

FILLING GAPS ON-LINE:
USE OF LEXICAL AND SEMANTIC INFORMATION IN
SENTENCE PROCESSING*

LAURIE A. STOWE
Rijksuniversiteit Groningen
MICHAEL K. TANENHAUS
University of Rochester
and
GREG N. CARLSON
University of Rochester

Two experiments investigated how people assign an interpretation to question phrases. In order to determine the meaning of the WH-phrase (e.g., who, what), a "gap" must be located and the role associated with the gap assigned to the WH-phrase. Two experiments tested the Lexical Expectation model of Fodor (1978), according to which lexical properties of the verb determine when a gap is posited, and the All Resorts model of Stowe (1984), according to which all possibilities are considered and evaluated on their pragmatic appropriateness. In Experiment 1, subjects judged the meaningfulness of full sentences. The frequency with which verbs are used transitively determined whether there was an effect of the plausibility of the WH-phrase to act as an object of the verb. Effects of plausibility of the WH-phrase as an object showed up in just those cases where the object role should be assigned to the WH-phrase according to the Lexical Expectation model, rather than as predicted by the All Resorts model. In Experiment 2, these results were replicated using the word-by-word self-paced reading paradigm. The plausibility effect showed up at the verb itself when it is normally used transitively. This evidence suggests that a gap is preferred even over a lexically filled object for transitive expectation verbs.

Key words: parsing, syntactic ambiguity resolution, sentence processing, gap-filling

INTRODUCTION

It is plausible to assume that, in understanding simple English declarative sentences such as *The student read a book*, people use the serial order of constituents to determine

* This research was partly supported by NSF grants BNS 82-17378 and BNS 86-17738. We would like to thank Susan Garnsey for helpful discussions about this research and Mike Anderson and Kent Crowell for assistance in conducting the experiments. A preliminary report of the two experiments reported here was presented at the seventh annual meeting of the Cognitive Science Society. Due to an error in the original data sorting program, the means originally reported for Experiment 2 were slightly inaccurate.

Send correspondence to: Laurie A. Stowe, Dept. of Linguistics, Faculteit der Letteren, Rijksuniversiteit Groningen, 9700 AS Groningen, The Netherlands.

grammatical relations. *The student* is the subject of the sentence, designating the reader, since it comes before the verb, whereas *a book* is the object, designating what is read, since it comes after the verb. However, serial order information alone is insufficient for assigning appropriate grammatical relations for many other constructions of English, such as WH-questions ("who", "what", "which girl") and related constructions involving "long-distance" dependencies. In such cases, additional sources of grammatical information must be brought into play. In (1), although *book* does not follow *read* (and in fact precedes the verb), it still designates what is read rather than the reader.

- (1) *Which book* did the student read?

Such constructions cannot be handled by simply adding order-based stipulations (e.g., an initial WH-phrase and another noun phrase followed by a verb are the object and the subject of the verb, respectively), since the WH-phrase can bear any of an indefinite number of grammatical relations in the sentence. Consider the examples in (2).

- (2) a. Which book ___ was read by the class?
 b. Which book did the student read about ____?
 c. Which book did the student say ___ disappeared from the library?
 d. Which book did the teacher say that the student stole ___ from the library?

In (2a), the WH-phrase bears the subject role, in (2b) it serves as the object of a preposition, in (2c) it is the subject of an embedded clause, and in (2d) the object of an embedded clause. We have marked the position in which a phrase bearing the role assigned to the question would appear in a declarative clause with '___

The most common approach in linguistic theory to the problem of interpreting sentences with long-distance dependencies is to follow the insights of transformational grammarians and to assume that the WH-phrase has been displaced from its original position in the deep structure of the sentence. This displacement can be visualized as leaving an empty "position" in the sentence, sometimes referred to as an "empty category", a "gap" or a "trace". These are the positions which we indicate with a '___' in (2). In most recent versions of generative grammar, the empty category receives the same grammatical relation as an overt phrase in that position would. The displaced phrase or "filler" inherits this grammatical relation through a process of association or "co-indexing"; under this view, the semantic interpretation of the WH-phrase can be handled by the procedures already necessary for declarative sentences with minimal extra assumptions. (See Kaplan and Bresnan, 1982; Chomsky, 1981; and Gazdar, Klein, Pullum and Sag, 1985, on how filler-gap association is treated formally in some current syntactic theories.) However, this does not explain how people **comprehend** WH-clauses. As pointed out above, the position of the WH-phrase does not give enough information to identify its grammatical relation to the other elements in the sentence. This can only be determined by "locating a gap" or finding a position which is not filled by a phrase of the same type as the WH-phrase (but which could be) and assigning the grammatical relation associated with that position to the WH-phrase, or "filling the gap". However, gaps are not overtly marked in spoken or written language, so the procedures that people

use to determine the structure of sentences (the "parser") must include means to identify gaps without hearing or seeing them.

In the best case, the parser is provided with unambiguous evidence for a gap when an obligatory noun phrase is missing. Thus a preposition like *onto* that is not followed by a noun phrase unambiguously marks a gap, as in sentence (3a).

- (3) a. Which shelf did John put the book onto ___?
 b. Which book did John put ___ onto the shelf?

Likewise, the absence of a noun phrase following a verb sometimes unambiguously signals a gap, as in sentence (3b). However, as the examples in (4) illustrate, many verbs can be used both transitively and intransitively.

- (4) a. John read the book.
 b. John read.

