TENSE, ASPECT, AND THE INTERPRETATION OF TENSELESS ELEMENTS IN ENGLISH

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1 Abstract

An analysis of English tense and aspect is presented that specifies temporal precedence relations within a sentence.\footnote{The work presented here was supported by SRI International. I am grateful to James Allen, Phil Cohen, Bill Croft, Doug Edwards, Jerry Hobbs, Doug Moran, and Fernando Pereira for helpful discussion and comments. Discussion after presentation of parts of this work at the ACL conference in Buffalo in June 1988 was very helpful. I would also like to thank Martha Dalrymple and Jack Kingsland for their help.} The relevant reference points for interpretation are taken to be the initial and terminal points of events in the world, as well as two "hypothetical" times: the perfect time (when a sentence contains perfect aspect) and the progressive or during time. We also describe a method for providing temporal interpretation for nontensed elements such as nouns and adjectives, whose interpretation may be temporally dependent.

2 Introduction

The analysis of tense and aspect requires specifying what relations can or cannot hold among times and events in the world. For example, a specification of the meaning of the past-tense sentence "John ate a cake" involves the fact that the time of the main event--in this case, the cake-eating event--precedes the time of utterance of the sentence. Various proposals have also been made regarding the analysis of aspect which involve auxiliary times or events, whereby the proper relationship of these auxiliary times or events to "real" main events is specified.

We provide an analysis of English tense and aspect that involves specifying relations among times rather than events. We also offer a means of interpreting tenseless elements like nouns and adjectives whose interpretation may be temporally dependent. For example, the noun phrase "the warm cakes" picks out different sets of cakes, depending on the time relative to which it receives an interpretation.

The analysis presented here has been implemented with the Prolog data base query system CHAT (Pereira 1983), and the representations are based on those used in that system. We shall show that an analysis of tense and aspect involving specification of relations among times rather than among events results in a clean analysis of various types of sentences.

3 Reichenbach

One of the earliest analyses of English tense and aspect was given by Reichenbach (1947). He introduced the notion of point of reference as distinct from point of the event and point of speech. According to his analysis, the semantic representations of all tensed sentences contain all three of these event points.

The following is Reichenbach's representation of the simple past:
R denotes the reference point, E the point characterized by the main verb, and S the speech time. The arrow indicates progression through time. Even for a simple tense, all three points are involved in the representation. Here the reference point R and the main event time E are identified.

The following is a representation of a sentence in the simple future:

Here it is the speech point S and the reference point R that are identified, with the main event time E situated at a future time.

Reichenbach's analysis involves the claim that these "points" are not exactly like one-dimensional points on a time continuum, since they can have duration if progressive aspect is involved. If there is progressive aspect, the points are considered to be extended. Reichenbach analyzes past progressives in the following way:

The reference event R and the main event E are identified with a reference point of non-zero duration. This point precedes the speech time S.

Analyses similar to this one, in which three time points are posited for each tensed clause and their position is fixed on a time line, have been proposed by Hornstein (1977) and Yip (1985), among others. We shall now discuss some deficiencies of analyses such as these.

4 Harper and Charniak

Harper and Charniak (1986) present an interesting and revealing analysis of tense and aspect for English which involves relations between events. There are several kinds of events: the utterance event, which is associated with the time of the utterance; the main event, or the event being described by the main verb of the sentence; the perfect event; and the progressive event. The representation of every sentence involves the utterance event and the main event; sentences with progressive or perfect aspect also involve progressive or perfect events.
Note that Harper and Charniak’s “utterance event” and “main event” are exactly parallel to the “speech point” and “main point” proposed by Reichenbach; the difference in Harper and Charniak’s analysis is that their representations do not include a reference point, but may include a perfect event or a progressive event. This is an important advantage of their proposal: they do not assume that the interpretation of every sentence involves exactly three events.

In addition to the main event and the speech event, sentences in progressive aspect embody a progressive event, and sentences in perfect aspect embody a perfect event. A perfect progressive sentence embodies a speech event, a main event, a progressive event, and a perfect event. In this way, Harper and Charniak furnish a uniform analysis of perfects and progressives without the need to introduce extraneous events or reference times into simple tense sentences.

