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Plausibility and Verb Subcategorization in Temporarily Ambiguous Sentences: Evidence from Self-Paced Reading

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A self-paced reading experiment investigated processing of sentences containing a noun-phrase that could temporarily be mistaken as the direct-object argument of a verb in a subordinate clause but actually constituted the syntactic subject of the main clause (often referred to as an early vs. late closure ambiguity). Subcategorization preference of the subordinate verb and plausibility of the syntactic misanalysis were manipulated. Elevated reading times occurred during processing of the temporarily ambiguous noun-phrase for those sentences where the noun-phrase was an implausible direct-object of the preceding verb, regardless of the verbs' subcategorization preferences. Elevated reading times were observed for all sentence types following syntactic disambiguation. Subsequent correlational analyses showed that the verbs' individual subcategorization preferences affected processing time on the critical noun-phrase and the syntactically disambiguating main verb.

KEY WORDS: Syntax; parsing; ambiguity; subcategory information.

Accounts of parsing can be classified according to the role they assign to detailed lexical information in ambiguity resolution. According to the *garden-path* account, the parser makes initial decisions about how to structure input based only on information about a word's major syntactic category (Frazier, 1979, 1987; cf. Frazier & Clifton, 1996). When more than one structure is licensed by the grammar, the parser employs heuristics like *build the simplest structure* (*minimal attachment*) or *attach material within the most recently constructed phrase* (*late closure*) to determine

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which analysis will be constructed. If the initial structure proves infelicitous, reanalysis occurs. *Constraint-based* accounts propose that the parser consults detailed lexical information, such as the conditional probability that a particular lexical item will appear in a specific syntactic structure, along with many other potentially useful sources of information, when more than one structure is licensed by the grammar (MacDonald *et al*., 1994; McRae *et al*., 1998; Pearlmutter & MacDonald, 1995; Spivey-Knowlton & Sedivy, 1995; Trueswell *et al*., 1993). In this class of account, the parser makes reference to all available information at the earliest possible moment and *foregrounds* (assigns the highest activation to) the most likely analysis.

These accounts can be applied to generate predictions for the processing of sentences like (1), which are sometimes described as containing an *early* versus *late closure* ambiguity:

When Susan fell(,) the policeman stopped and picked her up. (1a)
When Susan tripped(,) the table crashed to the ground. (1b)
When Susan tripped(,) the policeman stopped and picked her up. (1c)

Sentence (1a) differs from sentences (1b) and (1c) in that the verb *fell* cannot take a direct-object argument other than a cognate (as in, e.g., *Humpty dumpty fell a great fall*.), but *tripped* often takes a direct-object (as in *Mary tripped John*). In all three sentences, the verb in the subordinate clause (*fell* or *tripped*) is followed by a noun-phrase (*the policeman* or *the table*) that could be the subordinate verb's direct-object but is actually the subject of the main clause (as in *the policeman stopped and picked her up*). This becomes apparent as soon as the reader encounters the syntactically disambiguating main verb (*stopped* or *crashed*).

Different processing accounts make different assumptions as to what the parser does prior to encountering the disambiguating main verb. More specifically, different accounts predict disruption at different points in the sentence. Thus, contrasting readers' responses to ambiguous versions of sentence 1 (where the comma is absent) with unambiguous versions (where the comma is present) helps distinguish between different accounts of syntactic parsing.

On the garden-path account, readers should always attempt to attach the temporarily ambiguous noun-phrase as the direct-object of the preceding verb, because the subordinate verb-phrase is the phrase marker that is currently being constructed (Frazier, 1979, 1987). In sentences (1a) and (1b), this attachment decision leads to an anomalous semantic result. This becomes apparent when readers encounter the head of the noun-phrase

(*policeman* or *table*). Thus, the garden-path account predicts elevated reading times at the head of the ambiguous noun-phrase in (1a) and (1b). In (1c), attaching the ambiguous noun-phrase (*the policeman*) to the subordinate verb (*tripped*), produces a sensible semantic interpretation, so no disruption should occur prior to encountering the syntactically disambiguating main verb. Because the garden-path account presumes that the ambiguous noun-phrase will be treated as the direct-object of the subordinate verb, it predicts disruption of processing in all three versions of sentence (1) after readers encounter the syntactically disambiguating main verb (*stopped* or *crashed*). During reanalysis, readers may access sources of information beyond major syntactic category in the search for an alternative analysis. Previous research on plausibility and recovery from syntactic misanalysis demonstrates that readers have greater difficulty abandoning an analysis that produced a plausible semantic result (Pickering & Traxler, 1998; Pickering *et al.*, 2000; Traxler & Pickering, 1996a, b). Thus, readers may experience greater difficulty processing *stopped* in sentence (1c) than in the other two versions of the sentence (because *Susan tripped the policeman* makes sense, but *Susan tripped the table* does not). Further, readers may experience more difficulty processing syntactically disambiguating material in cases where the subordinate verb strongly prefers to take a direct-object.

According to constraint-based accounts, the subcategorization preferences of the subordinate verb influence the activation of alternative syntactic analyses and, therefore, which syntactic analysis is foregrounded. All other things being equal, there should be less difficulty processing both the ambiguous noun-phrase and the syntactically disambiguating matrix verb in sentences like (1a), in which the subordinate verb biases the reader toward the ultimately correct analysis, than in sentences like (1b), in which the direct-object analysis is equally implausible but the subordinate verb biases the reader toward the incorrect direct-object analysis.

Under a strong *lexical guidance* account, an account in which the subcategory preference of the subordinate verb is used to foreground an initial analysis, readers should avoid misanalyzing (1a) entirely, because the preferentially intransitive verb *fell* should cause the parser to foreground the intransitive analysis (see, e.g., Adams *et al.*, 1998; Ford *et al.*, 1983). This ranking would be reinforced by the uninterpretability of the direct-object analysis (i.e., *Susan fell the policeman*) and confirmed when readers encounter the syntactically disambiguating matrix verb *stopped*. Thus, the lexical guidance version of a constraint-based account predicts little or no difference in processing between the ambiguous (comma absent) and unambiguous (comma present) versions of sentence (1a). By contrast, readers should experience some difficulty processing the

ambiguous noun-phrase in sentence (1b) when the comma is absent. This occurs because the transitive-preference verb *tripped* causes readers to foreground the analysis under which *table* is the direct-object of *tripped*. The alternative analysis, under which *table* is the subject of the main clause, has a much higher plausibility, however, and so the direct-object and subject analyses begin to compete with one another for activation, which should produce elevated processing times (McRae *et al*., 1998; Spivey-Knowlton & Sedivy, 1995). If this competition causes the subject analysis to be foregrounded prior to readers encountering the syntactically disambiguating main verb, then little additional difficulty should be experienced there (i.e., at *crashed*). In sentences like (1c), readers should experience little difficulty during processing of the ambiguous noun-phrase (*policeman*), because both subcategory preference and plausibility constraints strongly favor the direct-object analysis, and so little competition between analyses would occur. In this case, competition would not begin until readers encounter the syntactically disambiguating main verb. Elevated reading times are predicted on the syntactically disambiguating verb because prior information strongly supported the misanalysis.