As a result, an optionally transitive verb that is not followed by an object noun phrase does not unambiguously mark a gap. Since displaced constituents are typically noun phrases and most noun phrases are arguments of verbs, the verb in a WH-construction frequently presents the parser with an ambiguity.

How then does the parser deal with the problem of ambiguities of this sort? In a seminal paper, Fodor (1978) discussed this question, first evaluating and rejecting two fairly straightforward models for locating gaps: the First Resort model and the Last Resort model. According to the First Resort model, the first possible gap location is assumed to be the correct one until further evidence forces revision of this hypothesis. Sentences with later gaps, like (5a), require re-analysis and should be harder to process than sentences like (5b) in which the gap is, in fact, in the first possible position.

- (5) a. Which book did the teacher read to the children about ___?
 b. Which book did the teacher read ___ to the children?

Intuitively, these predictions appear to be correct for (5a) and (5b), supporting the First Resort model. Additional evidence for a version of the First Resort model (the Active Filler Hypothesis) has been presented by Frazier and Flores d'Arcais (1989) and Frazier and Clifton (1989).

According to the Last Resort model, no commitment is made until unambiguous evidence for a gap appears or until the end of the sentence forces a gap that is not unambiguously signalled to be posited and its semantic role assigned to the WH-phrase. According to this hypothesis, since it is not certain that a gap follows the verb in (5a) and (5b), its existence will not be posited unless the parser reaches the end of the sentence without encountering another gap, as in (5b). At this point the parser will be forced to revise its initial analysis and posit an object gap. In contrast, the prepositional gap in (5a) should be located as soon as the preposition is identified, since there is unambiguous evidence for the gap; the preposition, unlike the verb, must have an object or the sentence is ungrammatical. Thus, under the Last Resort model a sentence with an unambiguously marked gap, such as (5a), should be easier to understand than one that

contains only a early gap that is not unambiguously signalled, like (5b). Jackendoff and Culicover (1971) discuss data from the comprehension of dative questions that suggests a Last Resort model of parsing.

Fodor (1978) noted that neither the First Resort nor the Last Resort model seems adequate to account for intuitions about the relative difficulty of sentences with gaps. Although intuitions about the sentences in (5) support the First Resort model, intuitions about other sentences, like those in (6), appear to better support the Last Resort model. Gaps which are not unambiguously signalled are marked by '()'

- (6) a. Who did the orderly hurry () quickly toward ___ at the doctor's office?
 b. Who did the orderly hurry () quickly toward the doctor's office.

For sentences like those in (6), the version with an unambiguously marked gap (6a) seems easier than the version with only an ambiguous gap (6b), as predicted by the Last Resort model.

Fodor resolved these conflicting intuitions by suggesting that whether a gap is initially located depends on the particular lexical items in the sentence, chiefly the verb, attributing the idea to unpublished work by Wanner and his colleagues. The idea, also argued for by Ford, Bresnan, and Kaplan (1982), is that the different syntactic structures in which a verb can be used (its subcategorizations) are ranked by some criteria, such as salience or frequency, with the highest ranking use determining the structure constructed in the first pass of the parser.

According to Fodor's Lexical Expectation model, when a sentence contains a verb which is normally used transitively, such as *read*, the parser will attempt to assign to it a transitive structure. A noun phrase following the verb will be analyzed as the object. If there is a WH-phrase but no object noun phrase, as in (5), the parser posits an object gap. That is, the parser first attempts a transitive analysis without a gap, followed by a transitive analysis with a gap. If there is a later unambiguously signalled gap in the sentence, the object gap analysis must be revised. Thus sentences like (5a), in which the object gap analysis turns out to be correct, are predicted to be easier to process than sentences like (5b), in which a later gap forces the parser to abandon its initial analysis. In sentences containing verbs which are normally used intransitively, such as *hurry* in (6), the sentence is initially assumed to be intransitive. Thus the parser will not expect an object noun phrase and in the absence of an object noun phrase will not posit a gap. At the end of the sentence, if no other unambiguously signalled gap has been located, the parser will have to backtrack and posit an object gap, so sentences like (6b) are predicted to be harder to understand than sentences like (6a), which seems correct.

However, Stowe (1984) pointed out that intuitive judgments about how easy it is to comprehend sentences containing gaps such as those cited by Fodor (1978) are also influenced by how plausible the WH-phrase is when associated with the potential gap. Consider (7):

- (7) a. Which book did the students read () quietly about ___?
 b. Which war did the students read () quietly about ___?

The gap following the preposition in (7a) seems to come as more of a surprise than the gap following the preposition in (7b) because *book* is a more plausible object of *read* than *war* (i.e., *read a book* is fine, but *read a war* sounds strange). Stowe further suggested that the intuitions which Fodor attributed to transitivity preferences might instead be due to plausibility differences among the individual sentences. As a result, Stowe proposed an alternative model, the All Resorts model of gap location, in which a gap is initially postulated following any potentially transitive verb. Plausibility information is then immediately used to decide whether or not to accept the gap analysis. In (7a), since *book* is a plausible object of *read*, the transitive analysis is immediately accepted and the gap is "filled" by the WH-phrase. However, in (7b), the transitive analysis is immediately rejected because the potential filler *war* is an implausible object of *read*. Thus the parser is still expecting a gap when it encounters the prepositional object gap. This model assumes some degree of parallel processing of syntactic possibilities with a semantically based decision procedure, similar to that proposed by Crain and Steedman (1985) and Kurtzman (1985).

