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Modification of Event Relations

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Introduction

The English word *then* appears at first sight to be a fairly straightforward adverb, with a simple semantics and rather minimal dependence on general discourse principles. We show that in fact there are some unexpected elements in the analysis of *then*, and that the treatment of *then* both draws on and has consequences for the overall treatment of temporal structure in discourse.

In this paper we will focus entirely on temporal relations among clauses, both in general discourse and in structures using *then*. We begin by describing the temporal senses of *then* which we analyze in this paper. Before giving the analyses, we outline a theory of temporal structure in discourse and a system for representing temporal relations in discourse. This theory and representation then serve as the bases for the analyses of *then*.

We assume that *then* has at least three distinct senses. The first is what we will call *sequential then*. This usage explicitly specifies that two events in the discourse occurred one after the other in time. (1) illustrates a use of sequential *then*.

(1) Ken filled a bucket with water. Then he poured it on his sister.

A second use of *then* is *cotemporal*, indicating that the second event mentioned takes place during the time of the first, illustrated in (2):

(2) Max grew up during the great depression. Then, many people roamed the streets in search of work.

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The final use is *consequential*, indicating a logical or causal connection between the events. With this reading, the second event introduced can temporally precede the first, as in (3). (This consequential meaning is the use of *then* which also appears in *if-then* constructions.) In (3), A and B indicate different speakers.

(3) A: I'll go to the bank this afternoon.
   B: Then I'll balance the checkbook this morning.

The meaning intended for *then* in a given sentence can often be distinguished by its location. In medial (Aux) position, a sequential reading is preferred over a consequential reading, whereas in final position the reverse holds and the consequential reading is much more easily found. Sentence-initially, *then* is cotemporal if set apart from the rest of the sentence, and sequential otherwise. For the consequential reading, the sentence containing *then* must usually be spoken by a different speaker than the previous sentence, as in (3). (Notice that if A and B are the same speaker, (3) would be somewhat odd.) Of the examples below, (4a) is ambiguous, (4b) strongly prefers a sequential reading and (4c) a consequential (or cotemporal). Notice that in (4c), it is equally possible for John to drop by Mary's house before or after going to the bank, indicating that the sequential reading is not available.

(4) a. A: John will go to the bank. B: Then he'll drop by Mary's house.
     b. A: John will go to the bank. B: He'll then drop by Mary's house.
     c. A: John will go to the bank. B: He'll drop by Mary's house then.

In the remainder of the paper we concentrate on the temporal readings of *then*, focusing only on the sequential and cotemporal readings. We show that each temporal reading of *then* indicates a certain temporal relation between two clauses, and that each of these relations is drawn from the set of clause relations allowed in general discourse. The effect of *then* is not to introduce a new kind of temporal relation but to specify which of the relations that are possible in general discourse does in fact hold between two particular clauses. In the next section we describe the kinds of temporal relations that can hold in discourse in general, and then we will return to the analysis of *then*. We use a theory and representation developed in Spejewski and Carlson (1991) for temporal relations in general discourse, and show how *then* fits into this schema.

Representing Temporal Structure

In this section, we describe how temporal structure can be represented in terms of reference times and event times. Reichenbach (1947) used reference times to represent the time relative to which an event occurred. For instance, in a past perfect clause, there is some contextually-defined time that the event is understood to have occurred before. In this case, the event time is situated before the reference time on a timeline:

```
-----------|--------|--------present
           E        R
```
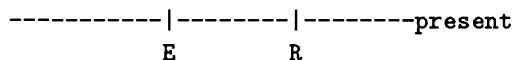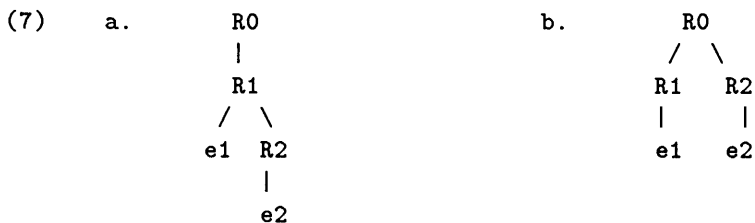
Reichenbach conceived of a reference time as being a point in time, but other researchers, such as Hinrichs (1981,1986) and Partee (1984), have applied the term to intervals of time. When the reference time is characterized as an interval, it has a more specific role than just being related to an event time: it is used to indicate a time *during which* an event occurred, as shown in (5) below.