PREVIOUS STUDIES OF THE PROCESSING OF OBJECT-SUBJECT AMBIGUITIES

Several studies have addressed processing of object-subject ambiguities like those in sentence (1). Results have been somewhat mixed, with some studies favoring lexical guidance in initial attachment decisions and some studies favoring accounts in which the use of subcategory information is delayed. Mitchell (1987) used a self-paced reading technique in which readers viewed sentences like (2):

> After the child had sneezed (during surgery) * the doctor ** prescribed a course of injections. (2a)
> After the child had visited (during surgery) * the doctor ** prescribed a course of injections. (2b)

In (2a), the verb is obligatorily intransitive and the ambiguous noun-phrase is implausible as direct-object of the subordinate verb. In (2b), the verb is preferentially transitive and the ambiguous noun-phrase is plausible as direct-object of the subordinate verb. Mitchell presented his sentences in two segments. The break between the segments occurred either just before the ambiguous noun phrase (at the point marked "*") or just after the ambiguous noun phrase (at the point marked "**"). In half

of the sentences, a prepositional phrase, like *during surgery,* disambiguated the sentence prior to the critical noun-phrase. Readers experienced disruption of processing in sentences like (2a), despite the fact that *sneezed* is obligatorily intransitive. Some critics rejected these findings, however, because of the use of artificial segmentation (e.g., Boland & Tanenhaus, 1991; Fodor, 1978, 1989).

Adams and her colleagues (1998) performed an eye-movement monitoring experiment that provided evidence for the segmentation explanation of Mitchell's (1987) results. They manipulated the subcategory preference of the subordinate verb and whether disambiguating information appeared early (in the form of an adverb immediately following the subordinate verb) or late (in the form of the matrix verb of the main clause). As in Mitchell's study, noun-phrases following intransitive verbs represented implausible or anomalous direct-objects, while noun-phrases following transitive-preference verbs represented plausible direct-objects, and no effort was made to assess effects of plausibility. Adams *et al.* found disruption during and after processing of syntactically disambiguating information only for those sentences containing transitive-preference subordinate verbs. When an intransitive-preference verb appeared in the subordinate clause, there was no difference in reading time on the noun-phrase following the subordinate verb or on the matrix verb between the ambiguous and unambiguous sentences. These results were interpreted as supporting early access and use of subcategory preference information to block construction of the incorrect direct-object analysis in sentences like (1).

Several other studies of sentences like those tested by Adams and her colleagues have produced results that are less compatible with the lexical guidance hypothesis. For example, an eye-movement monitoring study demonstrated that the length of the temporarily ambiguous noun region affects whether disruption will be observed in this region (Ferreira & Henderson, 1990, 1991; van Gompel & Pickering, 1998). In this study, subjects read sentences like (3):

> After the dog struggled the vet and his new assistant took off the muzzle. (3a)
> After the dog scratched the vet and his new assistant took off the muzzle. (3b)

These sentences used the same verbs as in the Adams *et al.* (1998) study, but had longer ambiguous regions. Readers had greater difficulty during processing of the region *the vet and his new assistant* in sentences like (3a), where the subordinate verb was intransitive, than in sentences like (3b), where the subordinate verb was transitive. This pattern of difficulty was reversed during processing of syntactically disambiguating information

(i.e., the verb phrase *took off the muzzle*). Disruption during processing of *the vet and his new assistant* following the intransitive verb *struggled* indicates that readers attempted to attach the compound noun-phrase to the preceding verb. This would lead to an initial interpretation of (3a) that was implausible or anomalous (it makes no sense to say *The dog struggled the vet and his new assistant*). The absence of a comparable slow-down during early processing of the same compound noun-phrase in (3b) indicates that the initial interpretation, that the dog scratched somebody, is plausible. When readers processed the part of the sentence that disambiguated the syntax (*took off*), they had less difficulty in sentence (3a) than in sentence (3b). This indicates that the semantic implausibility of the initial analysis in (3a) facilitated readers' computation of the correct intepretation. Because the target sentence stops making sense earlier in (3a) vs. (3b), the search for an alternative interpretation starts earlier in (3a), which facilitates processing of later information that confirms the alternative interpretation. The lexical guidance hypothesis has difficulty accommodating this finding. When the initial verb is strongly intransitive, as it is in (3a), the lexical guidance hypothesis predicts that readers will avoid mis-attaching the compound noun-phrase, and hence that the compound noun-phrase in sentence (3a) will be as easy to process as the comparable region in sentence (3b). This prediction is disconfirmed by Van Gompel and Pickering's results.

In another study, Pickering *et al.* (2000) employed eye-movement monitoring to investigate processing of sentences like (1b) and (1c), except that all of the verbs in the experimental items were intransitive-preference. They found effects nearly identical to those reported by Mitchell (1987). When the misanalysis was plausible (as in 1c), little disruption was observed prior to the syntactically disambiguating verb. By contrast, sentences like (1b) caused disruption during processing of the ambiguous noun-phrase. Following syntactic disambiguation, greater disruption was observed for sentences like (1c), where the misanalysis was plausible, than for sentences like (1b), where the misanalysis was implausible. Pickering and Traxler (1998) found a nearly identical pattern of results in an eye-movement monitoring study of sentences containing a mixture of transitive- and intransitive-preference verbs. Because the pattern of processing was so similar across the different sets of sentences, Pickering and his colleagues concluded that subcategory preference information did not prevent readers from adopting the (incorrect) direct-object analysis.

Pickering and his colleagues (Pickering & Traxler, 1998; Pickering *et al.*, 2000; Traxler & Pickering, 1996a, b; Traxler *et al.*, 1998) concluded further that the best way to explain subcategory-preference and plausibility effects in their experiments was to propose an effect of plausibility on

syntactic reanalysis. In particular, they proposed that implausible analyses are hard to adopt and plausible analyses are hard to abandon (see also Tabor & Hutchins, 2003, for a discussion of *digging in* effects in parsing). Subcategory information appeared to play a less important role in the initial formulation of a syntactic analysis.