In the case of perfect sentences like I will have arrived, the perfect event is a hypothetical event that occurs after the arriving event. It is this event that is adverbially modified in a sentence like I will have arrived by 3:00; the perfect event is constrained to occur at 3:00, and the arriving event occurs prior to it. As for the progressive event, it takes place during the main event. In the case of simple progressives, it is a hypothetical event that occurs during the main event. It is the event modified in utterances such as He was swimming at 3:00; the progressive event takes place at 3:00, during the swimming event. In the case of perfect progressives, the progressive event occurs during the main event, while the perfect event follows the progressive event.

This treatment is quite different from Reichenbach’s conception of “reference time”, which is assumed to be relevant for all sentences. To translate between the two systems, the reference time may be thought of as being represented by the perfect event in perfect sentences and by the progressive event in progressive sentences. In the case of perfect progressives, one might consider that there are two reference events, while in simple tenses there is no reference event at all. Alternatively, in a system like Webber (1987) in which reference points for each sentence are used to construct an event structure, the tensed event (what H&C call the “anchor event”) is the relevant one: the perfect event for sentences with perfect aspect; for sentences with progressive but no perfect aspect, the progressive event; or the main event for simple tense sentences.²

Another attractive feature of Harper and Charniak’s analysis is that they do not impose an absolute order on all the events in the representation of the sentence. That is, they do not represent the relations among these events on a Reichenbach-style time line. Rather, they impose constraints on relations among the events that need not fully determine all interevent precedence relations. For example, a simplified representation for a sentence like He will have arrived is the following:

\[(4) \quad \langle \leq \text{end arriving-event} \rangle \quad \langle \text{begin perfect-event} \rangle\]
\[
\langle \langle \leq \text{end utterance-event} \rangle \quad \langle \text{begin perfect-event} \rangle \rangle
\]

²Although instants rather than events are used in the representation described here, a similar strategy would be employable in building up a Webber-style event structure.
The main event (an arriving event) must conclude at or prior to the beginning of the perfect event. The perfect event must begin after the utterance event ends: that is, it must lie in the future.

Note that, in this case, no specification is made as to the relation of the main event (the arriving event) to the utterance time. In Reichenbach's treatment, and in more recent treatments (Hornstein 1977; Yip 1985), the main event is constrained to be in the future when the sentence is future perfect. This comes about because the representation of each sentence is constructed with reference to a time line, and it is not possible to assign a "vague" placement to an event on a time line. Its relation to all the other reference points must be completely specified. For Harper and Charniak's analysis, but not for the others, a sentence like

(5) He will surely have arrived by tomorrow, and he may already have arrived.

is not a contradiction. That is, even when the main event has occurred in the past, a future perfect sentence referring to that event may be true. By underspecifying relations among events, Harper and Charniak provide better coverage of the facts.

One important aspect of Harper and Charniak's analysis is their treatment of sequencing constraints among the events they posit. The order in which constraints are applied is main-progressive-perfect-tense, in a manner reminiscent of that described in Mathiessen (1984):

- First the main event times are provided; at the outset, the main event is the one to be predicated about.
- If the sentence contains progressive aspect, a progressive event is introduced and its relation to the main event made explicit. Progressive events are taken to be events that occur during the main event: they begin after the main event has started and end before its termination. The progressive event then becomes the event to be predicated about next.
- If the sentence contains perfect aspect, a perfect event is introduced. It is constrained to follow the event being predicated about (the progressive event, if there is one; otherwise the main event). The perfect event then becomes the one to be predicated about next.
- Finally, tense specifications are applied to whatever event is being predicated about (the perfect event, if there is one; otherwise the progressive event, if there is one; otherwise the main event). For example, if the sentence has future tense, the event is constrained to be in the future.

Harper and Charniak also pick out what they call the "anchor" event in the tensed clause. This is the event that is marked by tense: it is the first verb in the verb phrase except in the special case of the auxiliary verb will, which is treated as a tense marker. In the case of future tense, the event represented by the second verb is the anchor event.
Harper and Charniak use the “anchor event” in their analysis of adverbial subordinate clauses. They provide a very detailed analysis of several subordinate clause types; for the correct interpretation to be made, it is sometimes necessary in their analysis to determine whether the main clause or the subordinate clause contains progressive or perfect events. The information that must be present for adverbial subordinate clause interpretation is, therefore, the following:

1. aspect of the subordinate clause and main clause;
2. main and anchor events of the subordinate and main clause;
3. lexical form of the temporal connective.

