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Case-marking in the Parsing of Complement Sentences: Evidence from Eye Movements

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An eye-tracking experiment investigated the role of case-marking in parsing. We manipulated the case of pronouns in reduced complement sentences like *I recognized you and your family would be unhappy here* and *I recognized she and her family would be unhappy here*, in which the nominative pronoun *she* immediately disambiguates the sentences, in contrast to the ambiguous *you*. The nominative pronoun *she* disambiguates the sentence because *I recognised she* is ungrammatical, and thus *she and her family* must be the subject of an embedded sentence and not the NP-object of the preceding verb. Subjects took longer to read *she and her family* than *you and your family* during initial processing. The pattern reversed at the disambiguating phrase *would be*. Unambiguous control sentences containing the complementizer *that* did not produce case-marking effects. These results demonstrate very rapid effects of case-marking on parsing. Either case information is used immediately, or it is employed after an extremely short delay. We discuss implications for current theories of parsing.

Since Bever (1970), researchers in language comprehension have been concerned with the question of how the parser adopts a syntactic analysis for a sentence. Some sentences are globally ambiguous, in that the complete sentence is compatible with two different syntactic analyses and interpretations. Many more sentences are locally ambiguous: at some point during processing, the sentence fragment is compatible with more than one analysis. The crucial question is: how does the parser decide which analysis to adopt? An answer to this question would provide evidence about the mechanisms of sentence processing and about the architecture of the human sentence processor.

Consider sentence (1) below, which illustrates the *reduced complement* or *"NP/S"* ambiguity (Frazier & Rayner, 1982):

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1. *I recognised you and your family would be unhappy here.*

The fragment *I recognised you and your family* is compatible with two (relevant) syntactic analyses, the *NP* analysis, and the *S* analysis. The term NP refers to a noun phrase; the term S refers to a sentence. On the NP analysis, *you and your family* is the NP-object of *recognised*. In other words, the verb *recognised* takes a noun-phrase object—in this case, *you and your family.* At this point, the sentence could be complete, or there could be some concluding phrase like *right away*:

2. *I recognised you and your family right away.*

On the S analysis, *you and your family* is the subject of the reduced S-complement *you and your family would be unhappy here.* In other words, the verb *recognised* takes a complement that is a complete sentence. In (1), the S analysis turns out to be correct.

The existence of garden-path sentences indicates that the parser makes a choice between different analyses on at least some occasions. It must therefore incorporate a serial component, or possibly a parallel component in which different analyses are ranked. If the parser does choose a particular analysis, what guides the choice? We discuss this issue in the next section.

First, however, note that (1) does not produce an intuitively strong garden-path effect (Gorrell, 1995; Pritchett, 1992). It is possible that the parser does not adopt either analysis whilst the NP *you and your family* is processed, but, rather, delays making a choice. On this account, (1) should produce no processing difficulty when it becomes clear that the NP analysis is wrong; but (2) should produce no processing difficulty either. The delay account is advocated by Holmes, Kennedy, and Murray (1987) and by Kennedy, Murray, Jennings, and Reid (1989). Other research does find evidence of processing difficulty with (1) in certain conditions (Ferreira & Henderson, 1990; Frazier & Rayner, 1982; Pickering & Traxler, 1995; Rayner & Frazier, 1987; Trueswell, Tanenhaus, & Kello, 1993). These results provide some evidence that "NP/S" ambiguities are resolved immediately, though there is disagreement about the principles used to disambiguate. One purpose of the research reported here is to provide more evidence about whether such ambiguities are resolved immediately.

Notice that *unreduced complement* sentences like (3) do not contain a local ambiguity (except for a momentary possibility that *that* is a demonstrative, as in *that man*):

3. *I recognised that you and your family would be unhappy here.*

The NP analysis is not available because of the complementizer *that*. Hence, there should be no possibility of misanalysis.