The All Resorts and Lexical Expectation models can be distinguished by teasing apart the effects of plausibility and transitivity preferences on gap location and filling. While there is a growing literature on the use of verb-based preferences in the resolution of various ambiguities (Clifton, Frazier, and Connine, 1984; Ferreira and Henderson, 1990; Ford *et al.*, 1982; Holmes, Stowe, and Cupples, 1989; Mitchell, 1987; Mitchell and Holmes, 1985; Stowe and Holmes, 1990), only a few studies have investigated the role of verb preferences in gap-filling, and these studies have not manipulated the plausibility of the filler.

Clifton *et al.* (1984) found that sentences are judged more comprehensible and understood faster when the gap location corresponds to the transitivity preference of the verb, suggesting that transitivity preferences influence when gaps are posited. Interestingly, the effect of verb information appears to be minimal when there is a lexically specified filler, as opposed to *who* and *what*. As only plausible fillers were used, this may be taken as support for the All Resorts model. Frazier and Clifton (1989) compared reading times for sentences containing intransitive preference verbs with object and prepositional object gaps like those in (8). Sentences were presented in groups of words, and subjects pressed a button to get the next group. Time from presentation of the group until the button was pressed to obtain the next group was recorded as a measure of reading time. Reading times for groups like *to his fiancée about* in (8a) were longer than reading times for groups like *to his fiancée* in (8b), even when adjusted for differences in length.

- (8) a. What did the silly young man whisper (___) to his fiancée about ___ during the movie?
- b. What did the silly young man whisper (___) to his fiancée during the movie?

Frazier and Clifton attributed this difference to reprocessing that takes place as a result of having to revise an object gap analysis and thus concluded that gaps are posited after intransitive preference verbs as well as transitive preference verbs. However, an alternative explanation is that reading times for *to his fiancée* were faster than reading times for

to his fiancée about because of the experimental presentation. Only the former corresponds to a syntactic constituent, but given the presentation, people may attempt to take whatever is on the screen as a single, complete syntactic phrase as well as a visual group. This turns out to be efficient only with object gap sentences.

The two experiments reported here compared the Lexical Expectation and All Resorts models by examining the effects of transitivity preference and plausibility on the processing of WH-questions with optionally transitive verbs.

EXPERIMENT 1

The Lexical Expectation model and the All Resorts model were tested by independently manipulating the transitivity preference of the verb in a WH-clause and the plausibility of the WH-filler as the object of the verb in sentences where the actual gap was either immediately after the verb or after a later preposition. Subjects were presented with a single sentence on each trial and made a speeded judgment about whether or not the sentence "made sense". Processing difficulties and plausibility are assumed to affect both the speed and outcome of the judgment task. That is, we predict that, when people have difficulty understanding a sentence, they will tend to judge that it does not make sense; equally, when the interpretation of the sentence is implausible (even if the implausible interpretation turns out not to be the final interpretation of the sentence), people will take longer to judge that the sentence is sensible and will be more likely to judge that it is not. The predictions of the two models are as follows.

The Lexical Expectation model assumes that for transitive preference verbs, an object gap is located and filled immediately, regardless of the plausibility of the interpretation. Therefore, sentences with an object gap are predicted to be easier to process than sentences with a later prepositional object gap. For intransitive preference verbs, the object gap is not initially posited and sentences with a late unambiguously marked gap should be easier than if there is no late gap. However, positing a gap and filling it are not the only factors that affect reading times. The plausibility of the sentence interpretation also has an effect. When an implausible WH-phrase fills a gap, reading times can be predicted to be longer than if it were plausible. So the plausibility manipulation can be used to test if only those gaps that should be located and filled under the Lexical Expectation Hypothesis are in fact filled. For transitive expectation verbs, the object gap is posited and filled immediately; therefore differences in plausibility should be noticeable even if there is a later gap so that the eventual interpretation is equally plausible for both fillers. For sentences containing an intransitive preference verb, since the object gap is filled only when there is no later unambiguously signalled gap, a difference in plausibility of the filler as object of the verb should influence processing only when the parser does not encounter a later unambiguously marked gap.

In the All Resorts model, only plausibility information is used to decide whether to accept an ambiguous gap. If the WH-phrase cannot plausibly be assigned the meaning associated with an early ambiguous gap, the gap analysis is immediately rejected and the search for a gap continues. If the WH-phrase is a plausible object, the search for a gap is abandoned. Thus when the WH-phrase is implausible as a filler of the object gap,

sentences with a late prepositional object gap ought to be easier than those containing an object gap. The opposite is true for sentences with a plausible filler, since the transitive hypothesis is accepted immediately. We should see effects of plausibility only in those cases where people are forced to accept an analysis with an implausible filler, due to the lack of a later unambiguously marked gap. This differs from the plausibility effects discussed above in that it should be present for both verb types, since verb preference has no role in the decision.

Method

Subjects. Twenty-eight students at the University of Rochester participated in the experiment. An additional 32 subjects participated in the rating study described below.

Materials. Sixteen "transitive preference" and 16 "intransitive preference" verbs were selected from the norms collected by Connine, Ferreira, Jones, Clifton, and Frazier (1984).¹ Transitive preference verbs were used transitively more than 62% of the time (mean = 79.8%), whereas intransitive preference verbs were used transitively less than 26% of the time (mean = 11.6%). For each verb, two nouns were selected to be used as WH-fillers. The nouns differed in how plausible they were as direct objects of the verb. For example, *book* is a plausible direct object of the transitive preference verb *read*, whereas *song* is not.