The operation performed depends on the temporal connective.

Harper and Charniak take the position that every event can be modified. For example, a present perfect progressive sentence containing an adverb is triply ambiguous, depending on which of its three events is regarded as being modified by the adverb. This claim seems to be too strong. Consider a sentence with perfect and progressive aspect:

(6) John will have been swimming.

This sentence contains a perfect, a progressive, and a main event. Harper and Charniak place the following constraints on their sequencing: the perfect event is in the future, the progressive event precedes the perfect event, and the progressive event occurs during the main event.

We may add the adverbial modifier for three hours to produce

(7) John will have been swimming for three hours.

It does not seem reasonable to maintain that this sentence can be true when John has swum for only twenty minutes if one requires the perfect event to have a duration of three hours. It does not even seem to make sense to speak of the duration of the perfect event in this case, nor of the progressive event. A phrase like for three hours can be sensibly taken to modify only the main event. We shall return below to a discussion of problems such as this.

5 Time Points

In accordance with Harper and Charniak, we propose perfect reference points for sentences with perfect aspect and progressive reference points for sentences with progressive aspect. Thus, the interpretation of each sentence involves a number of relevant times: the beginning and end of the event described by the main verb for all sentences, the perfect time if it has perfect aspect, and the progressive time if it has progressive aspect. Our analysis differs
from that of Harper and Charniak, however, in the contention that what is relevant for the interpretation of sentences is not a set of events but a set of times or instants. Instants, unlike events, have no beginning or end: they are one-dimensional points. In our analysis, then, temporal relations will be specified between instants of time (such as the beginning and ending points of an event) rather than between events. There are several reasons for making this choice.

First, if the reference points for perfect and progressive sentences are events rather than instants, it ought to be possible to predicate duration of them. However, this is not a possible option for perfect and progressive sentences: durational adjuncts are only interpreted relative to the main event. The sentence John has swum for three hours is only true when the duration of the main event (the swimming event) is three hours.

Second, relations among events in Harper and Charniak’s system reduce anyway to relations between the starting and ending points of events. That is, the primitives of systems like Harper and Charniak’s are relations among times. There seems to be little to be gained from constructing hypothetical events based on these relations when a simpler and cleaner analysis can be constructed on the basis of these primitive notions alone.

There might seem to be the following objection to adopting times as relevant for the interpretation of sentences: given a sentence like ‘John was frosting a cake from 3:00 to 4:00 yesterday’, we know about the progressive reference point only that it lies between 3:00 and 4:00; there are infinitely many instants satisfying that condition. It would be impossible to iterate over all of these times to determine the truth of any utterance.

In fact, though, to determine whether a sentence containing perfect or progressive aspect is true, it is unnecessary to do this type of iteration. That is, there is no need to instantiate the perfect or progressive time to a specific value; it suffices to show that an interval exists within which such a point can be found. In this manner, perfect or progressive times may give the appearance of being similar to events with a starting and an ending point, because they are constrained only to exist within some nonnull interval. Checking whether or not the sentence is true involves determining whether the interval exists.

First, let us examine the form of representation for simple sentences and for sentences containing perfect and progressive aspect. (We shall see later that the representation of simple sentences must be enriched somewhat; here we present only a first approximation.) Next we will examine the way truth values of the formulas in these representations are determined.

The following is the representation for the simple past sentence John frosted a cake, with words in upper case representing variables and words in lower case representing predicate names or constants:

(8) exists C Start End
     holds(frost(john, C), Start, End)
     & cake(C)
     & precede(End, now)
The predicate holds in the first clause of the representation takes three arguments:

1. the predicate frost with its two arguments;
2. the beginning time of the cake-frosting event;
3. the ending time of the cake-frosting event.