The particular question we address in this paper is whether case-marking affects the process of syntactic ambiguity resolution. Case-marking refers to the fact that NPs can be marked by an inflection (in many languages, an ending to a word) to determine their role in the sentence. In English, case-marking is limited to pronouns. For example, the words *I*, *she*, *he*, *we*, and *they* are all in nominative case. Roughly, they must serve as the subject of a verb. In contrast, *me*, *him*, *us*, and *them* are all in accusative case. Roughly, they must

serve as the object of a verb (or preposition). Clearly, case-marking could affect parsing, in a sentence like (4):

4. *I recognised she and her family would be unhappy here.*

In (4), the NP analysis is impossible, because the nominative *she and her family* cannot be the object of *recognised*. However, there are different possibilities about when case information is employed, depending on whether initial parsing decisions are *restricted* or *unrestricted* with respect to case-marking.

Restricted and Unrestricted Parsing

Initial parsing decisions might be based on many different sets of criteria. However, we can distinguish two basic positions, which we call *restricted* and *unrestricted* accounts. Unrestricted accounts propose that all potentially relevant sources of information can be brought to bear on parsing decisions immediately (e.g. MacDonald, Pearlmutter, & Seidenberg, 1994; Spivey-Knowlton, Trueswell, & Tanenhaus, 1993; Trueswell et al., 1993; cf. Taraban & McClelland, 1988; Tyler & Marslen-Wilson, 1977). Restricted accounts of parsing propose that there is some stage during which the parser ignores some potentially relevant sources of information (e.g. Frazier, 1987, 1989; Mitchell, 1987, 1989). Of course, the parser must pay attention to some sources of information immediately. So a restricted account has to specify which sources of information are employed and which are ignored.

Researchers in the field of sentence processing have identified many potentially relevant sources of information. They do not, however, necessarily agree about which information is used during initial processing. These information sources include lexical preferences of individual verbs (Ford, Bresnan, & Kaplan, 1982), plausibility (Rayner, Carlson, & Frazier, 1983), discourse context (Crain & Steedman, 1985), punctuation (Mitchell & Holmes, 1985), prosody (Marslen-Wilson, Tyler, Warren, Grenier, & Lee, 1992), gender agreement (Brysbaert & Mitchell, 1996), and case-marking (Trueswell et al., 1993).

The most widely known restricted-parsing account is the "garden-path" model (Frazier, 1979, 1987). On this account, initial parsing ignores plausibility and discourse context. These factors can therefore only play a role in reanalysis (e.g. through the "thematic processor" discussed by Rayner et al., 1983). The parser can make use of prosodic information if it is inconsistent with particular syntactic analyses (though it may be very difficult to specify when a prosodic contour is inconsistent with a particular analysis and when it is merely preferentially associated with a particular analysis). The parser probably also employs punctuation such as commas if it is inconsistent with particular analyses (e.g. Mitchell, 1987).

Frazier's parser makes initial attachment decisions by applying the principles of *minimal attachment* and *late closure*, which are defined in terms of major category information alone (e.g. Frazier & Rayner, 1982; Rayner et al., 1983). We concentrate on minimal attachment here, which Frazier (1979, p. 24) defined as "Attach incoming material into the phrase-marker being constructed using the fewest nodes consistent with the well-formedness rules of the language under analysis". Minimal attachment applied to sentence (1), repeated below, causes the parser to attach the NP *you and your family* as the NP-object of the verb *recognized*, because this analysis produces fewer nodes than any alternative analysis at that point.

1. *I recognised you and your family would be unhappy here.*

In particular, the parser does not pay any attention to subcategorization preferences. It chooses the NP-object analysis of (1) even if *recognised* more frequently takes an S-complement. According to the strongest form of the model (e.g. Ferreira & Henderson, 1990; Mitchell, 1987), the parser does not pay any attention to subcategorization restrictions and will consider an analysis even if that analysis is not possible (but Frazier, 1987, pp. 566–569, is less explicit). On this account, the parser initially pays attention to major-category information (e.g. whether a word is a noun or a verb) but ignores subcategory information (e.g. whether or not the verb is transitive).

Assuming that the "garden-path" model does prohibit the use of any subcategory information, there is still the question of whether the model prohibits the use of other lexical–syntactic information that is not part of major category. The most austere version of the model admits major category information and nothing else. If so, case information, like gender and number information, should not be available to the parser. Hence, the parser should initially attach *she and her family* as the NP-object of *recognised* in sentence (4), repeated below:

4. *I recognised she and her family would be unhappy here.*

However, a different version of the garden-path model might hold that all lexical–syntactic information except subcategory information can be employed. On this account, *she and her family* should not be attached as the NP-object of *recognised.*

Hence, if the parser can make use of major-category information alone during initial processing, the critical NP will be treated as the NP-object of the verb *recognised*, whatever its case. But if the parser pays attention to case-marking during initial parsing, it will immediately treat the critical NP as being a subject.