For each of the 32 verbs, a set of four sentences was constructed with the verb being the main verb on an embedded WH-question. The four sentences were created by combining the two types of fillers (plausible or implausible) with two gap positions (early or late). In the early gap sentences the gap occurred immediately after the verb. In the late gap sentences the gap occurred after a preposition later in the clause. The materials were constructed so that the two fillers were equally plausible in the late gap position, i.e., as objects of the preposition. Sample materials appear in Table 1; the full set of materials appears in the Appendix. The four sentence conditions for each verb were counterbalanced across four lists so that each subject saw each sentence in only one form and saw an equal number of sentences in each condition. All subjects saw the same set of distracter items, approximately twice as many as target items. Two-thirds of the distracters were ungrammatical; some of these were filler-gap sentences.

Plausibility ratings. We conducted a rating study to test two important aspects of our materials. First, the degree of difference in plausibility for the two types of fillers should be comparable for the transitive preference and the intransitive preference verbs. Secondly, the two fillers should be equally plausible as objects of the prepositions in the late gap sentences. Plausibility ratings were collected to determine whether our materials had these characteristics. We chose not to have subjects rate the plausibility

¹ Connine *et al.* give detailed data concerning the sentence frames that the verbs they tested were used in. We counted all responses in Connine *et al.*'s categories 9 to 14 as transitive for this purpose. They report the results of two norming procedures. If a verb appeared in both study 1 and study 2, we considered the verb's transitivity expectation to be the mean of the transitivity norms calculated under these procedures.

TABLE 1

Sample materials for experiments

EARLY GAP

TRANSITIVE EXPECTATION

- PLAUSIBLE The teacher wondered which book the students read () during their class.
- IMPLAUSIBLE The teacher wondered which song the students read () during their class.

INTRANSITIVE EXPECTATION

- PLAUSIBLE The nurse wondered which patient the orderly hurried () to the doctor's office.
- IMPLAUSIBLE The nurse wondered which bed the orderly hurried () to the doctor's office.

LATE GAP

TRANSITIVE EXPECTATION

- PLAUSIBLE The teacher wondered which book the students read () quietly about ____
- IMPLAUSIBLE The teacher wondered which song the students read () quietly about ____

INTRANSITIVE EXPECTATION

- PLAUSIBLE The nurse wondered which patient the orderly hurried () quickly towards ____
- IMPLAUSIBLE The nurse wondered which bed the orderly hurried () quickly towards ____

of the actual test sentences because the ratings presumably would have been influenced by the filler-gap assignment process. Instead we had subjects rate the plausibility of the semantic role assignments required by each of the four versions of the test sentences. For each test sentence, a single clause declarative sentence was created by placing the noun from the WH-phrase (the filler noun phrase) in the position of the gap in the original test sentence. Sample materials appear in Table 2. Four lists were created by rotating the new item sets through a Latin square. Each subject saw equal numbers of each sentence type and only one form of each sentence. Thirty-two University of

TABLE 2

Sample materials for plausibility ratings

*EARLY GAP**

TRANSITIVE EXPECTATION

PLAUSIBLE The students read the book during their class.

IMPLAUSIBLE The students read the song during their class.

INTRANSITIVE EXPECTATION

PLAUSIBLE The orderly hurried the patient to the doctor's office.

IMPLAUSIBLE The orderly hurried the bed to the doctor's office.

*LATE GAP**

TRANSITIVE EXPECTATION

PLAUSIBLE The students read quietly about the book.

IMPLAUSIBLE The students read quietly about the song.

INTRANSITIVE EXPECTATION

PLAUSIBLE The orderly hurried quickly towards the patient.

IMPLAUSIBLE The orderly hurried quickly towards the bed.

*refers to the position of the gap in the experimental version on which this sentence was based.

Rochester undergraduates served as subjects. Subjects were instructed to rate the plausibility of each sentence on a scale of 1 to 5, with 5 being the most plausible. The mean ratings appear in Table 3. We were almost completely successful in equating differences in plausibility across verb types for the early gap position. An analysis of the ratings for the early gap position revealed only a main effect of Plausibility, $F(1, 30) = 94.62, p < 0.01$. Neither the effect of Verb Type nor the Verb Type \times Plausibility interaction approached significance (both $F_s < 1$).

We were not quite as successful in equating plausibility for the fillers as prepositional objects (late gap). There was a main effect of Plausibility, $F(1, 30) = 4.36, p < 0.05$, reflecting the fact that the plausible fillers were somewhat more plausible as prepositional objects than the implausible fillers. This difference was larger for the transitive preference verbs than for the intransitive preference verbs, but the interaction was not significant,

TABLE 3

Mean plausibility ratings for materials used in Experiment 1

	Early Gap		Late Gap	
	Plausible	Implausible	Plausible	Implausible
Transitive	4.315	2.591	3.994	3.342
Intransitive	4.177	2.486	4.166	3.962

*refers to the position of the gap in the original experimental version.

$F = 1.0$. There was also a main effect of transitivity, $F(1, 30) = 4.67, p < 0.05$. We will point out any conclusions in the judgment study that are compromised by these differences.