The predicate cake(C) specifies that the thing John frosted was a cake. We do not represent this with a holds predicate because we assume here that the property of being a cake is a static property, not one that changes over time.³

The predicate precede(End, now) specifies that the ending time End of the cake-frosting event must precede now, the current time. In the course of validating this logical form, the variable End will be instantiated to a numerical value, and the atom now will be replaced by the value of the current time. The predicate precede represents the less-than-or-equal-to relation, while the predicate strictly_precede represents the less-than relation. Thus, the cake-frosting event must occur in the past. This sentence will be true if there is an event involving John's frosting C, where C is a cake and the end of this cake-frosting event lies in the past.

Let us next consider the semantic representation of a sentence with perfect aspect, John will have frosted a cake:

(9) \[ \exists C \text{Start End Perfect} \]
\[ \text{holds(frost(john, C), Start, End)} \]
\[ \& \text{cake(C)} \]
\[ \& \text{precede(End, Perfect)} \]
\[ \& \text{strictly_precede(now, Perfect)} \]

The interpretation of perfect sentences involves a perfect time: the variable Perfect in the example above. This time is constrained to follow the main event; this is enforced by the clause precede(End, Perfect). Since this is a future perfect sentence, the perfect time Perfect is constrained to be in the future. The future tense is represented by the predicate strictly_precede; the perfect time must follow now (not coincide with it).

Note, therefore, that in the case of future perfect sentences the main event is required only to end before a time in the future, and that (as with Harper and Charniak's analysis) the following sentence is not a contradiction:

(10) John will have arrived by 3:00, and he may already have arrived.

³This is not a necessary part of the analysis; this decision has been made partly to simplify the representations presented here. It would be equally satisfactory to represent the predicate cake(C) inside a holds predicate, with the beginning and ending times corresponding to the times the cake began and ceased to exist.
Unlike analyses like Reichenbach’s, in which relations among all reference points are fully specified, this analysis allows the main event to be in the past even though the sentence itself is in future perfect aspect.

We shall now turn to the representation of sentences in the progressive. The following is a representation of the past progressive *John was frosting a cake:*

(11) \[
\text{exists } C \text{ Start End Progressive} \\
\text{holds(frost(john, C), Start, End)} \\
\& \text{ cake(C)} \\
\& \text{ precede(Start, Progressive)} \\
\& \text{ precede(Progressive, End)} \\
\& \text{ precede(Progressive, now)}
\]

Here the progressive time is represented by the variable Progressive. Progressive must occur during the cake-frosting event; that is, it must occur after the start of the main event Start, and before the end of the main event End. Since the sentence is a past progressive, there is a final requirement on the progressive time Progressive: it must precede now.

Notice that past progressives differ from simple past sentences in that it is the progressive time and not the ending time of the main event that is required to be in the past. Consequently, as in Harper and Charniak’s analysis, the interpretation of a past progressive like *John was frosting a cake* does not require that the main event lie entirely in the past, but only that some part of it be in the past. The following sentence is not a contradiction:

(12) *John was frosting a cake at 3:00, and he is still frosting it.*

The present analysis allows for the possibility that sentences analogous to this can be true.

We shall see in the next section that what was referred to as the progressive time in the foregoing example actually appears in the representation not only of progressives, but of every sentence, as what we shall call the during time. The during time will be used in the temporal interpretation of nontensed elements in the sentence. For this reason, the above representations of the simple past and future perfect sentences above were only a first approximation.

Finally, the representation of a sentence with both progressive and perfect aspect, like *John will have been frosting a cake,* is the following:

(13) \[
\text{exists } C \text{ Start End Perfect Progressive} \\
\text{holds(frost(john, C), Start, End)} \\
\& \text{ cake(C)} \\
\& \text{ precede(Start, Progressive)} \\
\& \text{ precede(Progressive, End)} \\
\& \text{ precede(Progressive, Perfect)} \\
\& \text{ strictly_precede(now, Perfect)}
\]
Progressive is the progressive or during time, occurring during the cake-frosting event:

(14) \( \text{precede(Start, Progressive)} \)
\( \text{precede(Progressive, End)} \)

The perfect time is Perfect. By the clause \( \text{precede(Progressive, Perfect)} \), the progressive time Progressive is constrained to precede the perfect time. In other words, for a perfect progressive sentence, the requirement is that some portion of the main event lie before the perfect time. The perfect time is constrained by the clause \( \text{strictly_precede(now, Perfect)} \) to lie in the future.

