

Tense, Temporal Context and Syntactic Ambiguity Resolution

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During sentence comprehension, events denoted by verbs must be related to other events already established in the discourse. This often requires the tense of a verb to be evaluated in relation to specific temporal properties of the discourse. We investigated the time course of this process by examining whether the usual bias to initially interpret a participial verb in a reduced relative clause as a past-tense verb in a main clause would be reduced or eliminated when the temporal properties of the discourse are inconsistent with a past-tense interpretation. In Experiment 1, the subjects completed fragments such as *The student spotted* when they appeared in contexts containing events occurring in the future or events occurring in the past. The fragments were typically completed as main clauses (e.g. *The student spotted - the proctor . . .*) in the past contexts, and as relative clauses (e.g. *The student spotted - by the proctor . . .*) in the future contexts. In Experiments 2 and 3, the subjects read target sentences presented two words at a time using a moving window paradigm. The target sentences began with relative clauses which were presented in past or future contexts. Reduced relative clauses were read faster in the future contexts as compared with the past contexts, indicating that the temporal information in the discourse reduced the garden path normally associated with this structure. The results demonstrate that temporal information from the discourse is accessed rapidly enough to be used in syntactic ambiguity resolution, indicating that the tense of a verb is immediately evaluated in relation to the discourse model. These results are interpreted as support for incrementalist approaches to comprehension in which a discourse model is continuously updated during comprehension and in which sentence processing is sensitive to the resulting constraints.

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INTRODUCTION

Recent incremental approaches to sentence comprehension assume that a mental model of the events and entities being discussed in a discourse (e.g. Garnham, 1981; Johnson-Laird, 1983; Webber, 1979) is continuously updated during sentence processing (Altmann & Steedman, 1988; Marslen-Wilson & Tyler, 1987). Moreover, these approaches assume that sentence processing is sensitive to constraints provided by the discourse which are motivated by the incremental hypothesis. Some of the clearest evidence in support of these assumptions comes from recent studies that have demonstrated that the referential context for a definite noun phrase is rapidly used in syntactic ambiguity resolution (Altmann & Steedman, 1988; Crain & Steedman, 1985; Ni & Crain, 1990). These studies demonstrate that (a) readers immediately attempt to establish referential links between definite noun phrases and the prior discourse and (b) that sentence processing is sensitive to constraints provided by the referential context. In this article, we report results from a complementary line of research that examines the time course with which events in a sentence are related to those events already established in the discourse. We examined whether constraints established by the discourse context that are relevant to establishing the temporal order of events in the discourse also influence syntactic ambiguity resolution. More specifically, we examined whether the temporary garden path that readers usually experience when reading reduced relative clauses (e.g. *The student spotted by the proctor . . .*) would be reduced or eliminated when the temporal structure of the preceding discourse was biased against the normally favoured past-tense interpretation of the verb.

In order to motivate our experiments, it will be helpful first to illustrate how the interpretation of tense is contextually dependent in much the same way as is the interpretation of a pronoun or a definite noun phrase. In fact, Webber (1988) has recently argued that tense, by definition, should be considered a discourse anaphor. Following Webber (1979, 1988), a linguistic expression can be considered to be a discourse anaphor if (1) it refers to some discourse entity that has already been established by a linguistic expression or (2) it creates a new discourse entity that is "dependent" upon some other discourse entity. An example of the first case is illustrated in the sentence:

1. John picked up the ball and hit it.

The pronoun "it" meets the first defining condition for an anaphor because it refers to the discourse entity created by "the ball". An example of a dependent anaphor, modified from Webber (1979), is illustrated by:

2. When the bus came around the corner, I signalled to the driver to stop.

The definite noun phrase "the driver" makes use of the discourse entity associated with "the bus" to create a new discourse entity, namely "the driver of the bus" (Webber, 1979). This it is considered to be an anaphor according to Webber's second criterion.

A number of researchers have pointed out that the tense of a verb can only be interpreted in relation to the temporal information associated with the event structure of the discourse (Dowty, 1986; Hinrichs, 1986; Partee, 1984; Steedman, 1982; Webber, 1988). It is this contextual dependency that underlies the anaphoric properties of tense.¹ We will make the standard assumption that a discourse model includes a representation of the events in a discourse and the temporal relations among those events. As the discourse develops, old events are referred to and new events are introduced. New events are typically introduced by a verb in a main clause. The tense of the verb helps establish the temporal relations between the new event and the other events in the discourse. However, the information provided by tense alone is insufficient. Tense must be used in conjunction with the event structure of the discourse. Thus, tense is an anaphor according to Webber's second criterion; it assists in establishing a new event that is dependent upon the temporal properties of other events already established in the discourse model (Webber, 1988).

In order to see this, we need to introduce some basic information about the English tense system. Most current models of tense take as their starting point the work of Hans Reichenbach, who developed a model of the underlying semantic structure of the English tense system. Reichenbach (1947) proposed that the interpretation of tense requires three separate semantic entities:

- time of speech (*S*);
- time of event (*E*); and
- time of reference (*R*).

The time of speech, *S*, is the time at which the utterance occurs (usually thought of as "now"). The time of event, *E*, is the time at which an event (usually denoted by a verb) takes place. The time of reference, *R*,

¹Although specific proposals differ on whether tense should be explicitly defined and treated as an anaphoric expression (Partee, 1984), there is general agreement that tense has contextually dependent properties that require analysis in relation to the temporal parameters of the discourse (Dowty, 1986; Hinrichs, 1986; Partee, 1984; Steedman, 1982; Webber, 1988).