Hinrichs and Partee both described certain possibilities for relations among reference times and event times for the various clauses in a discourse. Spejewski and Carlson elaborated on those relations, and we describe here that theory of temporal relations. We have found it useful to maintain the interval definition of reference times. We here specify that the reference time indicates the set of possible candidates for the event time: it represents the range of time during which the event could have occurred. The event time is then inserted within its reference time. Our representaton uses a tree-type diagram, in which a daughter e of another node R indicates that e occurs within the time represented by R, as shown in (6).

```
(5)        R----------------      (6)    R
             e----                        |     indicates e contained in R
                                          e
```
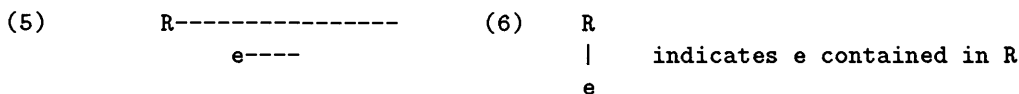
A distinction is made between two types of temporal relation: there can be a subordination relation between two clauses, in which case one event is temporally dependent on the other and can usually be understood as being a part of the other event, or else the two events can be considered temporally distinct. If one event is subordinate to another, then it must occur within the same reference time as the other event; otherwise it need not. In both cases, each event introduces a reference time indicating all the allowable time for the event to occur.[1] Then the event-time is located within that reference time. We assume that the discourse itself introduces some reference time R0, which represents the entire time-span of the discourse, so all further times are inserted within that time. Diagram (7a) represents the relation "e2 is subordinate to e1", and (7b) the relation "e1 and e2 are temporally distinct".

```
(7)    a.      R0               b.        R0
               |                         /  \
               R1                      R1    R2
              /  \                     |     |
            e1   R2                   e1     e2
                  |
                 e2
```

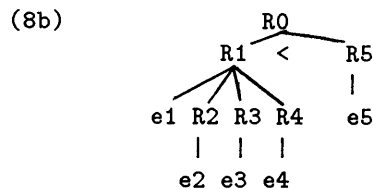[1]We have the events introduce their own reference times, rather than their being introduced by the previous event, as in Hinrichs and Partee's systems, because under our assumptions of multiple possible insertion sites, the location of the reference time in the structure is not predictable, and it is more complex to introduce a reference time in each possible insertion site than to simply add one in the required location.

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These relations are strictly temporal and do not represent rhetorical relations such as causality. We assume that the possible temporal relations between clauses can help to determine the rhetorical relations, but we do not deal with them here.
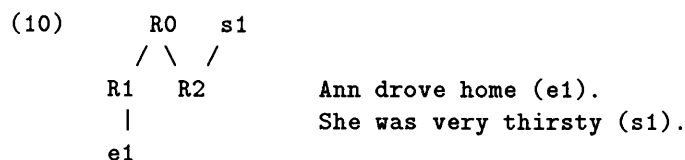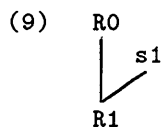
Suppose we have a discourse such as (8a):

(8a)   Edgar bought a new car at Freddy's (e_1). The salesman gave him information about the different types of cars (e_2), and recommended a 4-door hatchback (e_3). Edgar instead chose a convertible (e_4). Then he bought a boat (e_5).