Given a representation like this one, the advantages of Harper and Charniak’s system are retained. Underspecification of relations among times yields results that match the natural-language semantics of sentences. Use of a perfect and a progressive time allows uniform treatment of perfects and progressives without the complication of introducing otherwise unwarranted reference events into the representation of simple tenses. The disadvantages of Harper and Charniak’s rather cumbersome use of events instead of times in their representations are also allayed.

6 Temporal Interpretation of Nontensed Elements

Not only tensed verbs, but also other nontensed elements in the sentence – adjectives, nouns, prepositions, and so on – must be interpreted with respect to some instant or time interval.

Consider the sentence

(15) \( \text{Are there any warm cakes?} \)

The adjective warm must be interpreted relative to some time: in this case, the present. The question is about cakes that are currently warm.

The interpretation of nontensed elements does not always depend on the time the sentence is uttered, though. The sentence

(16) \( \text{The third-year students had to take an exam last year.} \)

can be interpreted in two ways. Under one interpretation, those who were third-year students last year (the current fourth-year students) had to take a test last year. The interpretation of the noun phrase the third-year students is dependent on the tense of the main verb in this case. Under the other interpretation, those who are currently third-year students took a test last year, when they were second-year students.

Another example of the same type is:

\(^4\text{We have not yet enriched the representation of individual predicates to include inherent aspect, as described in, for example, Passoneau (1987). We feel, though, that the resulting representations will still involve the use of perfect and during times, and will still be amenable to the treatment of nontensed elements described in the next section.}\)
(17) John will frost a warm cake at 3:00.

Under one interpretation, the cake is warm at 3:00 when he frosts it, but it is not necessarily warm at the time of utterance of the sentence. Under the other interpretation, the cake is warm now, but it may not be warm when he frosts it.

However, the interpretation of nontensed elements with respect to the tense of the main verb in the sentence is not entirely unconstrained. Consider the following sentence:

(18) The wife of the president was working in K-Mart in 1975.

*Wife* and *president* are both predicates that must be interpreted with respect to a particular time. The current president is not the same as the 1975 president; if he divorced and remarried, his 1975 wife is not necessarily the same person as his current wife.

Given the fact that both *wife* and *president* are interpretable with respect to either the time of the tensed verb or the time of the utterance, there ought to be four possible interpretations of this sentence. In fact, there are only three:

- He is the current president and she is his current wife
- He is the current president and she was his wife in 1975
- He was the president in 1975 and she was his wife then (but perhaps he is divorced and no longer president)

The missing interpretation is that

- He was the president in 1975 and she is his current wife (but was not his wife then)

A skeletal tree for this example is:

(19)

```
s
  np
    the wife

  pp
    p
      of
      np
        the president

  vp
    was working in K-Mart in 1975
```
The sentence involves the syntactic embedding of one NP (the president) inside another NP (the wife). The unavailable interpretation is one in which the embedded NP is interpreted with respect to the event time of the higher verb, whereas the intervening NP is not. That is, the unavailable interpretation involves interpreting a discontinuous portion of the tree with respect to the main verb. It is not possible to interpret a deeply embedded predicate with respect to the event time of the main tensed verb unless the intervening material is also interpreted in the same manner.

As a first approximation, one may think of the main-verb event time as being passed or disseminated through the tree. It may be passed down to embedded predicates in the tree only when it is passed through intermediate predicates and used in their interpretation. If a predication is interpreted with respect to the current time rather than to the event time of the main verb, all predications that are syntactically subordinate to it are also interpreted with respect to the current time. When this happens, the main-verb event time ceases to be passed down and may not be reinstated for interpretation.

Note, however, that the verb time and the time with respect to which the nontensed elements are interpreted are not always completely coextensive. Consider again the example

(20) John will be frosting a warm cake at 3:00.

Under the interpretation that the cake is warm while John is frosting it, the time span during which the cake is warm must include the time 3:00, but the cake may have been warm before John starts frosting it; moreover, it may continue to be warm after John finishes frosting it. That is, the starting and ending points of the cake-frosting event need not coincide exactly with the starting and ending points of the interval at which the cake is warm. The only requirement is that both events must hold at 3:00.

Now consider the sentence

(21) John built a new house.