In contrast, recent constraint-based models constitute unrestricted accounts (e.g. MacDonald et al., 1994; Spivey-Knowlton et al., 1993). They assume that ambiguity resolution is a continuous process, in which there is no distinction between information that is employed initially during parsing and information that is delayed. In (4) above, as in many other sentences, the case-marking provides immediate and unequivocal evidence about the appropriate syntactic analysis of the sentence, so constraint-based parsers would apply this strong constraint immediately and adopt the S-analysis immediately the pronoun is encountered.

Experimental Investigations of Parsing

One major difficulty for distinguishing restricted and unrestricted accounts is that it is impossible to be sure whether a particular technique taps into initial parsing decisions. On the one hand, an effect due to a particular factor may not in fact have occurred during

initial parsing. On the other hand, null effects may be due to weak manipulations. Rapid effects of the meaning of particular analyses have been found by Trueswell, Tanenhaus, and Garnsey (1994), contrary to Rayner et al. (1983). Some studies support rapid effects of discourse context (Altmann & Steedman, 1988; Altmann, Garnham, & Dennis, 1992; Altmann, Garnham, & Henstra, 1994; Britt, 1994; Britt, Perfetti, Garrod, & Rayner, 1992; Spivey-Knowlton et al., 1993), whereas other studies do not support rapid effects of discourse context (Clifton & Ferreira, 1989; Ferreira & Clifton, 1986; Mitchell, Corley, & Garnham, 1992; Rayner, Garrod, & Perfetti, 1992). Some evidence suggests that prosody and punctuation have rapid effects (e.g. Marslen-Wilson et al., 1992; Mitchell & Holmes, 1985).

For current purposes, the most relevant research concerns the use of lexical–syntactic information in parsing. To determine whether initial parsing is restricted, researchers have considered whether people ignore subcategory information and other linguistic information, such as whether a constituent is an argument or an adjunct. Empirical evidence for restricted parsing with respect to verb information comes from Mitchell (1987), Clifton, Speer, and Abney (1991), and Ferreira and Henderson (1990). Mitchell presented subjects with sentences like (5) below in a self-paced reading study:

5a. *After the child visited the doctor/prescribed a course of injections.*
5b. *After the child sneezed the doctor/prescribed a course of injections.*

The slashes mark the points where the stimuli were segmented. Readers read the first segment of (5a) faster than the first segment of (5b), but they read the second segment of (5b) faster than the second segment of (5a). Mitchell suggested that subjects initially ignored subcategorization information and treated the NP *the doctor* as the object of both the transitive verb *visited* and the intransitive verb *sneezed*. In (5b), subjects rapidly revised this decision when subcategorization information became available, thus producing the long reading time for the first segment. In (5a), revision occurred after *prescribed* was processed, thus producing the long reading time for the second segment.

Clifton et al. (1991) tested sentences like (6) using self-paced reading and eye-tracking:

6a. *The doctor lectured the obese patient on heart disease but he feared that his warning would go unheeded.*
6b. *The doctor delivered a lecture on Sunday afternoon but he feared that his warnings would go unheeded.*
6c. *The doctor delivered a lecture on heart disease but he feared that his warnings would go unheeded.*
6d. *The doctor lectured the obese patient on the scale but he feared that his warnings would go unheeded.*

One crucial question in the study concerned the processing of the prepositional phrases or PPs (e.g. *on heart disease*). In both experiments, readers read the PP faster when it modified a verb (6a & b) than when it modified a noun (6c & d). This suggested that readers preferentially attach PPs to verbs, in accordance with minimal attachment.

A second crucial question concerned the processing of arguments and adjuncts. In (6a & c), the PP serves as an argument; in (6b & d), the PP serves as an adjunct. If adjunct/argument status influences initial parsing decisions, then readers should have taken a different amount of time to process the PP in (6a & c) than the corresponding PP in (6b & d). In fact, Clifton et al. (1991) found no such difference in the initial processing of the PP in either experiment. In both experiments, however, readers read the region following the PP (e.g. *but he feared*) faster when the PP was an argument than when it was an adjunct.