In none of the previous studies was any attempt made to assess the relationship between the magnitude of disruption during processing of the critical noun phrase or the syntactically disambiguating matrix verb and the degree to which the subordinate verb preferred a direct-object. Thus, these prior studies have not settled to everyone's satisfaction the question of whether and when readers access and use subcategory preference information in parsing. In the current experiment, sentence-generation data were collected to assess the degree of transitive-intransitive preference for all of the subordinate verbs used in the study. By comparing processing of sentences containing obligatorily intransitive verbs and sentences with verbs that had a broad mixture of preferences, and sentences with implausible misanalyses to sentences with plausible misanalyses, it should be possible to determine whether readers use subcategory information to avoid misanalysis in sentences like (1a) and (1b) and, if subcategory information does not allow readers to avoid misanalyzing sentences like (1), whether subcategory information plays a role in recovery from syntactic misanalysis (cf. Garnsey *et al*., 1997; McRae *et al*., 1998; Trueswell *et al*., 1993).

If the overall pattern of processing for sentences like (1a) closely resembles the pattern for (1b), that would suggest that implausibility of the misanalysis is the critical factor in determining processing difficulty prior to syntactic disambiguation. If, by contrast, readers use subcategory preference information to foreground an initial analysis, this predicts a pattern of results similar to that obtained by Adams *et al*. (1998). In this case, when the initial verb is strongly intransitive, processing times for the critical noun-phrase (*the policeman*/*the table*) and the matrix verb (*stopped*/*crashed*) should be the same whether the sentence contains a comma or not. When the initial verb is strongly transitive, processing time on the critical noun-phrase should depend on how sensible the noun is as a direct-object of the preceding verb. If verb subcategorization plays a significant role in recovery from misanalysis, then less disruption should occur at and following the disambiguating verb in sentences like (1a), where the subordinate verb supports the correct analysis, than in sentences like (1b), where the subordinate verb supports the misanalysis. Subcategory preference effects in reanalysis should manifest themselves as correlations between processing time on the disambiguating material and strength of preference for the incorrect (direct-object) analysis. One previous study on adults has attempted such an analysis for this construction (Kjelgaard & Speer, 1999), with inconclusive results (see also

Jennings *et al.*, 1997, for subcategory effects in naming for object-complement ambiguities). A further self-paced reading study on elementary school children produced evidence for a subcategory-preference effect on syntactic parsing and reanalysis in one out of three experiments (Traxler, 2002).

As you will see below, readers in this experiment experienced difficulty processing the critical noun-phrase when it was an implausible direct-object of the preceding verb, regardless of the preceding verb's subcategory preference. This indicates that subcategory information was not used to block the direct-object interpretation of the critical noun-phrase. However, subcategory preference correlated with reading times on the critical noun and on the disambiguating matrix verb. This indicates that subcategory information affected the strength with which readers committed to their syntactic analyses.

EXPERIMENT

In the three-part experiment reported here, verb subcategorization preference and plausibility were manipulated independently. In the first group of items, obligatorily intransitive verbs appeared in the subordinate clause. In the second and third group of items, the verbs in the subordinate clause varied widely in the their subcategory preferences (from 5% to 95% direct-object preference; see Appendix B). In the first and second group of items, the syntactic misanalysis (under which the temporarily ambiguous noun-phrase would be taken as the direct-object argument of the preceding verb) was implausible or anomalous. In the third set of items, the syntactic misanalysis was plausible. In half of the items, a comma following the verb in the subordinate clause provided early disambiguation. Thus, sentences containing a comma served as the baseline against which the difficulty of the ambiguous versions of the sentences could be assessed. The fourth cell (i.e., intransitive preference verbs followed by plausible direct-objects) was not tested. Any effects there would be indistinguishable from intralexical priming effects because only cognates could be used (i.e., subjects would have to read *sneezed a big sneeze*, *died a slow death*, *snored a gigantic snore*).

Method

Subjects

Sixty native English speaking college students participated in the self-paced reading portion of the study. None participated in any other

phase of the study. Subjects received partial credit toward fulfilling a course requirement in return for their participation.

Items

The experimental stimuli consisted of 26 sets of items like (1), repeated here:

When Susan fell(,) the policeman stopped and picked her up. (1a)
When Susan tripped(,) the table crashed to the ground. (1b)
When Susan tripped(,) the policeman stopped and picked her up. (1c)

Each sentence began with a subordinate clause ending with a verb. Sentences lacking a comma were disambiguated by the matrix verb. Each sentence contained a main clause beginning with a simple noun-phrase, followed by the matrix verb, followed by various sensible, gramatically legal endings. All of the items appear in Appendix A. Sentences like (1a) and (1b) contained a noun-phrase following the subordinate verb that made an implausible direct-object for the subordinate verb (see plausibility norming, below). Sentences like (1c) contained a noun-phrase following the subordinate verb that made a plausible direct-object for the subordinate verb.

Note that the three sentence types were read by three different groups of participants. 1/3 of the participants read each type of sentence. Note further that each participant read some temporarily ambiguous and some control sentences (i.e., half of the sentences that a participant read would contain a comma, and half would not). The experimental items were presented to participants along with 60 fillers of various types. Many of the filler sentences had verbs followed by direct objects (e.g., *John wondered whether he would get any mail. The computer made a funny noise and stopped working*).

Verb Norming

The verbs included in the study were selected from a set of 75 verbs that were tested in a sentence-generation task. Twenty subjects read a list of verbs and wrote down the first grammatical, sensible sentence that came to mind. This technique is commonly used to assess verbs' subcategorization preferences (e.g., Pickering *et al.*, 2000). These sentences were hand-scored and classified according to what kind of argument (e.g., direct-object, prepositional-phrase, infinitival, etc.), if any, directly followed the verb. The full results of this scoring procedure for all 75 verbs are reported in Appendix B. Twenty six verbs (like *fell*) were selected that

never appeared with a direct-object argument in the completions.[2] A further 26 verbs (like *tripped*) varied in their tendency to take a direct-object (range = 5%–95%).

Plausibility Norming

Plausibility pre-tests assessed the plausibility of the syntactic misanalysis and the plausibility of the correct analysis. To assess the plausibility of the syntactic misanalysis, subjects read items composed of the noun phrase and verb in the subordinate clause followed by the subject noun phrase of the embedded sentence (as in 6). Mean plausibility ratings appear following each example item.