The building event can be thought of as beginning before the event of the house's being new. At the start of the building event, there is no house, nor, obviously, is there any event of the house's being new. In a situation like this, one does not want to require that the building event be contained within the event of the house's being new, but rather, merely to require that the two events should overlap.

Our claim is that, in general, temporal interpretation of nontensed elements relative to the tense of the main verb of the sentence requires only that the event denoted by the main verb overlap (not be coextensive with or be contained in) the events denoted by the nontensed elements. We shall accomplish this by positing a time for each main verb, the

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5As we will see in the next section, it is possible to construct a context in which the "missing interpretation" is in fact available for this sentence. The claim made here is that this interpretation is not available by means of the syntactic variable-passing mechanism discussed in this section, but is only available by appealing to the context constructed. The "missing interpretation" is missing when there is no context to refer to for additional interpretations.
inteval: a'rn and fro,st. The first holds predicate, specifies that John frosted C (required by the second clause in the example to be a cake) from time Start1 to time End1. The second holds predicate.

exists C Start1 End1 During Start2 End2
holds(frost(john, C), Start1, End1)
& cake(C)
& precede(End1, now)
& precede(Start1, During)
& precede(During, End1)
& holds(warm(C), Start2, End2)
& precede(Start2, During)
& precede(During, End2)

There are two predicates in this example that are interpreted with respect to a temporal interval: warm and frost. The first holds predicate

holds(frost(john, C), Start1, End1)

specifies that John frosts C (required by the second clause in the example to be a cake) from time Start1 to time End1. The second holds predicate

holds(warm(C), Start2, End2)

specifies that C is warm from time Start2 to time End2. The precede predicates specify the relations between these times. The predicate precede(End1, now) specifies that the end of the cake-frosting event precedes now, the time of utterance. That is, the cake-frosting event must lie in the past. The next two predicates

precede(Start1, During)
precede(During, End1)

specify that time During is the during time for this event. The final two predicates

precede(Start2, During)
precede(During, End2)

specify that the during time of the cake's being warm is also During. In other words, there must be a time During that occurs during both the cake-frosting event and the event of the cake's being warm: the two events must overlap.
Since the interpretation of every sentence involves positing a *during* time, we propose that progressive aspect involves nothing more than a kind of syntactic access to this *during* time. What Harper and Charniak call the “progressive event” is simply the *during* time in a syntactically accessible form.

For example, consider the sentence

(27) *John was frosting warm cakes at 3:00.*

The modifier *at 3:00* instantiates the *during* time to 3:00. In this case, there are two predicates whose interpretation is temporally dependent: the adjective *warm* and the verb *frost.* Instantiating the progressive/*during* time to 3:00 means not only that there must be an event of John’s frosting the cakes going on at 3:00, but also that the cakes must be warm at 3:00. It is not enough simply to require that the cakes were warm at any time during the event of John frosting them.

Further, all elements within a NP node are interpreted with respect to the same event. It is not possible, for example, to interpret some elements of a noun phrase with respect to the time of utterance, others with respect to the main verb *during* time. Consider the sentence

(28) *John frosted three stale warm cakes yesterday.*

Despite the pragmatic predilection for interpreting *stale* and *warm* at different times (it is hard to imagine how cakes that are still warm could already be stale), this sentence has only two interpretations:

- John frosted three cakes that were both stale and warm yesterday.
- John frosted three cakes yesterday that are both stale and warm now.

It is not possible to give the sentence the interpretation that the cakes he frosted were warm yesterday and are stale now, or were stale yesterday and are warm now. Both adjectives must be interpreted with respect to the same time.