Taken together, these two findings suggest that readers have an initial preference to treat PPs in sentences like (6a–d) as modifying verbs. Furthermore, they suggest that, although argument/adjunct status plays an important role in sentence comprehension, this distinction does not play a role in initial parsing decisions. Thus, Clifton et al.'s (1991) data suggests that the parser is restricted with respect to argument/adjunct status.

Ferreira and Henderson (1990) tested sentences like (7a–d) using self-paced reading and eye-tracking:

7a. *He forgot Pam needed a ride home with him.*
7b. *He forgot that Pam needed a ride home with him.*
7c. *He wished Pam needed a ride home with him.*
7d. *He wished that Pam needed a ride home with him.*

In sentences (7a & c), the NP *Pam* is actually the subject of an embedded sentence (here, *Pam needed a ride home with him*). However, *Pam* could be misanalysed as the NP-object of the preceding verb. This ambiguity is resolved only when readers process the verb *needed*, which tells them that *Pam* is actually the subject of an embedded sentence.

The main verb in sentences like (7a & b) preferentially takes an NP object (i.e. it is NP-biased), whereas the main verb in sentences like (7c & d) preferentially takes a sentential complement (i.e. it is S-biased). Ferreira and Henderson (1990) reasoned that if readers make use of this verb-specific information in their initial parsing decisions, then they should have found evidence for syntactic misanalysis in (7a), but not in (7c). More specifically, readers should have taken longer to read the syntactically disambiguating verb *needed* in (7a) than in (7b), but they should have taken an equal amount of time to read *needed* in (7c) and (7d). In fact, although Ferreira and Henderson found that readers took longer to read the disambiguating verb in sentences that did not contain the complementizer *that*, they found no difference between sentences like (7a) and (7c). In another experiment, reading times for the entire sentence were longer for sentences like (7a) than for sentences like (7c). Ferreira and Henderson concluded that readers ignore verb-specific information during initial stages of parsing.

Trueswell et al. (1993) obtained contrary results for sentences like (8) in self-paced reading and eye-tracking experiments:

8a. *The student forgot the solution was in the back of the book.*
8b. *The student forgot that the solution was in the back of the book.*
8c. *The student hoped the solution was in the back of the book.*
8d. *The student hoped that the solution was in the back of the book.*

Sentences (8a & b) contain NP-biased verbs, whereas (8c & d) contain S-biased verbs. In (8a & b), initial reading times for the syntactically disambiguating region *was in the* were longer in (8a) than in (8b). In (8c & d), first-pass reading times for the syntactically disambiguating region *was in the* did not differ between (8c) and (8d). Trueswell et al. suggested that readers avoided misanalysing sentences like (8c), which contained S-bias verbs, and thus that verb-specific information guided readers' initial parsing decisions.

Gender and case information do not constitute part of major category information, though neither are they subcategory information. If only major category information is employed during initial parsing, then there should be some period during which these sources of information have no effect on parsing.

Brysbaert and Mitchell (1996) provide evidence that gender information is sometimes ignored during processing. They found that Dutch subjects preferred high attachment of relative clauses in "NP of NP" construction (Cuetos & Mitchell, 1988). Interestingly, this preference remained even when the relative pronoun was disambiguated by gender information to low attachment.

In contrast, Trueswell et al. (1993) provide some evidence that case information may be used during early processing. Subjects listened to sentence fragments like *the old man insisted that* and then named a visually presented case-marked pronoun, either *he* or *him*, presented at the offset of the final syllable of the fragment. In this condition, *he* is a possible continuation of the sentence, but *him* is not possible because it is accusative. They found longer naming latencies to *him* than to *he*. Other conditions employed the fragment *the old man insisted*, which preferentially takes a sentential complement, and *the old man observed*, which preferentially takes an NP object. A sentential complement requires a nominative subject, but an NP object must be accusative. In fact, naming latencies to *he* were shorter after *the old man insisted*, and latencies to *him* were shorter after *the old man observed*. Because naming latencies were around 500 msec in this experiment, we can be certain that case marking was employed rapidly. Hence we might expect that case marking would be used fairly rapidly during normal reading. Our experiment tests this proposal.

