J., 1943. Études d'Aspect. Acta Jutlandica 15 (2), 1–84.

Hornstein, N., 1981. The problem of meaning in natural language: three approaches to tense. In: Hornstein, N., Lightfoot, D. (Eds.), Explanation in Linguistics. Longman, London.

Hornstein, N., 1990. As Time Goes By: Tense and Universal Grammar. MIT Press, Cambridge, MA.

Kamp, H., Reyle, U., 1993. From Discourse to Logic: Introduction to Modeltheoretic Semantics of Natural Language Formal Logic and Discourse Representation Theory. Kluwer, Dordrecht.

Klein, W., 1994. Time in Language. Routledge, London.

Kratzer, A., 1981. The notional category of modality. In: Eikmeyer, H., Rieser, H. (Eds.), Words, Worlds, and Contexts: New Approaches to Word Semantics. Mouton de Gruyter, Berlin, pp. 38–74.

Kratzer, A., 1998. More structural analogies between pronouns and tenses. In: Strolovitch, D., Lawson, A. (Eds.), Proceedings of Semantics and Linguistic Theory VIII, Ithaca. CLC Publications, New York, pp. 92–110.

Krifka, M., 1989. Nominal reference temporal constitution and quantification in event semantics. In: Bartsch, R., van Benthem, J., von Emde Boas, P. (Eds.), Semantics and Contextual Expression. Foris Publications, Dordrecht.

Landman, F., 1992. The Progressive. Natural Language Semantics 1, 1–32.

Lewis, D., 1979. Attitudes *de dicto* and *de se*. The Philosophical Review 88, 513–543.

Matthewson, L., 2002. Tense in a 'tenseless' language, talk presented at University of Washington, May 24, 2002.

McCoard, R.W., 1978. The English Perfect: Tense-Choice and Pragmatic Inferences. North-Holland Publishing Company, Amsterdam.

Montague, R., 1973. The proper treatment of quantification in ordinary English. In: Hintikka, J., Moravcsik, J.M.E., Suppes, P. (Eds.), Approaches to Natural Language, Proceedings of the 1970 Stanford Workshop on Grammar and Semantics. D. Reidel, Dordrecht, pp. 221–242.

Ogihara, T., 1995a. The semantics of tense in embedded clauses. Linguistic Inquiry 26, 663–679.

Ogihara, T., 1995b. Double-access sentences and reference to states. Natural Language Semantics 3, 177–210.

Ogihara, T., 1996. Tense, Attitudes and Scope. Kluwer Academic Publishers, Dordrecht.

Ogihara, T., 1998. The ambiguity of the *-te iru* form in Japanese. Journal of East Asian Linguistics 7, 87–120.

Parsons, T., 1990. Events in the Semantics of English: A Study in Subatomic Semantics. MIT Press, Cambridge.

Partee, B.H., 1973. Some structural analogies between tenses and pronouns in English. The Journal of Philosophy 70, 601–609.

Prior, A., 1957. Time and Modality. Clarendon Press, Oxford.

Prior, A., 1967. Past, Present and the Future. Clarendon Press, Oxford.

Reichenbach, H., 1947. Elements of Symbolic Logic. Macmillan, New York.

Stump, G., 1985. The Semantic Variability of Absolute Constructions. D. Reidel, Dordrecht.

Taylor, B., 1977. Tense and continuity. Linguistics and Philosophy 1, 199–220.

Vendler, Z., 1967. Linguistics in Philosophy. Cornell University Press, Ithaca, New York.

Vlach, F., 1981. The semantics of the progressive. In: Tedeschi, P.J., Zaenen, A. (Eds.), Syntax and Semantics, vol. 14: Tense and Aspect. Academic Press, New York, pp. 271–292.

Wulf, D. 2000. The imperfective paradox in the English progressive and other semantic course corrections. Ph.D. dissertation, University of Washington, Seattle, WA.