If a system like Harper and Charniak, in which events and not instants are taken to be the relevant reference points, were extended to include interpretation of nontensed elements as described here, such a system might use primitives such as those of Allen (1984). However, none of the primitives of Allen’s system is suitable for defining the relation of the *during* time to the main event: *during(DuringEvent, MainEvent)* is not sufficient, since Allen’s “during” relation does not permit the DuringEvent to coincide with the beginning or end points of the main event. The example “John built a new house” shows that this is necessary; in this case, it is precisely the end point of the building event that coincides with the beginning of the event of the house being new. In a system using Allen’s primitives, the proper relation between the DuringEvent and the MainEvent would be a disjunction:

(29) *during(DuringEvent, MainEvent) OR starts(DuringEvent, MainEvent) OR ends(DuringEvent, MainEvent)*
7  Passing the During Time: Rules for Temporal Interpretation

In the previous section, we examined the temporal interpretation of phrases with respect to the *during* time of the main verb. In addition, we proposed a constraint on the passing of this *during* time from the verb through its arguments and adjuncts, according to which predicates interpreted according to the *during* time must occupy a non-discontinuous portion of the tree. From the point of view of the tenseless phrase, however, the same process can be seen in a different light.6

We may think of the interpretation of temporally dependent elements in a phrase as proceeding in the following manner:

- The phrase is interpreted with respect to a temporal modifier internal to the phrase; otherwise
- The phrase is interpreted with respect to the closest higher tensed element (allowing for restrictions on the distribution of the *during* variable); otherwise
- The phrase is interpreted with respect to some contextually relevant time.

Temporally dependent nontensed elements in previous sections were always contained in phrases that lacked internal temporal modifiers, so the first option was not applicable. One of two interpretations was given for tenseless elements: they were interpreted with respect either to the *during* time of the main verb or to *now*, the time of utterance. Interpretation with respect to *now* seems to be a particular instance of the general possibility of interpretation with respect to a contextually relevant time; since no context was given for the examples in the previous sections, no other contextually relevant time was available. When a phrase contains a phrase-internal temporal modifier, the predicates in that phrase must be interpreted with respect to that modifier, as in the example

(30) The 1975 president is living in California.

The modifier 1975 in the phrase the 1975 president provides the temporal interpretation of the phrase: it must be interpreted with respect to that time. It is not possible to interpret president relative to the *during* time of the main verb.

Hinrichs (1987) also proposes that noun phrases be interpreted relative to a time restricted by the context; the difference between his analysis and ours is that, of the three options presented above, he offers only the last. He contends that the only option for temporal interpretation of nontensed elements is the third one, namely, by reference to context.

Given an analysis like that of Hinrichs, it is difficult to explain the facts noted in the preceding section. In the absence of context (or when the sole context is the moment of utterance), Hinrichs would not predict the absence of one reading for sentences such as

6I am grateful to Bill Croft for helpful discussion on these points.
(31) The wife of the president was working in K-Mart in 1975.

(cannot mean that he was the president in 1975 and she is his current wife, but was not his wife then)

In an analysis like the one presented here, where the interpretation of non-tensed elements is determinable in some instances through syntactic processes, the absence of these readings is expected.

It seems that it is not possible to pass a during time through a NP containing an internal temporal modifier. Consider the following sentence:

(32) The 1970 wife of the president was working in K-Mart in 1975.

The main verb during time is constrained to be in the year 1975, whereas the wife predicate must hold in 1970. It is difficult to attach any strict temporal interpretation to the noun phrase the president; it seems that its interpretation must be done pragmatically.²

Enc (1981) and Hinrichs (1987) both argue convincingly that there are many instances in which a temporally dependent element is interpreted with respect to a time that is neither the during time nor now. Hinrichs furnishes the following example:

(33) Oliver North’s secretary testified before the committee.

At the time she testified, she was no longer his secretary; she was also not his secretary at the time this sentence was uttered. It would receive the following interpretation:

(34) exists FH Start1 End1 During1 Start2 End2 During2
    holds(secretary(north, FH), Start1, End1)
    & precede(Start1, During1)
    & precede(During1, End1)
    & holds(testify(FH), Start2, End2)
    & precede(Start2, During2)
    & precede(During2, End2)
    & precede(End2, now)

The first four clauses specify simply that there is an event of FH being secretary to Oliver North that holds from Start1 to End1. During1 is a time during this event.

The next clauses specify that there is a testifying event by FH that holds from time Start2 to time End2. The during time for this event is During2. As indicated by the clause precede(End2, now), this event is in the past.