Our understanding of the temporal relations among the five clauses in this discourse are represented in (8b) below and can be described as follows: e2-e4 are all subparts of the overall event e1 and e2-e4 are all temporally distinct from one another; e5 is temporally distinct from e1-e4. In terms of reference times, the event e1 introduces a reference time R1 which covers the event e1 as well as all its subordinate parts. Since e2-e4 are all subordinate parts of e1, they must all be inserted within that reference time. Each of the subevents also must introduce a reference time to cover the subevent and any events which may be subordinate to it. Therefore R2-R4 are all inserted within R1, and e2-e4 within their respective reference times. Since e5 is not a part of e1, it is not inserted within the reference time introduced by e1, which contains both of these events and their reference times and subordinates.

```
(8b)                RO
                 R1   <   R5
               / / | \      |
          e1 R2 R3 R4     e5
              |  |  |
             e2 e3 e4
```

States also introduce their own reference times, but instead of the state time being inserted as a daughter of the reference time, it is inserted as a parent of the reference time, as in (9). This follows Hinrichs in representing states as surrounding their reference times rather than being contained within them. In (10) we show a state within a discourse.

```
(9)   RO              (10)      RO   s1
       |  s1                   / \  /
       | /                   R1    R2      Ann drove home (e1).
       |/                     |            She was very thirsty (s1).
       R1                     e1
```

The effect is that part of the state is contained in the same reference time as the event; part of the state is temporally related to the event, though there need not be any overlap between the two. It is possible to have states in overlap relations with the event, but also to have the state occur before or after the event, with no overlap or only endpoint overlap.

Analyses of *Then*

In this section we return to an examination of *then* by showing what effect *then* has on the temporal structure of a discourse. We will look at sequences of events both with and without *then*, and see what differences in interpretation result when we add the adverb. These differences will reveal information about the meaning of *then* and also about how events can relate to one another when *then* is not present.

Sequential *Then*

We look first at the sequential reading. Consider the following pair of discourses, which differ only by the presence or absence of *then*:

(11) a. Ken filled a bucket with water. He poured it on his sister.
      b. Ken filled a bucket with water. Then he poured it on his sister.

In a case like (11), *then* appears to contribute little to the understanding of the discourse. The temporal representation for both (11a) and (11b) would be the same. Provided we assume that events in a narrative are by default ordered sequentially with respect to one another, it may appear that *then* in fact makes no contribution but simply emphasizes an ordering determined by other principles.
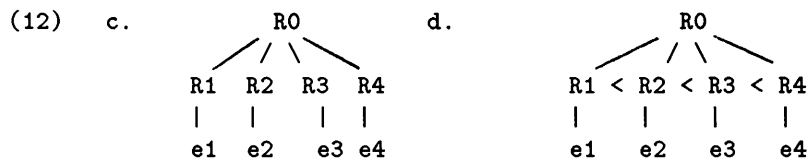
But *then* can make a difference in other cases. One such case is the "grab-bag" interpretation of a series of events (Spejewski and Carlson, 1991). For instance, if we assume the general topic is what Mary did today, then the narrative in (12a) can be understood as simply mentioning events which fit that topic, but not necessarily mentioning them in chronological order.

(12a) Mary went to the store. She fixed a faucet. She wrote a long overdue thank-you letter to her nephew. She read the morning paper.

However, if we add *then* to each sentence in the sequence (except the first), a "grab-bag" interpretation vanishes, as one would expect.

(12b) Mary went to the store. Then she fixed a faucet. Then she wrote a long overdue thank-you letter to her nephew. Then she read the morning paper.

Using the kind of the representation outlined above, the difference we would see in the representation of (12a) and (12b) is that for (12b) there would be specifications on how the various items are ordered with respect to one another (i.e. R1<R2, etc.) as shown in (12d); without such specifications the diagram simply says that the items all occurred within the same timespan, as in (12c), which is exactly what we need for grab-bag constructions.