Procedure. Subjects judged whether sentences presented on the screen of an Apple IIe computer "made sense" or not. The entire sentence was presented at once, on a single line. Subjects pressed a button labelled YES if the sentence made sense and a button labelled NO if the sentence did not make sense. Subjects were instructed to make these judgments as quickly and accurately as possible. The computer recorded the response that the subject made to each sentence and the time from presentation until the decision was made. Timing was controlled by a Digitry CTS system.

Results and discussion

Two types of data were collected in this experiment: Yes/No judgments about whether the sentence made sense and response times to make the judgment.

Yes/No judgments. Table 4 presents the percentage of sentences judged to make sense for each of the eight conditions. The results were analyzed using an ANOVA with Verb Type, Gap Position, and Filler Plausibility as factors. List was also included as a between subjects and between items factor. Separate analyses were conducted with subjects and items as the random factor, resulting in separate F values, F_1 and F_2 . We will report only those analyses in which both analyses were significant at the 0.05 level or one was significant and the other approached significance with $p < 0.10$, unless the comparison is particularly germane to the discussion.

There was a main effect of Gap Position, $F_1(1, 24) = 30.58, p < 0.001, F_2(1, 24) = 21.66, p < 0.001$, with late gap sentences judged to be sensible more frequently than early gap sentences. Gap position also interacted with Verb Type, $F_1(1, 24) = 40.80, p < 0.001, F_2(1, 24) = 29.77, p < 0.001$. This interaction reflects the fact that sentences with intransitive preference verbs were judged acceptable more often when the gap was late than when it was early, $F_1(1, 24) = 81.55, p < 0.001, F_2(1, 12) = 52.00,$

TABLE 4

Percentage of sentences judged to make sense (Experiment 1)

	Early Gap		Late Gap	
	Plausible	Implausible	Plausible	Implausible
Transitive	83.03	64.27	78.58	64.27
Intransitive	64.27	47.32	83.03	84.83
Mean	73.65	55.80	80.80	74.55

$p < 0.001$, whereas, in contrast, judgments to sentences with transitive preference verbs did not differ for the two gap positions (both $F_s < 1$). There was a main effect of Plausibility, $F_1(1, 24) = 29.55$, $p < 0.001$, $F_2(1, 24) = 9.49$, $p < 0.01$. Predictably, the plausible versions were on the whole judged to be sensible more often than the implausible versions. The Plausibility \times Gap Position interaction was significant in the subject analysis, $F_1(1, 24) = 4.37$, $p < 0.05$, and approached significance in the item analysis, $F_2(1, 24) = 3.22$, $p < 0.1$. This tendency is presumably due to the fact that plausible sentences did not differ significantly according to gap position, $p > 0.1$ for both subjects and items, while implausible sentences did differ significantly, $F_1(1, 24) = 15.80$, $p < 0.005$, $F_2(1, 24) = 19.89$, $p < 0.001$. The triple interaction did not reach significance.

Overall, the judgments reflect difficulty with WH-questions where there is not an unambiguously marked gap, with high rejection rates even for the easiest conditions. The pattern of results for the judgments is clearly inconsistent with both the First Resort model and the Last Resort model. The First Resort model predicts that there should be an overall advantage for sentences with early gaps. This prediction is clearly not confirmed. In fact, sentences were more often judged to make sense when the gap was late. A late gap advantage is, of course, just what a Last Resort model would predict. However, the Last Resort model cannot readily account for the interaction between Verb Type and Gap Position.

The interaction arises because sentences with intransitive preference verbs show a marked late gap advantage, whereas sentences with transitive preference verbs do not. This interaction is closer to the predictions of the Lexical Expectation model. Recall that, according to this model, the transitivity preference of the verb should determine whether or not the post-verbal gap is immediately located and filled. Although the interaction between Transitivity and Gap Position supports this prediction, the form of the interaction is somewhat different from what the Lexical Expectation model would predict. According to the model, sentences with late gaps should be judged to make sense more often than sentences with early gaps for the intransitive preference verbs, whereas for the transitive preference verbs the opposite pattern should obtain. For

intransitive preference verbs, sentences with early gaps were in fact judged to make sense less often than sentences with late gaps. However, sentences with transitive preference verbs were judged to make sense equally often, regardless of gap position.

A second prediction of the Lexical Expectation model concerns the distribution of plausibility effects. According to the model, the early gap is initially filled for sentences with transitive preference verbs. As a consequence, these sentences should show a plausibility difference for sentences with both early and late gaps. This prediction is clearly confirmed. There was no tendency toward an interaction between gap position and plausibility for the sentences with transitive preference verbs (both $F_s < 1$). In contrast, for sentences with intransitive preference verbs, the early gap should not be initially located and filled; filling is only forced by the lack of a late gap. Therefore, plausibility effects should be present only in the sentences with early gaps. For the sentences with intransitive preference verbs, this interaction between gap position and plausibility showed the predicted pattern and was significant in the subject analysis but only approached significance in the item analysis, $F_1(1, 24) = 5.91, p < 0.05$; $F_2(1, 12) = 3.88, p < 0.10$. It should be noted that these interactions with plausibility are somewhat compromised by plausibility differences found for the late gap sentences in the rating study. However, even with this caveat, the data clearly support a version of the Lexical Expectation model.

The data do not support the All Resorts model. This model correctly predicted that there would be an interaction between Plausibility and Gap Position. However, the form of the interaction should have been that sentences with early gaps were easier to comprehend than sentences with late gaps when the filler was plausible. Instead, even with plausible fillers, the sentences with early gaps were judged to make sense less frequently than the sentences with late gaps. This result was due to the sentences with intransitive preference verbs, but the All Resorts model, unlike the Lexical Expectation model, does not predict that lexical preference will influence gap-filling.