²It is, of course, possible to construct a discourse context for this example such that either 1970 or 1975 will be the preferred time with respect to which the president is interpreted; the claim here is that these interpretations do not result from the syntactic option of passing of a during time through a tree, but are supplied pragmatically.
In this example, the event of FH's being a secretary is not required to overlap with the event of FH's testifying. The *during* times are merely existentially quantified over. In a more complete representation, the appropriate restrictions would be imposed on time
Start2: the time during which FH is a secretary would be restricted by the context, in line with Hinrichs' suggestions.

8 Progressive Aspect and Stative Verbs

There are interesting similarities between progressives and statives. These similarities come about because the *during* time is important in the interpretation of both. Mathiessen (1984) provides the following example in which both perfect aspect and a stative verb are used:

(35) *In 1970, John had lived in Kuala Lumpur for five years.*

This contrasts with a sentence not involving a stative verb, like the following:

(36) *In 1970, John had read War and Peace.*

In the first example, it is not necessarily the case that John is no longer living in Kuala Lumpur, nor that he did not continue to live there after 1970. On the other hand, in the second example, John must have finished *War and Peace* by 1970; he cannot still have been in the process of reading it.

On the other hand, consider the following sentence:

(37) *In 1970, John had been reading War and Peace for five years.*

Here it is possible that John is still reading *War and Peace*, and that he continued to read it after 1970. These facts parallel those in the example containing the stative verb *live*.

The same facts obtain in simple tenses. Consider the following sentence:

(38) *John lived in Kuala Lumpur in 1975.*

Let us assume that the current time is after 1975. This sentence can be true in a situation when John is still living in Kuala Lumpur; the following sentence is not a contradiction:

(39) *John lived in Kuala Lumpur in 1975, and he is still living there.*

However, if a nonstative verb is used, the facts are different:

(40) *John frosted the cake at 3:00.*
This sentence entails that the event of frosting the cake is complete: that its end point lies in the past. The following sentence is not felicitous:

(41)  # John frosted the cake at 3:00, and he is still frosting it.

However, this sentence is not a contradiction:

(42)  John was frosting the cake at 3:00, and he is still frosting it.

We claim that this is because statives and progressives are alike in the following way: both involve predication not over the beginning or end of the main event, but over the during time. This is further evidence that the during time is involved in the interpretation of every sentence, not just progressives.

9 Further Results

It appears that the during time of the main clause is used in some instances in the interpretation of tensed subordinate clauses: for example, in the interpretation of relative clauses. Consider the sentence “He will catch the dog that is running.” Under one interpretation of this sentence, the catching event is simultaneous with the running event – both events take place in the future. In this case, the interpretation of the main verb in the relative clause depends on the during time of the main clause. There is also another interpretation, according to which the dog that will be caught later is running now. In this case, the interpretation of the relative clause depends on the time of utterance of the sentence. This seems to be possible only with future tense sentences, however: there is only one interpretation for “He caught the dog that is running”, the one where the dog is running when the sentence is uttered. The interpretation where the dog is running when it is caught is not available.

One remaining task is to provide a reasonable analysis of the bare present using this system, including generic sentences like “It is (usually) cold in Alaska.” We feel that such an analysis awaits the incorporation of a representation of inherent lexical aspect as in Passoneau (1987); without a representation of the distinction between (for example) states and activities, a coherent representation of simple present tense sentences is not possible.

Another task is to provide a reasonable account of the imperfective paradox. For a sentence like

(43)  John was reading a book at 3:00, but he never finished reading it.

the end point of the reading event is asserted to exist and to follow the during time of the book-reading event; the during time is instantiated to 3:00 and precedes the End time. The second clause asserts that the culmination of the reading event, usually taken to be equivalent to the end point of the reading event, did not occur. This remains an outstanding
problem; the solution might be to allow events to end without being culminated, though. That is, the end of an event would not always be associated with the completion of that event; in the case described above, the end of the book-reading event would occur, but the inference that John had therefore finished the book would not be valid.

10 Conclusion

We have shown that distributing an existentially quantified during time variable throughout the tree enables interpretation of nontensed elements in the sentence according to the time of the main verb. Further, the during time is useful in the interpretation of several sentence types: progressives, statives, and sentences containing relative clauses. Finally, an analysis that utilizes underspecified relations among times (not events) provides a good prospect for analyzing tense and aspect in English.

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8This suggestion was made by a discussant at the ACL conference, Buffalo, N.Y., June 1988.
References