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```
(12)   c.          R0            d.            R0
                  / / \                       / / \
               /  / \  \                   /  / \  \
             R1  R2 R3  R4              R1 < R2 < R3 < R4
              |   |  |   |               |    |    |    |
             e1  e2 e3  e4              e1   e2   e3   e4
```

So *then* does make an independent contribution of its own, even if in examples like (11) its effects are duplicated by independent discourse processes. Another type of structure in which *then* has even a greater differential effect is the subordination structure. This relation is found in (13a); in (13b), though, the presence of *then* eliminates the possibility of subordination, changing the interpretation considerably.

(13)   a.   Ken filled a bucket with water. He used water from the garden hose.
           b.   Ken filled a bucket with water. Then he used water from the garden hose.

These examples are represented as different temporal structures, shown in (13c) and (13d) respectively. In (13a) using water from the hose occurs at the same time as filling the bucket: it is subordinate to filling the bucket, and so it is inserted under the reference time for that event. The inference made with this example is that using the hose is *a part of* filling the bucket. In (13b), on the the other hand, using water from the hose is specifically declared to be a separate event from filling the bucket, and so the reference times are given the relationship of sisters, not daughters.

```
(13)   c.        R0          d.           R0
                 |                        / \
                R1                    R1  <  R2
               / \                     |      |
              e1  R2                   e1     e2
                  |
                  e2
```
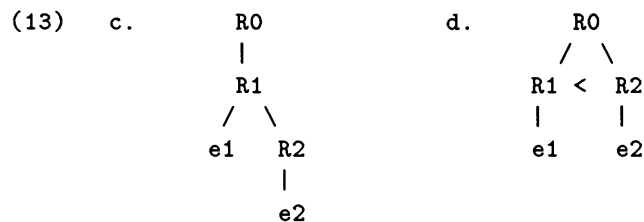
The clearest cases of temporal subordination are those where a subsequent series of events gives a more detailed account of the more general superordinate event; in cases such as (14) it is tempting to identify subordination with event decomposition. In (14), the first sentence is superordinate, and the remaining sentences are all subordinate.

(14)   John made dinner last night. He cooked some turnips and fixed a pot roast. He made a Greek salad. For dessert he made Key lime pie.

However, subordination is not always event decomposition; this structure may relate a series of events having the superordinate event as the goal or outcome of the subordinate sequence. Events can be included which both precede and follow the actual event and are not strictly a part of the event decomposition. Consider (15):

(15a) John bought a birthday present for his sister yesterday. First, he got up and hurried out to the mall in his car. Then he drove downtown. Finally, he located a country jewelry store. He bought the present, a jade necklace, shortly after noon. He hurried home and gave it to his sister. She thanked him profusely and put the gift on. Then John hurried out to get an anniversary present for his parents...

(15b)
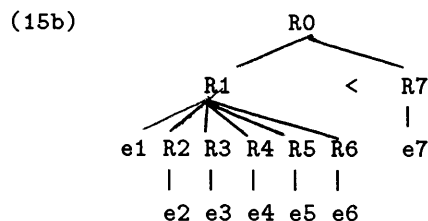
In this case, the event of buying the birthday present is referred to as both the single act of buying the necklace and also as the superordinate event consisting of the shopping, the buying, and the giving. This duality is easily accounted for within this framework by the two different reference times assigned to the two different occurrences of "buy a present" in the discourse, R1 for the superordinate and R5 for the subordinate. Note that in a subordinate structure, some events may temporally follow the superordinate event. In discourse (15) the first occurrence of *then* relates the first two events in the overall gift-buying event. The second instance of *then*, in the last sentence, begins a new superordinate structure.

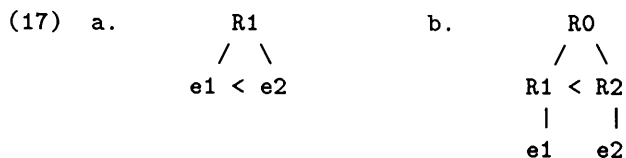Now consider the following contrasting pair of sentences:

(16) a. The volcano erupted. It frightened 10,000 people away from their homes.
      b. The volcano erupted. Then it frightened 10,000 people away from their homes.

We assume that the most natural order of events is the eruption before the frightening away. However, there is a difference in understanding between the examples of (16) that is not simply a matter of ordering the events in different ways. Rather, in (16b) the suggestion seems to be that the volcano did something else later to frighten the people, whereas (16a) allows there to have been one action and one result. This example is like (13). Our claim is that *then* disallows a subordination relation between the events ordered temporally, and that the natural understanding of (16a) requires a subordination structure.

So we conclude that *then* not only has an effect of telling us the explicit order of events, but it also affects the possible structures that can be built in the discourse, which in turn affects our understanding of what the discourse is saying.

Given the above data and conclusion, we attempt to give an intepretation for *then*. The basic idea is to temporally locate an event after the previously-mentioned

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event. However, since an event is represented as both an event time and a reference time, there is some question as to whether *then* locates the second event-time after the first event-time, or whether it locates the second reference time after the previous reference time. We have already ruled out a subordination structure for the representation, but the following are both possible options:

```
(17)  a.        R1              b.        R0
              /   \                     /   \
            e1  <  e2                  R1  <  R2
                                       |      |
                                       e1     e2
```

In the first case, e2 is simply located after e1 and there is no reference time introduced by e2. The interpretation of this representation is that e1 and e2 both occur within the same period of time, but are ordered within that timespan. This sounds like it could work, until we examine a case like (18):

(18)   From 5:00 to 5:15 John took a shower. Then he got dressed.

The shower event must be placed within a reference time that begins at 5:00 and ends at 5:15, since a reference time indicates the possible span of time during which an event occurs.[2] Getting dressed clearly does not fall within that reference time, but must occur in a reference time which is after the reference time for e1, so (17a) is ruled out. (17b) then looks like a more appropriate representation. Notice that now the effect of *then* is not to order the *events* but to order the *reference times*. This means that we are not only referring to two different events, but to two different periods of time which could each be referred to independently.

It appears, then that when *then* joins two events, it constrains the temporal representation to that in (17b) above. What happens when *then* is used in conjunction with states? Does *then* constrain states to the same representation as it does events? In examining these questions, we will look at examples with two states or states in combination with events. We begin with a case in which a state is given second, both with and without a conjoining *then*.
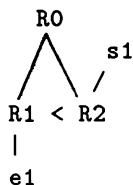
(19)   a.   John took a Valium. He was indifferent to his fate.
          b.   John took a Valium. Then he was indifferent to his fate.

Our understanding of (19a) is that the state held either at the same time as the event, or else after the event as a consequence of it. This ambiguity is captured by the representation above in (10b). The understanding for (19b) is only that the
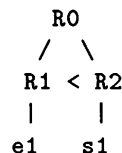
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[2]Here we assume that the time restriction is a feature of the reference time introduced by the event, rather than there being a separate reference time to denote the time period specified.

event occurred, and after that the state began to hold. It does not seem that the state could hold before or during the event. Suppose we try to represent (19b) in (19c) below, using the above analysis, in which a state surrounds its reference time, assuming that *then* only introduces the"$<$" ordering specification. This representation indicates that the state surrounds its reference time, so the state could possibly spill out into an earlier time and overlap with the event. This is not the representation we seek. What we need is to ensure that the state not begin until after the event has occurred. The cleanest way to do this is to contain the state within a reference time, and then specify that the reference time be located after either the previous event or that event's reference time. This is the structure in (19d):

```
(19c)          R0              (19d)          R0
              /\  s1                          /  \
             /  \ /                         R1  <  R2
            R1  <  R2                        |     |
            |                                e1    s1
            e1
```

Notice that (19d) looks just like (17b), which depicts two events joined by *then*. We claim that *then* induces this particular structure when the first item is an event, whether the second is an event or a state.

Now what happens when the first clause expresses a state? In (20), the first clause is a state, and the second an event.

(20a)   John was depressed. Then he took a Valium.

Here it does not seem that *then* means simply that the second item occurred after the first item finished, but that the event occurred *during* the state.[3] This interpretation is in fact possible with the representaton we have developed. If *then* does what we have suggested, then there is some reference time established for the first clause, and the second clause should have its reference time located after that one. Let us again try to use the analysis of states described earlier:

```
(20b)          R0
              /\
             / s1\
            / /   \
           R1  <   R2
                    |
                    e1
```
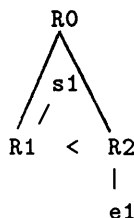
As in (19c), the state surrounds its reference time, so it is possible for the state to overflow the reference time and to overlap with the neighboring event. For (20a) this is apt.

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[3]The *inference* we make is that the state ceases to occur after the event occurs, but this may not be a part of the interpretation of *then*, and this inference may not always hold.

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If we accept (19d) and (20b) as appropriate representations for (19b) and (20a) respectively, then we appear to have two different ways of representing states: either as surrounding their reference time or as being inserted within their reference time. This may seem puzzling or erroneous until we consider that there are actually two different ways of using states: as statives or as inchoatives. A stative simply says that a certain predicate holds, while an inchoative says that a certain predicate *begins* to hold at a specified point. An example of an inchoative interpretation is (21):

**(21)**   Suddenly there were people all around him asking him questions.

We claim that using *then* in a clause with a state causes that state to act as an inchoative rather than as a stative. In this case, the state acts essentially as an event, and this is why the representation for the state as the second clause, (19d), looks identical to the representation for the event as the second clause, (17b). The default interpretation for a state is as a stative, and this use doesn't specify either a beginning or an ending point for the stative. This is why the clause that is unmodified by *then* is represented with the state surrounding its reference time: this allows for the beginning and ending points to be unspecified in the representation.

Let us now check our analysis by using two states joined by *then*.

(22a)   Karl was hungry. Then he was thirsty.

The interpretation of this sequence is that the second state begins after the first state begins. It does not specify that the second state begin after the first state ends, because it is entirely possible here for the first state to continue on, and for the second state to be added to the predicates holding at that time. According to our analysis, the first state should be represented as a stative, i.e. surrounding its reference time, and the second as an inchoative, inserted within its reference time.

(22b)
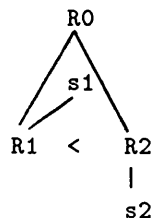
Here we do get the correct interpretation: the first state surrounds its reference time and so could spill over into the next reference time, while the second state is contained within a reference time which is located after the first state's. This ensures that the first state begins before the second state begins, and that the first state may continue on after the second state begins (but is not required to).

In order to show that *then* has contributed the inchoative reading, and that it does not come about as a more general discourse effect, we compare the following:

(23) a.   Beth was a lawyer and she was an artist.
      b.   Beth was a lawyer and then she was an artist.

The most natural interpretation of (23a) is that Beth was a lawyer and an artist at the same time, but with the beginning and endpoints of each state unspecified, and so the amount of overlap unspecified. It is also possible to read this as a "grab-bag" construction, in which the relation between the two states is unspecified (there may or may not be overlap), but again the beginning and endpoints are irrelevant. Neither of these is a possible reading of (23b). Only when *then* is added does the second state take on the inchoative (specified beginning point) reading. If we accept as the default interpretation for states that the state surrounds its reference time, then (23a) would be represented as in (23c), while the temporal structure for the sequence in (23b) would be the same as (22b).

(23c)
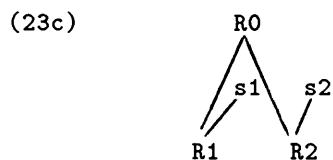
As we have mentioned, the inchoative use of states occurs in discourse outside of the *then* construction as well. For example, the state in (24) has both the stative and the inchoative readings:

(24)   Liz ran down the hall. She was sick.

This can mean either that Liz was sick *as* she ran down the hall, or *after* she ran down the hall. The representation described above for the inchoative use of a state following *then*, in which the state is inserted within its reference time, can also be used for the inchoative reading of (24). Again we see that *then* does not introduce a unique temporal relation, but simply specifies among general discourse relations.

We now summarize the interpretation of sequential *then* to cover both events and states. The interpretation need not specify how the first item in the sequences above is represented, because that comes from the more general rules of discourse interpretation. Under those rules, events are inserted within their reference times, and states surround their reference times.[4]

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[4]By "Ry strictly after Rx" we mean that Ry occurs after Rx and that Rx and Ry do not overlap at any points. We do not attempt here to quantify the amount of time which may intervene between the two times; this seems to be relative to the length of the event times and also depends on pragmatic factors.

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(25)   Assume that the reference time most recently added to a temporal structure is Rx, and that the next event introduces its own reference time, Ry. The interpretation of sequential *then* modifying a clause is:

   a. Rx < Ry (Ry occurs strictly after Rx)
   b. The event or state modified by *then* is inserted within Ry.

Sequential *then* has two different effects: it orders a new reference time after the previous reference time, and it inserts the new event time within that reference time. The interesting points here are that *then* does not simply order events but orders time periods, and that *then* causes states to behave as events. The construction using sequential *then* has provided a clear-cut case of states acting as inchoatives, and has thus motivated our making a distinction between two different behaviors of states. This in turn allowed us to develop two different temporal representations for states in discourse generally.

Cotemporal *Then*

Our claim for cotemporal *then* is that it behaves in a nearly opposite way from sequential *then*: cotemporal *then* indicates a subordination relation. In order to show that this is the relationship indicated by that use of *then*, we will work through some other possibilities and show that none of them captures the appropriate relationship of event times and reference times.

One possibility is that *then* indicates that an item not introduce its own new reference time, but that it be related to the reference time of the previous item mentioned in the discourse, as in (26b). This makes some sense, since this reading of *then* can be paraphrased as "at that time", and this may indicate that the time-span for the second event is the same as for the first. Two events related by cotemporal *then*, as in (26a) would be represented as in (26b), with the second event being attached to the existing reference time in the same way as it would to a reference time it introduced itself (i.e. the event is inserted as a daughter of the existing reference time).

(26) a. Len grew up in western Massachusetts.   b.   R1
         He learned how to track raccoons then.   / \
                                                              e1   e2

This representation may be fine when the discourse only contains two events in this substructure. However, if we add another event, we can see that this structure is inadequate. Suppose we add another event that has a particular relation to e2 but not to e1, as in (27a):

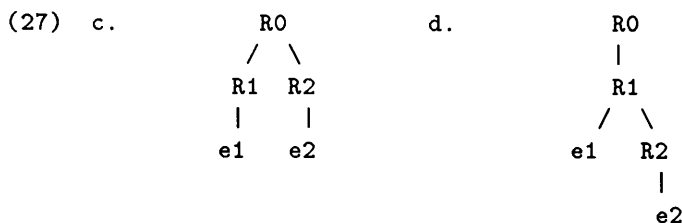(27a)   Bill went shopping this morning. He went to the bank then. Then he stopped by the donut shop.

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On one reading, e2 occurs during the same time period as e1. Additionally, e3 occurs after e2, but not necessarily after e1. According to our analysis of sequential *then*, e3 must introduce a reference time which is inserted as a sister to the reference time of e2. Since R1 is that reference time, we get the structure in (27b):