Response times. The latencies for the sentences judged to make sense are presented in Table 5.² In general, the response time results parallel the judgment results. There was a significant main effect of Gap Position, $F_1(1, 24) = 7.81, p = 0.01, F_2(1, 24) = 5.38, p < 0.05$, with the response time to the sentences with late gaps being faster overall than to the sentences with early gaps. Note that the main effect of Gap Position is confounded with sentence length. The sentences with late gaps were one word shorter than the sentences with early gaps.³ The interaction of Verb Type with Gap Position was significant by subjects, but not by items, $F_1(1, 24) = 7.29, p < 0.05, F_2(1, 24) = 1.28, p > 0.1$. Separate analyses on each Verb Type found that the sentences with

² Missing data were replaced by the subject's mean response time.

³ We do not analyze our subject's responses as reading times per letter or reading time per word to control for this difference since nothing critical hangs on it; if, for example, we attempted to use this main effect to argue for the Last Resort model directly, such a re-analysis would be necessary (see Frazier and Clifton, 1989, for the use of such a procedure).

TABLE 5

Reading times in milliseconds (Experiment 1)

	Early Gap		Late Gap	
	Plausible	Implausible	Plausible	Implausible
Transitive	4623	4864	4539	4832
Intransitive	4819	5374	4657	4701
Mean	4721	5119	4598	4767

intransitive preference verbs showed a significant effect of gap position, $F_1(1, 24) = 14.35$, $p < 0.001$, $F_2(1, 12) = 5.10$, $p < 0.05$, whereas the sentences with transitive preference verbs did not (both $F_s < 1$).

There was a main effect of Plausibility, $F_1(1, 24) = 7.62$, $p < 0.025$, $F_2(1, 24) = 8.14$, $p < 0.025$; the sentences with plausible fillers were understood faster overall than the sentences with implausible fillers, even when the gap was late. The triple interaction failed to reach significance.

As above, neither the First nor the Last Resort model predicts these results. Although there is a main effect of Gap Position, it does not necessarily support the Last Resort model due to the confound with sentence length. In any case, most of the effect is due to the sentences with intransitive preference verbs. This is not predicted by either of these two models. Similarly, although there is a main effect of Plausibility, as there would be if the early gap were located and filled for all sentences, this does not appear to be the correct explanation for the effect, since there were signs of an interaction between Gap Position and Plausibility for intransitive preference verbs considered independently, $F_1(1, 24) = 7.39$, $p < 0.05$, $F_2(1, 12) = 3.32$, $p < 0.10$. There is no interaction for transitive preference sentences (both $F_s < 1$). This is exactly the pattern of results predicted by the Lexical Expectation Hypothesis. The interaction between Gap Position and Plausibility predicted by the All Resorts model did not even approach significance.

Considering the results of both the judgment and response time analyses, the predictions of the Lexical Expectation model were most clearly met. This model predicts that gaps are posited and filled following verbs that are typically used transitively, but not following verbs that are typically used intransitively. Both judgment and response time data supported this prediction. Verb Type interacted with Gap Position, as predicted by the model. Moreover, the plausibility of the filler as the object of the verb influenced comprehension of the late gap sentences for the verbs with transitive, but not intransitive preferences. This result indicated that a gap was temporarily posited and filled at the verb for transitive preference verbs, but not for the intransitive preference verbs, exactly as predicted by the Lexical Expectation model.

There was one aspect of the results that did not fit with the Lexical Expectation model. The Lexical Expectation model predicts that both transitive preference verbs with late gaps and intransitive preference verbs with early gaps require accessing a less preferred subcategorization frame after the subcategorization that is initially selected proves to be incorrect. Thus re-analysis should be equally difficult for both of these cases. However, readers seemed to have little, if any, difficulty with late gap sentences containing transitive preference verbs, even when the filler was a plausible object of the verb. This suggests that recovery from an incorrect gap assignment is not difficult when the true gap is clearly marked.

EXPERIMENT 2

The previous experiment demonstrated that people fill a gap following a transitive expectation verb without waiting to make sure that no later gap is present in the sentence. However, it did not provide information about the precise point at which gaps are postulated and filled, except that gap-filling must have taken place before the late gap was encountered. In the version of the Lexical Expectation model presented by Fodor (1978), the parser first checks the next constituent following a transitive preference verb to determine whether or not it is a noun phrase before positing a gap. Thus in a question such as *What did John hit the ball with?*, people should not immediately fill the potential gap in object position before noticing that there is already an object, *the ball*. This "try the next constituent" strategy makes intuitive sense because it prevents the parser from spuriously postulating a gap in a position that is already occupied by an overt noun phrase. Experiment 1 did not test the try-the-next-constituent strategy, since there was no object noun phrase in the test sentences. Thus, the results are consistent with a parser that follows this strategy.

However, there is experimental evidence that is at odds with the try-the-next-constituent strategy. In word-by-word self-paced reading experiments, Crain and Fodor (1985) and Stowe (1984, 1986) found longer reading times for object noun phrases in WH-clauses than in corresponding clauses that did not contain a filler-gap dependency. Their explanation for these results was that in the WH-clauses readers posited and filled a gap in the object position as soon as they read the verb. The long reading times at the object noun phrase reflected the revision of the mistaken gap analysis. Although their interpretation seems reasonable, it is important to obtain additional evidence. The Crain and Fodor (1985) and Stowe (1984, 1986) experiments compared reading times across different syntactic structures, which is potentially problematic. Also, their evidence for immediate gap-filling at the verb is somewhat indirect in that increased reading times for the noun phrase following a verb in a WH-question were taken as evidence that a gap associated with the verb has already been posited and filled. Ideally, one would like a more direct measure that a gap has been filled at the verb. Also, these studies did not address the role of lexical preference in gap-filling.