Method

Subjects

Twenty-four normally sighted English speakers were paid to participate. Some had taken part in other eye-tracking experiments.

Stimuli

We constructed 28 sets (see Appendix) of four sentences like (9):

9a. *I recognised you and your family would be unhappy here.*
9b. *I recognised she and her family would be unhappy here.*
9c. *I recognised that you and your family would be unhappy here.*
9d. *I recognised that she and her family would be unhappy here.*

One version from each set appeared in each of four lists of items. Equal numbers of items from each condition appeared in each list. All sentences were presented on a single line.

Procedure

An SRI Dual Purkinje Generation 5.5 eye-tracker monitored subjects' eye movements. The tracker has angular resolution of 10′ of arc. The tracker monitored only the right eye's gaze location. A PC displayed materials on a VDU 70 cm from subjects' eyes. The VDU displayed four characters per degree of visual angle. The tracker monitored subjects' gaze location every millisecond, and the software sampled the tracker's output to establish the sequence of eye fixations and their start and finish times.

Before the experiment started, subjects read an explanation of eye-tracking and a set of instructions. The instructions told them to read at their normal rate and comprehend the sentences as well as they could. The experimenter then seated subjects at the eye-tracker and used bite bars and forehead restraints to minimize head movements. Next, subjects completed a calibration procedure. Before each trial, a small "+" symbol appeared near the upper left hand corner of the screen. Immediately subjects fixated the "+" symbol, the computer displayed a target sentence, with the first character of the sentence replacing the "+" on the screen. The "+" symbol also served as an automatic calibration check, as the computer did not display the text until it detected stable fixation on the "+" symbol. If subjects did not rapidly fixate the "+" symbol, the experimenter recalibrated the eye-tracker. When subjects finished reading each sentence, they pressed a key, and the computer either displayed a comprehension question (e.g. *Did you and the others take the exam?*), on about half of the trials, balanced across conditions, or proceeded to the next trial. Half of these questions had "yes" answers, half had "no". Subjects responded to the questions by pressing a button and did not receive feedback on their answers. After subjects completed each quarter of the experiment, the experimenter recalibrated the equipment and subjects had a short break. Thus, the eye-tracker was calibrated a minimum of three times during the experiment and usually more.

The computer displayed each experimental list in a fixed random order together with 28 sentences like *While Jane was drawing, the poodle barked twice and bit her*, and 69 additional filler sentences of varous syntactic types.

Regions. For analysis, we defined the *NP* region as the pronoun, the word *and*, and the other conjunct (e.g. *she and her family*), because early case effects could occur there if readers made use of this information. We defined the *Verb* region as the disambiguating main verb plus any auxiliaries (e.g. *would be*), because effects in this region could indicate whether case-marking influences recovery from misanalysis. The other regions resulted from the positioning of the two critical regions. All regions included the character spaces before the first word in the region.

Analyses. An automatic procedure pooled short contiguous fixations. The procedure incorporated fixations of less than 80 msec into larger fixations within one character and then deleted fixations of less than 40 msec that fell within three characters of any other fixation. Following Rayner and Pollatsek (1989), we presume that readers do not extract much information during such brief fixations. Before analysing the eye-movement data, we eliminated the occasional trial when the subject failed to read the sentence or when tracker loss ensued. More specifically, we removed trials where two or more adjacent regions had zero first-pass reading time. This procedure removed 4.3% of the data.

First-fixation time is the duration of the first fixation within a region. *First-Pass Reading Time* is the sum of the fixations occurring within a region before the first fixation outside the region. If the eye fixates on a point beyond the end of a region before landing in the region for the first time, then the first-fixation and first-pass time for that region are zero. *Total Reading Time* is the sum of all fixations in a region.

The analyses we report excluded 0-msec times that occurred when readers skipped a region. In fact, there was only one 0-msec time for the NP region. Readers skipped the Verb region on 12% of trials. A second set of analyses included 0-msec times and matched the results of the first nearly exactly. One subject with extremely long reading times (7 trials with first-pass reading times greater than 100 msec/character) was removed from the data set, and a replacement subject was run. Further, we eliminated first-pass times of greater than 100 msec/character from the remaining data (0.3% of the data).