```
(27b)           RO
               /  \
             R1  <  R2
            /  \     |
          e1   e2   e3
```
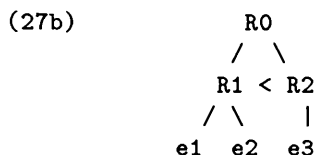
This structure indicates that e3 occurred after e2, but also after e1, and this is not our understanding of the passage. It is of course one possible interpretation, but that particular ordering is not required by the discourse. We need a structure that allows a grouping of e2 and e3 distinct from e1. This is not possible unless there is a reference time for e2 which is distinct from that of e1.

There are still two ordinary ways to join two items that both have reference times. One is to make the reference times sisters. This gives the ordinary grab-bag structure, shown in (27c), in which case the structure of the passage is the same as it would be without *then*. The other way is to make the second reference time a daughter of the first, which is the usual subordination structure, shown in (27d).

```
(27)  c.         RO          d.          RO
                /  \                      |
              R1   R2                    R1
               |    |                    /  \
              e1   e2                  e1    R2
                                             |
                                            e2
```

We first consider the grab-bag structure. It does seem in many cases that there is no difference in temporal understanding between a discourse with and without a cotemporal *then*. However, there are examples in which the cotemporal *then* does make a contribution, and that is to rule out a simple grab-bag construction.

(28) a. I'm going shopping and I'm going to the dry cleaners.
          b. I'm going shopping and I'm going to the dry cleaners then.

There is a slight difference between (28a) and (28b): (28a) only says that both tasks will be accomplished, while (28b) indicates that both will be accomplished within the same trip and at very nearly the same time. In (28b), the first event sets up a time period, and the second event is claimed to occur within that same time period. This is a typical subordination relation. In (28a) the speaker is referring to two separate overall events . This is a subtle difference, but it is an important one for a hearer's understanding of the temporal ordering among events. With (28a),

a hearer can make inferences about the relation between the events, but these are inferences only and are not relations indicated by the discourse itself. In the second case, the temporal connection is directly indicated by the word *then* in the discourse.

We claim, then, that (27d), the subordination structure, is the appropriate representation for two events joined by a cotemporal *then*. The second event is claimed to occur within the same time-frame (reference time) as the first event. This predicts that cotemporal *then* can not be used in a case where two distinct time periods are specifically mentioned. (29b) is ill-formed on the cotemporal reading, because the time-period "tomorrow" cannot be contained within the time-period "today".

(29)   a.   I'm going shopping today. I'm going to the dry cleaners tomorrow.
        ??b. I'm going shopping today. I'm going to the dry cleaners then tomorrow.

This prediction of our analysis is borne out, and the representation appears to characterize a passage in which two events are joined by cotemporal *then*. We now show that the subordination relation also characterizes the cotemporal *then* relation when at least one of the items is a state rather than an event.

```
(30)   a. I once played a mean trick on my little       b.        R0
          brother.  I was ten years old then.                     |
                                                                  R1    s1
                                                                  | \  /
                                                                  e1 R2
```

Here the second item joined by *then* is a state. The diagram in (30b) indicates that the state is true during at least part of the same time as the event occurs, but that the state can also occur outside of the time the event occurs. At first glance this does not seem quite strong enough: we seem to want the state to surround the event explicitly. However, a longer example shows that the state need not be true during the event at all, but could even be a result of the event. Example (31) justifies the above diagram, rather than one in which the state surrounds the event.

(31)   I once got an F on my report card because my teacher didn't like my accent. I was surprised about it then, but I'm not surprised now.

When the state is first, it seems that the event does need to occur while the state is true, as our analysis predicts.

```
(32)   a. Wes used to be in love with a bass player (s1).     b.        R0 s1
          He acquired his love of jazz music then (e1).                 | /
                                                                        R1
                                                                        |
                                                                        R2
                                                                        |
                                                                        e1
```

Finally, when both items are states, the effect is that there must be some overlap between the two states, which again is predicted by the analysis. (33b) indicates that some part of the duration of s2 holds during a part of the duration of s1.

```
(33) a. In 1972 Jen was in the fifth grade.      b.      R0 s1
        She was ten years old then.                       | /
                                                          R1 s2
                                                          | /
                                                          R2
```

Our summary of the interpretation of cotemporal *then* is:

(34)   Assume the reference time most recently added to a temporal structure is Rx, and that the next event introduces its own reference time, Ry. The interpretation of cotemporal *then* modifying a clause is:

      a. Ry $\subset$ Rx (Ry is inserted as a daughter of Rx).
      b. Insert the event/state time according to general discourse rules.

Conclusion

The work we have presented here is a study in what we can learn about general discourse principles by focusing on some tiny fraction of discourse, in this case the effects of a particular word. We have shown that we can characterize the temporal effects of the word *then* using a very small number of relations, namely the daughter relation for subordination, and the sister relation for temporally distinct events; both of these are claimed to be relations used in general discourse, and this analysis strengthens the possibility that these may be the only temporal relations required to charactize discourse. The study of *then* has also provided clarification for how to treat states as temporal entities.

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