In Experiment 1 we manipulated the plausibility of the filler as the object of a following verb partially because plausibility was the critical variable for testing the predictions generated by Stowe's All Resorts model. Experiment 2 uses plausibility

effects as a diagnostic for the point at which gaps are posited and filled in a self-paced word-by-word reading time experiment. Associating an implausible filler with a gap should result in a sentence becoming implausible, thereby slowing reading times at the point in the sentence where the filler-gap association takes place. Thus plausibility effects can provide a diagnostic for when filler-gap association has taken place.

We used the late gap versions of the materials used in Experiment 1, so that all of the actual gaps occurred two words after the verb of interest. Where a gap in object position is posited and filled, reading times should be longer when the filler is an implausible object of the verb than when the filler is a plausible object of the verb. Based on the results of Experiment 1, plausibility effects should be observed for transitive preference verbs, but not for intransitive preference verbs.

Method

Subjects. Twenty-eight University of Rochester undergraduates participated in the experiment. None had participated in Experiment 1.

Materials. The test materials were a subset of the late gap sentences used in Experiment 1 (see the Appendix). For sample materials, see the bottom half of Table 1. A total of 28 sentence sets were used. Half of the sentences contained transitive preference verbs, the other half intransitive preference verbs, as described in Experiment 1. In one version the filler was a plausible object of the verb, and in the other the filler was an implausible object of the verb. Both fillers were plausible objects of the preposition which marked the true gap location. Recall, though, that the rating study showed that there was a small plausibility difference for the prepositional object gap as well.

The two versions of each test sentence were counterbalanced across two presentation lists. The 28 test sentences were intermixed with 72 filler sentences.

Procedure. The sentences were presented with each word overlaying the preceding word in the upper left-hand corner of an Apple IIe computer screen. The trial was initiated when the subject pressed a response button to obtain the first word. Subsequent pressure of the same button brought up each word in turn. The computer recorded the response time between button presses as a measure of the "reading time" for each word. Timing was accomplished using a Digity CTS system. At the end of a randomly selected subset of sentences, the word REPEAT appeared, which signalled to the subject that he or she was to repeat the sentence aloud as accurately as possible. This secondary task was used to encourage subjects to pay attention to the sentences. A tape recorder was kept running during the experimental sessions, but the responses were not saved.

Results and discussion

The mean reading times for individual positions in the embedded clauses of Experiment 2 appear in Table 6. As in Experiment 1, subject and item analyses were performed separately, with List as a between subjects and items factor. The reading times were similar for both sets of sentences and there were no effects of plausibility until the verb in the embedded WH-clause. At the verb, there was an 85 msec plausibility effect

TABLE 6

Mean reading times for word positions (Experiment 2)

	DET	NOUN	VERB	ADVERB	PREPO- SITION
	the	student	read	quietly	about
	Transitive Expectation Verbs				
Plausible	482	501	491	557	680
Implausible	476	500	576	553	708
	Intransitive Expectation Verbs				
Plausible	452	484	514	648	723
Implausible	460	487	514	648	721

for the transitive preference verbs, which was significant in both the subject and item analyses, $F_1(1, 26) = 4.19, p < 0.05$, $F_2(1, 12) = 5.99, p < 0.05$. In contrast, there was a zero msec plausibility effect for the intransitive preference verbs. The interaction between Verb Type and Plausibility was significant in the subject analysis $F(1, 26) = 4.22, p < 0.05$, and marginally significant in the item analysis, $F_2(1, 12) = 3.60, p < 0.08$.

The plausibility effect for the transitive preference verbs indicates that a gap was being posited, filled, and semantically interpreted immediately at the verb, supporting the conclusions reached by Crain and Fodor (1985) and Stowe (1984, 1986). The absence of a plausibility effect for the sentences with intransitive preference verbs is predicted by the results of Experiment 1, which suggested that lexical information determines whether an object gap is immediately posited.

Two positions following the verb were also tested, the adverb and the final preposition. The preposition was accompanied on the screen by a period so that it was apparent that it was the final word in the sentence. There were no significant effects at this position. The lack of difference at the preposition emphasizes again that people seem to have very little difficulty in recovering from early gap filling for the transitive expectation verbs. At the adverb, sentences containing intransitive preference verbs took 93 msec longer to read than sentences containing transitive preference verbs. This difference was significant by both subjects and items, $F_1(1, 26) = 8.79, p < 0.05$, $F_2(1, 24) = 4.95, p < 0.05$. This is probably due to an imbalance in the between item design; the adverbs in the intransitive sentences were slightly longer (1.6 characters per word on the average) and also they were less familiar (the adverbs in the intransitive

expectation sentences had an average frequency of 22 as opposed to 84 for those in the transitive expectation items, according to the Francis and Kucera norms), leading to longer reading times. If this is the cause, the effect does not bear on the models at all.