Susan fell the policeman. (6a)	4.1
Susan tripped the table. (6b)	4.1
Susan tripped the policeman. (6c)	1.4

The sentences were randomized and sorted into a list such that the different versions of the sentences were separated as far as possible. Twenty three raters read each of the sentences and rated them on a scale from 1 (makes perfect sense) to 5 (makes no sense; see e.g., Pickering & Traxler, 1998; Traxler *et al*., 1997). A one-way ANOVA with item group as a between items factor produced a robust difference [$F(2, 75) = 534$, $p < 0.0001$, MSe = 0.119]. Simple contrasts showed that items like (6a) and (6b) produced uniformly low plausibility ratings that did not differ ($F < 1$, NS), and both differed from items like (6c), with both $F > 700$, $p < 0.0001$. Raters also rated the plausibility of the unambiguous versions of sentences like (1a–c; i.e., sentences with the comma present). This was done to help ensure that the plausibility of the ultimately correct analysis was matched across item types. Mean plausibility ratings of the correct analysis were 1.6 for sentences like (1a), 1.9 for sentences like (1b), and 2.0 for sentences like (1c). This small numerical difference produced a main effect of sentence type in a one-way ANOVA with sentence type as a between-items factor [$F(2, 75) = 4.77$, $p = 0.01$, MSe = 0.223]. This main effect occurred because sentences like (1a) received higher plausibility ratings than sentences like (1b) and (1c), which did not differ [1a vs.

[2] with one exception (see Appendix B). The verb *was skipping* was used in transitive constructions 25% of the time. In every instance the complete phrase was *X was skipping class*. We did not feel that this interpretation of the verb would occur to subjects in the self-paced-reading portion of the study, because the entire item was *While the little girl was skipping, the dog chased a cat*. Nevertheless, we performed a set of subsidiary analyses after excluding this item. When we analyzed the data excluding this item, the results were identical.

1b, $F(1, 25) = 5.62$, $p = 0.02$; 1a vs. 1c, $F(1, 25) = 8.41$, $p < 0.01$; 1b vs. 1c $F(1, 25) < 1$, NS].

Apparatus and Procedure

Sentences were presented to subjects using a self-paced moving window paradigm. Purpose-built software running under the DOS shell on a PC controlled stimulus presentation and data collection. Before the experiment started, subjects were instructed to read and understand the sentences well enough to answer comprehension questions. They were instructed further to read at their normal, comfortable pace. Each trial began with a series of dashes on the computer screen in place of the letters in the words. Punctuation characters (here, commas and periods) were shown in the positions at which they occurred in the sentence. When subjects pressed the space bar for the first time, the first set of dashes changed to the first word in the sentence. When subjects pressed the space bar for the second time, the second set of dashes turned into the second word in the sentence and the first word changed back into dashes. Subjects continued through to the end of the sentence by pressing the space bar (cf. Just *et al.*, 1982). A yes-or-no question followed each sentence. Subjects recorded their answers by pressing the y-key or the n-key (y for "yes", n for "no"). The computer recorded the time from when a word was first displayed until the subject pressed the space bar and subjects' answers to the comprehension questions. The computer timing was accurate to within the nearest millisecond. Presentation of the words and the beginning of the timing was tied to the monitor's refresh cycle so that when a subject pressed the space bar in the middle of a raster sweep, the computer would delay restarting the timer until the raster had reached to top of its sweep. This ensured that the reaction times would reflect the time that had elapsed after each word was displayed, not the entire time between bar presses, which would include a variable amount of time that the subjects spent looking at the previous word after pressing the space bar.

RESULTS

All of the data reported here were taken from correct-answer trials. Comprehension question performance was 98% for items like 1a, 98% for items like 1b, and 94% for items like 1c. There were no main effects of item group (sentences like 1a vs. sentences like 1b vs. sentences like 1c) or ambiguity (ambiguous vs. unambiguous sentences), nor was there an interaction, in subjects' accuracy on the comprehension questions.

Table I. Mean Reading Time by Region and Condition

Example test sentences:

Intransitive Bias, Implausible:

When Susan **fell(,) the policeman stopped and** picked her up. (1a)

Transitive Bias, Implausible:

When Susan **tripped(,) the table crashed to** the ground. (1b)

Transitive Bias, Plausible:

When Susan **tripped(,) the policeman stopped and** picked her up. (1c)

	Region				
Condition	subordinate verb	determiner	noun	matrix verb	spillover 1
Experiment 1a					
Ambiguous	541	509	488	472	450
Unambiguous	750	492	416	441	459
Experiment 1b					
Ambiguous	518	508	520	561	524
Unambiguous	652	498	460	476	508
Experiment 1c					
Ambiguous	487	458	510	573	533
Unambiguous	657	464	468	471	495

Table I presents mean reading time by region and condition for the three types of items. Table II presents the results of a series of ANOVAs testing for an effect of sentence type (comma present vs. comma absent).

Based on prior results for similar materials (Pickering *et al.*, 2000; Pickering & Traxler, 1998), I predicted a three-way interaction of region (noun region vs. matrix verb region), ambiguity (ambiguous vs. unambiguous sentences), and item group (sentences like 1a vs. sentences like 1b vs. sentences like 1c). Separate $2 \times 2 \times 3$ repeated measures ANOVAs treating subjects and items as random factors produced reliable 3-way interactions in the items analysis [$F2(2, 75) = 3.46$, $p < 0.05$, MSe = 5180] and a trend in the by-subjects analysis [$F1(2, 57) = 2.79$, $p = 0.07$, MSe = 4786]. Thus, readers responded differently to the three different types of items. The remainder of the statistical analyses explored the factors that produced this difference.

One effect that deserves some attention is the main effect of sentence type (ambiguous vs. unambiguous) in the noun region for sentences like (1a) and sentences like (1b). This result replicates previous findings (Adams *et al.*, 1998; Clifton, 1993; Pickering & Traxler, 1998; Pickering

Table II. Results of ANOVAs

	F1	(MSe)	F2	(MSe)
Statistical Analyses by Region for the First Set of Items				
Subordinate verb	13.6**	32156	30.4**	21162
Determiner	<1	3800	<1	5136
Noun	24.5**	2121	6.54*	6282
Matrix verb	5.04*	1970	2.43	3944
Spillover	<1	2618	<1	4403
Statistical Analyses by Region for the Second Set of Items				
Subordinate verb	23.5**	7614	25.5**	9112
Determiner	<1	2914	<1	9899
Noun	15.7**	7706	17.3**	9130
Matrix verb	24.7**	2889	10.2**	9143
Spillover	<1	3377	<1	8877
Statistical Analyses by Region for the Third Set of Items				
Subordinate verb	21.2**	11573	19.7**	16490
Determiner	<1	4540	<1	11161
Noun	2.17	6833	1.17	19806
Matrix verb	10.2**	8686	6.53*	20313
Spillover	1.27	9618	1.58	20776

Note: Degrees of freedom are (1, 19) for by-subjects analyses and (1, 25) for by-items analyses. * indicates $p < 0.05$. ** indicates $p < 0.01$.
Source: Sentence Type (Ambiguous vs. Unambiguous)

et al., 2000; Stowe, 1989). In short, regardless of the subordinate verbs' subcategorization preferences, readers spent longer processing the head noun of the main clause subject noun-phrase when the sentence was ambiguous and the noun-phrase was implausible or anomalous as the direct-object of the subordinate verb. This indicates that readers attempted to treat the noun-phrase as the direct-object of the subordinate verb, whether or not the subordinate verb preferentially took a direct-object argument. The lack of a reliable sentence-type effect (ambiguous vs. unambiguous) for sentences like 1c at the critical noun-phrase is also compatible with this conclusion, because the main clause subject noun-phrases in sentences like 1c were plausible direct-objects for the subordinate verb. Although there was a numerical difference between the ambiguous and control conditions here, it is not likely that this numerical difference is interpretable. First, the absence of a statistically significant result is consistent with similar null results in several previous studies (Ferreira & Henderson, 1990, 1991; Mitchell, 1987; Pickering & Traxler, 1998; Van Gompel & Pickering, 1998; Traxler, 2002). Second, none of the processing accounts predicts a difference between those two conditions at that point.