Results

Figure 1 represents first-pass and total reading times by condition for the NP and Verb regions. Table 1 presents mean first-fixation times for the NP region. Let us focus first on the NP region, where case information first becomes available. To investigate processing in the NP region, we performed 2 (complementizer: present vs. absent) × 2 (case-marking: case-marked pronoun vs. unmarked pronoun) ANOVAs. First-pass data from the NP region suggest an early effect of case-marking. 2 (complementizer) × 2 (case-marking) ANOVAs demonstrated that readers spent more time on their first pass through the NP region processing sentences that lack the complementizer *that*, $F_1(1, 23) = 5.48$, $p < .05$ and $F_2(1, 27) = 9.80$, $p < .01$. In addition, readers spent more time processing sentences that contained case-marked pronouns, $F_1(1, 23) = 7.54$, $p < .01$ and

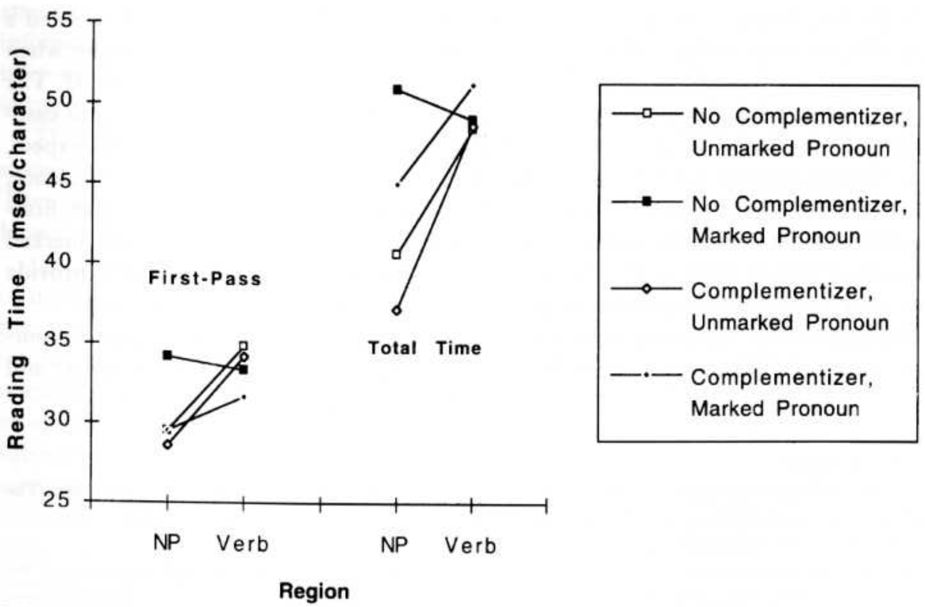

FIG. 1. First-pass and total reading time by condition for the NP and Verb regions.

TABLE 1
First Fixation Times for NP Region

	Case-marking	
Complementizer	*Unmarked*	*Marked*
Absent	232	259
Present	238	244

$F_2(1, 27) = 13.76$, $p < .001$. These analyses also revealed an interaction of complementizer and case-marking, $F_1(1, 23) = 4.68$, $p < .05$ and $F_2(1, 27) = 3.54$, $p < .07$.[1]

As the left side of Figure 1 shows, first-pass reading times are long when there is no complementizer and the pronoun is case-marked. Scheffé post-hoc means comparisons demonstrated that first-pass reading times in the NP region for sentences with case-marked pronouns and no complementizer differed from sentences with case-marked pronouns and the complementizer *that*, $t_1(23) = 3.80$, $p < .001$ and $t_2(27) = 3.52$, $p < .01$.[2] These analyses also demonstrated that, in sentences without complementizers, readers spent more time processing the NP region when the sentence contained a case-marked pronoun than when it contained an unmarked pronoun, $t_1(23) = 3.91$, $p < .001$ and $t_2(27) = 3.63$, $p < .01$. In contrast, these analyses revealed no differences between sentences with case-marked and unmarked pronouns in sentences that contained the complementizer *that*, with both $t < 1$. Likewise, in sentences with unmarked pronouns, readers processed the NP region equally rapidly in sentences with and without the complementizer, with both $t < 1$. Hence, the interaction between complementizer and case-marking was clearly driven by long reading time on sentences with a case-marked pronoun and no complementizer.[3]