If this numerical difference reflected a real difference in processing, this would be difficult to accommodate under any of the processing hypotheses.

Finally, all three groups of sentences produced evidence for disruption of processing in the ambiguous versions after readers encountered the syntactically disambiguating matrix verb (see Tables I and II). However, sentences like (1a), in which the misanalysis was implausible and the subordinate verb was strongly biased against the direct-object analysis, produced a statistically significant slow-down in the ambiguous condition only in the by-subjects analysis. This could be interpreted as indicating that the correct analysis was easier to adopt when the subordinate verb and implausibility of the misanalysis favored the correct analysis. A further series of correlational analyses explored this possibility.

If verb subcategorization preference influences how strongly the reader commits to an analysis, then readers should commit more strongly to the direct-object analysis in sentences like (1b) than in sentences like (1a), because the subordinate verbs in sentences like (1a) rarely or never take a direct-object. Because these two groups of sentences have equally implausible misanalyses, the contribution of verb subcategorization preference to processing time can be estimated by performing correlational analyses. Thus, the first set of correlational analyses were performed on data from Experiments 1 and 2 combined (so there were 52 items included in this analysis; see Table III). Using each individual item as the unit of analysis, strength of the subcategorization preference (how often a subordinate verb took a direct-object in the completion task) was correlated with reading times on the determiner, the head noun of the subject noun-phrase, and the disambiguating verb. These analyses allow a comparison of the degree of direct-object preference with reading time by region and condition for each item. Later, a series of additional analyses eliminated potential artifactual explanations for the results of this initial set of analyses.

Raw reading time served as the dependent measure and direct-object-preference (from 0% to 95%) served as the predictor variable in a series of simple correlational analyses on each region individually. The results of these analyses are summarized in Table III. First, the determiner region failed to produce a reliable correlation between direct-object preference and reading time in either the ambiguous or unambiguous conditions. However, reading times across both ambiguous and unambiguous versions of sentences like (1a) and (2a) in the noun and matrix verb regions did correlate with the degree of direct-object preference (with Pearson r ranging from 0.25 to 0.40. See Table III, section marked "A"). Before interpreting these results, however, potential artifactual explanations must be eliminated.

The first potential confound is that of length. Even though length and frequency of the target regions were identical across conditions (because

Table III. Results of Correlational Analyses

Condition	Region	Pearson r	$t(50)$	p	MSe
A. Experiment 1a and 1b: Correlation between verb subcategorization preference and raw reading time by condition and region					
Ambiguous	Noun	0.31	2.30	0.03	954631
Unambiguous	Noun	0.25	1.85	0.07	400381
Ambiguous	Matrix Verb	0.40	3.08	0.01	669794
Unambiguous	Matrix Verb	0.31	2.26	0.03	398091
B. Experiment 1a and 1b: Correlation between verb subcategorization preference and residuals of length-reading time correlation					
Ambiguous	Noun	0.29	2.12	0.04	844782
Unambiguous	Noun	0.26	1.86	0.07	400428
Ambiguous	Matrix Verb	0.43	3.35	0.01	642494
Unambiguous	Matrix Verb	0.35	2.65	0.01	361823
C. Experiment 1a and 1b: Correlation between verb subcategorization preference and residuals of unambiguous condition reading time-ambiguous condition reading time correlation					
Ambiguous-Unambiguous Residuals	Noun	0.41	3.13	0.01	512670
Ambiguous-Unambiguous Residuals	Verb	0.32	2.31	0.03	709980
D. Experiment 1c: Correlation between verb subcategorization preference and raw reading time by condition and region					
Ambiguous	Noun	0.10	0.49	0.63	380129
Unambiguous	Noun	0.18	0.92	0.37	391162
Ambiguous	Matrix Verb	0.33	1.71	0.10	580182
Unambiguous	Matrix Verb	0.27	1.39	0.18	282011
E. Experiment 1c: Correlation between verb subcategorization preference and residuals of unambiguous condition reading time-ambiguous condition reading time correlation					
Ambiguous-Unambiguous Residuals	Noun	0.22	1.10	0.28	359641
Ambiguous-Unambiguous Residuals	Verb	0.40	2.14	0.04	283202

Example: When Susan tripped(,) the policeman stopped and picked her up. (1c)

precisely the same words were used), it is still possible that the length of the scoring regions could have been confounded with degree of direct-object preference (except for the determiner region, which was always three characters long, but which did not produce a correlation between subcategorization preference and reading time). If this were so, then the correlations reported in the previous paragraph could just as easily reflect an effect of length as a subcategorization-preference effect. However, when the relationship between subcategorization preference and length was tested, the two did not correlate with one another in either the noun region [$r = 0.11$, $t(50) = 0.810$, NS] nor in the matrix verb region

[$r = -0.01$, $t(50) = -0.69$, NS]. To be absolutely certain that length did not affect the previously reported correlations, an additional set of analyses was performed. The first separately correlated length with reading time for the noun region and matrix verb region for each condition. The next correlated direct-object preference with the residuals of this analysis. In other words, the residual analysis looked at that part of subjects' reading times that was uncorrelated with the length of the scoring region. More specifically, strength of subcategorization preference was used to predict those residual reading times. As shown in Table III section B, there were reliable correlations between subcategorization preference and these residual reading times in both conditions in both the noun and matrix verb regions. Thus, the initial results were not an artifact of a length confound.