In the first-fixation data, 2 (complementizer) × 2 (case-marking) analyses revealed a main effect of case-marking. Readers' first fixations in the NP region were briefer when the pronoun was unmarked, $F_1(1, 23) = 7.93$, $p < .01$ and $F_2(1, 27) = 6.05$, $p < .02$. The analyses also produced a weak trend toward an interaction of complementizer and case-marking, $F_1(1, 23) = 2.73$, $p < .12$ and $F_2(1, 27) = 2.50$, $p < .13$. As one would expect, first-fixation times did not differ when the complementizer *that* appeared in the sentence, with both $F < 1$. In contrast, Scheffé post-hoc means comparisons showed that first-fixation times in sentences without the complementizer were longer for case-marked pronouns, $t_1(23) = 2.93$, $p < .01$ and $t_2(27) = 2.93$, $p < .01$. Thus, the data provide some weak evidence that case information influences very early stages of parsing.

Finally, consider the pattern of total reading times for the NP region. Here, 2 (complementizer) × 2 (case-marking) ANOVAs produced main effects of complementizer and

1 We also performed these analyses on data that had not been subjected to a msec/character transform. The results were nearly identical, so we did not conduct further analyses on the untransformed data.

2 Note: p values for all Scheffés are based on two-tailed tests.

3 We also examined *regressions* (defined as leftward movements across a region boundary beginning at the rightmost point the subject has fixated). We found no reliable differences in number of regressions between conditions in the NP and Verb regions, with all $F < 1$.

case-marking. As the right side of Figure 1 shows, readers spent more time processing the NP region when the sentence contained a case-marked pronoun than when it contained an unmarked pronoun, $F_1(1, 23) = 31.05$, $p < .0001$ and $F_2(1, 27) = 26.12$, $p < .0001$. Likewise, readers spent more time processing the NP region when the complementizer was absent than when it was present, $F_1(1, 23) = 8.97$, $p < .01$ and $F_2(1, 27) = 7.03$, $p < .01$.

DISCUSSION

The interaction of complementizer and case-marking in the NP region, which was due to the elevated reading time for sentences with case-marked pronouns and no complementizer, clearly demonstrates that case-marking rapidly affected processing of "NP/S" sentences. By the time that subjects had finished reading the NP, they must have adopted the NP analysis for the sentence, and must have processed the case information.

Hence the data are incompatible with accounts that claim that "NP/S" constructions do not produce garden-path effects under any conditions (Holmes et al., 1987; Kennedy et al., 1989). The effect of case-marking showed that the parser adopted the NP analysis (on at least a large proportion of trials). It did not delay choice of analysis or adopt the S-analysis. This finding is compatible with either a restricted or an unrestricted account of parsing.

The data also show that subjects made use of case information very rapidly. Subjects employed case information while they were processing the critical NP (e.g. *she and her family*).

Data from sentences containing complementizers suggest that the complementizer prevented readers from considering the misanalysis. Because readers did not attempt to attach the NP beginning with the pronoun as the direct object of the preceding verb, case information had no influence on processing. As readers did not need to consult case information, no differences between case-marked NPs and unmarked NPs occurred in sentences that contained a complementizer.

Thus, our results suggest that the processor initially assumed that the main verb in our materials took an NP object rather than an S complement in cases of local ambiguity. They also suggest that case information is rapidly employed in ambiguity resolution. However, within this range, they are compatible with two related accounts of parsing.

On one account, the processor attached the NP as the object of the main verb, whether or not this analysis was permitted by case information. The proposed verb–object structure was then rapidly reviewed by a structure-checking procedure which employed case information to filter out ungrammatical constructions. Because NPs beginning with nominative pronouns cannot serve as objects, the structure-checking procedure produced an error signal. The parser then attempted to generate an alternative structure for the subject–verb–NP fragment. Because NPs beginning with nominative pronouns can serve as subjects of embedded sentences, the parser proposed that structure to the checking mechanism. In contrast, NPs beginning with unmarked pronouns can serve as objects. Thus, the structure-checker did not produce an error signal for reduced complement sentences containing NPs beginning with unmarked pronouns until the processor encountered the syntactically disambiguating verb. Hence, error signals and recovery