Another possible confound arises from the between-subjects design. Because items like 1a with a strong intransitive bias were read by a different group of subjects than items like 1b with mixed subcategory preference, global differences in reading times could artifactually induce a correlation between direct-object preference and reading time. In fact, items like 1b produced longer average reading times in the noun and matrix verb regions than items like 1a. The trick in testing the hypothesis that group reading speed differences produced the initial correlation between subcategory preference and reading time in the critical regions is to separate out the influences of the experimental manipulation from subject-produced influences. This was accomplished in two different ways. First, if the subjects who read items like 1b were simply slower readers than subjects who read items like 1a, then that difference should turn up in the filler items, which were identical between groups. Thus, the filler items were divided into eight regions. The first seven regions consisted of one word each. The eighth region consisted of the remainder of the sentence. Using item group (1a vs. 1b) as a between-subjects factor, one-way ANOVAs tested for differences in mean reading time on any of the eight scoring regions in the filler items. This technique increases the possibility of suffering a Type I error and so, perversely, gives the best chance of producing evidence for the artifact in question. However, these statistical analyses revealed no reliable differences in any of the scoring regions in the filler items (all $F < 1$, NS). This suggests that any differences observed in the experimental items is due to item-specific factors (like subordinate verb subcategorization-preference), and not to global differences in reading speed between groups of subjects.

Another way to remove subject-related variance from the analysis is to use reading times in the control condition (comma present) to predict reading time in the experimental condition, and then use direct-object preference to predict the residuals of this correlation. This analysis

has the additional advantage of simultaneously removing whatever variance is associated with length and frequency of the individual words. In other words, direct-object preference can be correlated with reading time after subject-specific and region-specific variance have been removed. These analyses showed that difficulty of processing the noun region and the matrix verb regions increased with direct-object preference of the subordinate verb (see Table III, section C). Thus, global reading time differences can be excluded as the determining factor in the raw score results.

The data thus demonstrate that the difficulty readers experienced processing sentences that contain subject noun-phrases that are implausible as direct-objects of a preceding verb increases as the preceding verbs' preference to take a direct-object increases. This pattern carries over into the disambiguating region. Here, the difficulty readers had processing disambiguating information increased as the strength of support for the misanalysis increased.

One final set of correlational analyses tested predictions developed from the results of the first set of analyses. If verb subcategorization preference affected how difficult it is for the readers to adopt the direct-object analysis and how easy it is for readers to abandon this analysis once syntactic information rules it out, this predicts a different pattern of correlations in the third set of items. Recall that all of the items in the third set (sentences like 1c) contained subject noun-phrases whose heads represented plausible direct-objects of the subordinate verb. Thus, whether the verb strongly or weakly preferred a direct-object, there should be little processing difficulty when readers adopt the direct-object analysis; and therefore, there should be no correlation between direct-object preference and reading times in the noun region in the third experiment. However, if the correlation between direct-object preference and reading time in the matrix verb region in the previous experiments was based on increased difficulty computing an analysis that violated the subcategorization preference of the subordinate verb, then there should be a correlation between direct-object preference and processing time on the disambiguating matrix verb in the third set of items (as there was in the first two sets of items). In this case, readers would compute the misanalysis in the noun region and be compelled by syntactic information to abandon this analysis when they reached the matrix verb. If the process of recovery from misanalysis were affected by the strength of support for the misanalysis, difficulty processing syntactically disambiguating material should increase as the direct-object preference of the subordinate verb increased.

A set of analyses similar to those reported above tested this hypothesis. The raw score analyses produced no evidence of a correlation between direct-object preference and reading time in the noun region (see Table III,

section D). Likewise, the raw score analyses produced only a weak trend toward a correlation for the matrix verb data. In a residual analysis using the unambiguous conditions as a baseline (see above), there was still no correlation between verb subcategorization preference and processing time in the noun region, but there was a reliable correlation in the matrix verb region (Table III, section E). Thus, the third set of items also produced evidence that subcategorization preference affected recovery from misanalysis.

The final effect of note is the reliable slow-down in the unambiguous (i.e., comma-present conditions) across all three item types (see Table Ia–c) in the subordinate verb region. These effects reflect clause wrap-up operations (Just & Carpenter, 1980; Green *et al.*, 1981).

DISCUSSION

There are two main results to consider. First, readers appeared to attach the main clause subject noun-phrase as the direct-object of the subordinate verb whether or not the subordinate verb preferentially subcategorized for a direct-object. This conclusion is supported by the fact that the subject noun-phrases produced longer reading times in the ambiguous condition than the unambiguous condition when the subject noun-phrase was implausible as the direct-object of the subordinate verb, regardless of the subcategorization preference of the subordinate verb. It is further supported by the fact that the ambiguous conditions (with the possible exception of items like 1a) produced longer reading times at the syntactically disambiguating matrix verb. If readers had used the subordinate verb's subcategorization preference to avoid misanalyzing the sentence prior to encountering the disambiguating verb, then there should have been no difference between the ambiguous and unambiguous conditions at the matrix verb.

The second main result to consider is the fact that verb subcategorization preference did influence how difficult the sentences were to process. Verb subcategorization preference created two distinct types of difficulty for readers. The difficulty that subjects experienced increased when the subordinate verb's subcategory preference reinforced a syntactic analysis that produced an implausible semantic result (as in the first two sets of items). Additionally, regardless of the plausibility of the misanalysis, processing of syntactically disambiguating information became more difficult as the degree of direct-object preference increased (and became easier as the degree of direct-object preference decreased).

The finding that readers did not use subcategory information to avoid syntactic misanalysis is consistent with a number of previous findings indicating that initial choice of analysis does not depend solely upon internalized frequency counts (Bader, 2000; Brysbaert & Mitchell, 1996; DeVincenzi & Job, 1995; Ferreira & Henderson, 1990; Traxler, 2002; Traxler *et al.*, 1998, 2000; van Gompel *et al.*, 2000, 2001; cf. McElree & Griffith, 1995; Ford *et al.*, 1983). However, because effects of verb subcategorization preference occurred during processing of the ambiguous noun-phrase, these data suggest fairly rapid access to and use of verb subcategorization information.

At least two processing accounts are consistent with this pattern of results. Under the first account, the parser did not access subcategory information, or accessed and ignored it, until after an initial analysis had been computed. This would explain why noun-phrases that made implausible direct-objects for the preceding verb were difficult to process, irrespective of the preceding verbs' subcategorization preferences. After an error message was generated due to the implausibility of the direct-object analysis, the parser began searching for an alternative analysis. At this point, subcategory information was consulted so that the parser could determine what, if any, alternative constructions were possible. In other words, subcategory information was accessed and used after the initial attachment had been made. If the subordinate verb strongly preferred to take a direct-object, then the initial analysis was reinforced, regardless of its semantic qualities. Likewise, if the subordinate verb had a strong intransitive preference, then commitment to the initial analysis was weakened. If subcategory information affected the strength with which the parser committed to the (implausible) direct-object analysis, then this would explain the graded effects in the noun region when the misanalysis was implausible. The same principle would apply to processing of the syntactically disambiguating region. Here, readers experienced across-the-board difficulty in the ambiguous region, indicating that they routinely misanalyzed the sentences, but there were also graded effects based on the subcategorization preferences of the subordinate verb. This is what would occur if subcategory information affected strength of commitment to the misanalysis.

This account is wholly compatible with Frazier's (1987) answer to the question about when and how perceivers bring to bear different sources of information to structure temporarily ambiguous input. On this account, parsing preferences "... result from the time pressures involved in comprehension—the parser simply adopts the first available analysis of all items that must be attached to the current phrase marker... lexical restrictions are then used to filter out inappropriate syntactic analyses whenever these lexical restrictions become available (p. 299)." It is also consistent with

findings concerning the interaction of prosodic and subcategory information (Kjelgaard & Speer, 1999).

This account supposes, then, that subcategory information either is not accessed or is ignored until after an initial attachment decision has been made. It is possible that subcategory information was accessed and did influence the initial attachment decision, but that the overall influence of subcategory information was masked by other factors (like the plausibility of alternative analyses and structural preference information based on major category information like *minimal attachment* and *late closure*). It has been suggested previously (e.g., Garnsey *et al*., 1997; Jennings *et al*., 1997) that subcategorization preference is one influence among many that affects what analysis is adopted (or foregrounded) initially. It could be that information from a different level of analysis (e.g., that most verbs in the language are transitive or that most sentences in the language contain direct-object constructions) outweighed subcategory information in the initial choice of analysis, but that subcategory information became more important when a choice had to be made whether to drop (or background) the initial analysis. This formulation represents the best chance of reconciling these findings with *unrestricted* accounts of parsing (see Traxler *et al*., 2002; van Gompel *et al*., 2000a; cf. MacDonald *et al*., 1994).

Finally, these findings may also bear on a novel parsing system that is closely related to (but different than) constraint-based lexicalist parsers, namely *self-organizing* parsers (Stevenson, 1994; Tabor & Hutchins, 2003; Vosse & Kempen, 2000). On this account, "... links between nodes in parse trees change strength with time" based on factors like sense-semantic fit between constituents and positions in a verb's argument structure. Parsing in this system is accomplished by simultaneously attaching all available constituents to all available argument positions. Readers experience disruption of processing in sentences like 1a–1c because subcategory and sense-semantic plausibility factors cause the direct-object interpretation of strings like *While Mary tripped the policeman...* to out-compete the alternative subject interpretation. Because of the dynamic quality of attachments in the processing system, this type of account naturally predicts graded effects such as those observed in this experiment.

CONCLUSIONS

Two sets of findings from the current experiment bear on the question of how readers parse temporarily ambiguous sentences. First, disruption during processing of the ambiguous region when the potential direct object was implausible and during processing of the syntactically disam-

biguating region indicates that readers routinely mis-parsed the test sentences. This indicates that subcategory information linked to the subordinate verb did not dictate the initial parse, and readers attempted the direct-object interpretation even for sentences containing intransitive-preference verbs. Correlations between degree of intransitive preference and the magnitude of disruption following syntactic disambiguation suggest that parsing operations are senstive to verb-preference information following syntactic misanalysis. These results may indicate that subcategory preference behaves like semantic plausibility or case-marking. For example, previous studies demonstrated that the plausibility of the initial syntactic analysis affects the strength with which readers commit to that analysis, but implausibility does not result in the immediate filtering of the syntactic analysis leading to the implausible interpretation (e.g., Pickering & Traxler, 1998; Pickering *et al*., 2001). Although readers do not avoid syntactic analyses that produce implausible semantic results, even when an alternative analysis is more plausible and supported by detailed lexical information, plausibility can affect how easy or difficult it is to recover from a syntactic misanalysis. Likewise, readers do not avoid syntactic analyses that both violate subcategory preferences and lead to an implausible semantic interpretation. But importantly, subcategory preference can contribute to the overall difficulty readers experience processing syntactically ambiguous and disambiguating input. These findings are most easily accommodated by proposing that subcategory preference affects the strength with which readers commit to their initial syntactic analysis. Such a formulation can also explain other graded effects following syntactic disambiguation (Garnsey *et al*., 1997; Trueswell *et al*., 1993). When the relevant factors like semantic plausibility, subcategory preference, or case marking conspire against an analysis, that analysis becomes more difficult to adopt and easier to abandon.

APPENDIX A: EXPERIMENTAL MATERIALS

Set A: Intransitive Subordinate Verbs, Implausible Misanalysis

When the tiger appeared(,) the lion roared very loudly.
Although the bear disappeared(,) the deer was frightened quite badly.(,)
While the students listened(,) the teacher told them a story.
When the boy sneezed(,) the girl walked to the door.
After the man came(,) the woman had some pie.
After the man talked(,) the woman told a story.
When the girl screamed(,) the boy ran away from the dog.

While the girl was skipping(,) the dog chased a cat.
As the boy was hopping(,) the girl played with a ball.
As the horse was leaping(,) the cow ate some grass.
When Sue fell(,) the policeman stopped and helped her up.
While the girl danced(,) her mother took some pictures.
When the baby smiled(,) the nurse clapped her hands.
After the doctor laughed(,) the woman jumped to her feet.
Before the girl coughed(,) the doctor was reading his notes.
Because the girl was sobbing(,) the man gave her some ice cream.
While the cat was purring(,) the dog was sitting near the fireplace.
While the dog was sleeping(,) the cat was drinking some milk.
Because the man was snoring(,) the woman plugged her ears.
As the dog was growling(,) the owner was talking on the telephone.
While the girl was praying(,) the woman got ready to go to bed.
When the customer complained(,) the salesman called the boss.
While the balloon was rising(,) the child was shouting and running.
While the girl was giggling(,) the man was watching a movie.
As the crowd was clapping(,) the actor was bowing and smiling.
While the dancer was bowing(,) the crowd was shouting and clapping.

Set B: Mixed-Preference Subordinate Verbs, Implausible Misanalysis

While the boy drank(,) the girl ate some ham.
While the girl ate(,) the boy had some milk.
While the man sang the drummer(,) banged on a bass drum.
As the fireman was humming(,) the truck came into the station.
As the woman was cleaning(,) the doctor walked into the room.
As the child was climbing(,) the woman pushed the stroller.
Before the plane landed(,) the pilot saw the jet.
While the girl was running(,) the teacher was helping the boy.
When the captain was sailing(,) the truck crossed over the bridge.
When Sue tripped(,) the table fell over and the vase was broken.
As the man was walking(,) the house was being painted by the workmen.
When the girl called(,) the phone rang six times.
When the boy was racing(,) the street was full of people.
While the boy was fighting(,) the newspaper landed on the porch.
As the player was hitting(,) the noise made by the crowd got louder.
While the man was parking(,) the horn went off and scared the dog.
When the boy was playing(,) the dog found a bone in the garden.
While the chef was baking(,) the stove was very hot.
As the woman was driving(,) the brush fell out of her purse.
When John was dealing(,) the hamburger sat on the tray.

As the girl was dressing(,) the mirror fell onto the floor.
While the boy was hiding(,) the air became colder and colder.
When the child asked(,) the bone was given to the dog.
While the fisherman was casting(,) the boat was floating down the river.
As the woman was spinning(,) the fire was dying down.
While the children were reading(,) the cook was making some lunch.

Set C: Mixed-Preference Subordinate Verbs, Plausible Misanalysis

While the boy drank(,) the milk got warm and the food got cold.
While the girl ate(,) the ice cream melted and ran down the side of the bowl.
While the man sang(,) the song was playing on the radio.
As the fireman was humming(,) the tune could be heard outside the station.
As the woman was cleaning(,) the stove began to heat up.
As the child was climbing(,) the ladder fell down with a crash.
Before the pilot landed(,) the plane flew through a thick cloud.
While the girl was running(,) the race was shown on TV.
When the captain was sailing(,) the ship passed under the bridge.
When Sue tripped(,) the girl fell over and the vase was broken.
As the man was walking(,) the dog was barking and jumping up and down.
When the girl called(,) the dog came running as fast as he could.
When the boy was racing(,) the bike was taken by the very bad man.
While the boy was fighting(,) the bully snuck off and went home.
As the player was hitting(,) the ball was thrown back from the outfield.
While the man was parking(,) the car bumped into the green truck.
When the boy was playing(,) the trumpet made a screeching sound.
While the chef was baking(,) the cookies were cooling on the counter.
As the man was driving(,) the truck crashed into the fire hydrant.
When John was dealing(,) the cards landed all over the place.
As the girl was dressing(,) the doll fell onto the floor.
While the boy was hiding(,) the toy got stolen by the big kid.
When the child asked(,) the teacher answered right away.
While the fisherman was casting(,) the net trailed in the water behind the boat.
As the woman was spinning(,) the yarn got twisted into a big knot.
While the children were reading(,) the books arrived from the library.

APPENDIX B: VERB SUBCATEGORIZATION PREFERENCES

Subjects wrote sentences for the list of 75 verbs printed below. The 52 experimental verbs are first in the list, followed by an additional 25 filler verbs. Subjects' responses were placed into one of 8 categories based on the material in their response that immediately followed the verb.

	Type of Phrase Immediately Following the Verb							
	Direct Object	Prepositional Phrase	Intransitive	Infinitival	Complement	Adjunct	Passive	Other
Verb								
appeared	0	70	20	0	0	5	0	5
disappeared	0	30	65	0	5	0	0	0
listened	0	95	5	0	0	0	0	0
sneezed	0	30	65	0	5	0	0	0
came	0	60	15	15	0	10	0	0
talked	0	85	15	0	0	0	0	0
screamed	0	35	50	0	15	0	0	0
was skipping	25	55	15	0	5	0	0	0
was hopping	0	65	25	5	0	0	0	5
was leaping	0	80	20	0	0	0	0	0
fell	0	80	5	0	5	10	0	0
danced	0	35	55	0	0	10	0	0
smiled	0	50	35	0	15	0	0	0
laughed	0	60	35	0	5	0	0	0
coughed	0	25	65	0	10	0	0	0
was sobbing	0	60	20	0	20	0	0	0
was purring	0	0	90	0	10	0	0	0
was sleeping	0	5	70	0	25	0	0	0
was snoring	0	5	95	0	0	0	0	0
was growling	0	60	35	0	5	0	0	0
was praying	0	65	15	0	20	0	0	0
complained	0	65	20	0	15	0	0	0

was rising	0	45	50	0	5	0	0	0
was giggling	0	45	45	0	10	0	0	0
was clapping	0	65	30	0	5	0	0	0
was bowing	0	50	35	0	10	0	0	5
ate	90	10	0	0	0	0	0	0
sang	70	20	10	0	0	0	0	0
was humming	40	25	30	0	5	0	0	0
was cleaning	60	0	20	0	20	0	0	0
was climbing	90	5	5	0	0	0	0	0
landed	10	60	30	0	0	0	0	0
was running	10	65	15	5	5	0	0	0
was sailing	20	65	10	0	0	0	0	5
tripped	5	60	25	0	10	0	0	0
was walking	15	70	10	0	0	0	0	5
called	60	15	20	0	5	0	0	0
was racing	30	35	20	10	5	0	0	0
was fighting	40	45	5	5	0	0	0	5
was hitting	95	5	0	0	0	0	0	0
was parking	80	5	0	0	15	0	0	0
was playing	35	45	10	0	10	0	0	0
was baking	80	5	5	0	0	0	0	10
was driving	40	30	15	0	10	0	0	5
was dealing	90	10	0	0	0	0	0	0

APPENDIX B. Continued

	Type of Phrase Immediately Following the Verb							
	Direct Object	Prepositional Phrase	Intransitive	Infinitival	Complement	Adjunct	Passive	Other
was dressing	35	40	5	15	0	0	0	5
was hiding	15	65	10	0	10	0	0	0
asked	50	25	0	5	15	0	5	0
was casting	70	30	0	0	0	0	0	0
was spinning	35	25	35	0	5	0	0	0
were reading	80	5	10	0	5	0	0	0
drank	95	0	0	0	5	0	0	0
Filler verbs								
gave	100	0	0	0	0	0	0	0
flew	5	80	10	0	0	5	0	0
drew	95	5	0	0	0	0	0	0
made	95	0	0	0	0	0	0	5
drove	30	60	5	0	0	5	0	0
went	0	75	0	5	0	15	0	5
gave	95	5	0	0	0	0	0	0
found	85	0	0	0	5	0	0	5
was sitting	0	90	5	0	0	5	0	0
struck	75	0	0	0	0	0	20	5
left	65	10	0	0	0	5	20	0
cleaned	100	0	0	0	0	0	0	0
was raining	0	0	0	0	0	0	0	100
was over	0	35	65	0	0	0	0	0
wants	55	0	0	40	0	0	0	5

lost	60	0	5	0	0	0	15	20
wondered	0	5	0	0	95	0	0	0
do	25	0	15	0	10	0	0	50
stood	0	60	15	0	0	25	0	5
entered	75	15	5	0	0	0	5	0
started	35	0	15	35	0	15	0	0
liked	80	0	0	5	0	0	0	15
finished	70	20	5	0	0	0	0	5

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