GENERAL DISCUSSION

The experiments reported here investigated the role of verb-based transitivity preferences and plausibility in processing sentences with filler-gap dependencies. Experiments 1 and 2 both found that the frequency with which a verb is used transitively, as indexed by sentence completion norms, determines whether readers fill a potential gap in object position without waiting to see if there is a later gap, as proposed by Fodor's (1978) Lexical Expectation model. The plausibility of a filler as the potential object of verb did not affect whether or not the gap was filled, contrary to the predictions made by Stowe's (1984) All Resorts model. The results are also clearly inconsistent with the Last Resort model and any simple version of the First Resort model.

Clifton and Frazier (1989) and Frazier and Clifton (1989) have recently proposed a "lexical filtering" variant of the First Resort model which they argue is not ruled out by these data, as reported in the proceedings of the 7th Cognitive Science Society meeting. According to their proposal, gaps are initially posited without reference to specific lexical knowledge. Lexical information is then used to filter out gaps when the verb is typically used intransitively. This is certainly a viable alternative. We note, however, that their proposal requires three additional assumptions beyond those needed for the filtering account itself in order to fully account for the two experiments reported here. First, lexical filtering must take place **immediately** at the verb. If lexical information is available so quickly, in fact actually at the point where the gap is being posited, it would make sense not to commit to an analysis without making use of the information. Second, lexical filtering must take place before plausibility information comes into play, or we would expect equivalent plausibility effects for both verb types at the verb. Third, lexical filtering must be nearly **cost-free**, since there was no evidence of processing difficulty associated with sentences containing intransitive preference verbs and late gaps.

All three assumptions are natural under the Lexical Expectation Hypothesis. We are proposing that verb information is used as soon as the verb is identified (immediacy), that it determines to a large extent what interpretation is initially arrived at (before plausibility effects), and that the information is used consistently for both types of verbs and therefore there should not be appreciable differences in processing effort for those verbs where lexical information blocks the gap analysis and those where it does not (cost-free).

Experiment 2 found that for transitive preference verbs potential object gaps were filled and interpreted immediately when the verb was read. Thus we failed to find any support for Fodor's hypothesis that gaps are not posited until after the parser checks to make sure that the next constituent is not a noun phrase. This result confirms Crain

and Fodor's (1985) and Stowe's (1986) explanation of the filled gap effect, in which reading times are longer for object noun phrases which occur in a position that might have contained a gap instead in WH-clauses than for object noun phrases in corresponding clauses without a possible filler-gap dependency. One possible criticism of this conclusion is that the reading times are unnaturally slow per word. We agree that this is the case, but point out that the important point in regard to the original hypothesis is that all the information that people have to have in hand to make a decision is the lexical expectation of the verb. The immediacy of the plausibility effect is also consistent with a number of recent experimental demonstrations that filler-gap association takes place extremely rapidly (Boland, Tanenhaus, Carlson, and Garnsey, 1989; Clifton and Frazier, 1989; Nicol and Swinney, 1989; Garnsey, Tanenhaus, and Chapman, 1988; Swinney, Ford, Frauenfelder, and Bresnan, 1988; Tanenhaus, Garnsey, and Boland, 1991).

In order to accommodate verb-based preferences with gap-filling at the verb, Fodor's Lexical Expectation model could be revised so that the parser would posit a gap before checking to see whether a noun phrase followed the verb for transitive preference verbs. While a model like this can account for both transitivity preferences and gap-filling at the verb for transitive preference verbs, it does not explain why there was an asymmetry between transitive and intransitive preference verbs when the position of the gap did not match the lexical expectation. As expected, subjects had difficulty identifying object gaps following intransitive expectation verbs when that became necessary. However, for transitive preference verbs, there seemed to be little cost associated with revising an incorrect early gap hypothesis when the true gap occurred later. This difference makes intuitive sense. It seems reasonable that making a revision that is clearly marked by the presence of an unambiguously marked late gap should be easier than backtracking to search for an alternative structure. However, under the assumption that gap-filling is mediated by rankings among verb subcategorization frames, both of these cases require rejecting the initially selected subcategorization in favor of a less preferred subcategorization. Without further assumptions, then, both cases should lead to equivalent increases in processing difficulty. Clearly more research is necessary to elucidate the nature of this asymmetry. For one line of research which may provide an account, see Carlson and Tanenhaus (1988), Stowe (1988), Tanenhaus and Carlson (1989), Tanenhaus, Boland, Garnsey, and Carlson (1989). They have proposed that gap filling is thematic rather than syntactic in nature. In line with Fodor (1978) and Stowe (1984), we have assumed throughout the preceding discussion that the essential operation in interpreting a WH-phrase is to identify an empty syntactic position. It is equally possible that the verb's expectation is for a particular semantic role to be assigned; identifying the verb makes this role available and it may be directly available to the filler. A semantic role is made available by the preposition too, in the late gap case, which can readily be assigned to the WH-phrase, while in the case of the intransitive expectation early gap cases, a potentially time-consuming search through lexical information may be necessary to complete the re-analysis. However, discussion of this proposal is clearly beyond the scope of this paper.

In sum, then, the experiments reported here demonstrate three main points about

gap-filling. First, the preferred transitivity of a verb influences whether or not a gap is initially posited in a WH-question. Second, the results clearly support the other recent studies demonstrating that (for transitive preference verbs) gaps are filled upon encountering a verb, before there is direct evidence for a missing object noun phrase. Third, recovering from a premature gap assignment is easier than recovering from ignoring a potential gap. Of the four hypotheses originally considered, a slightly modified Lexical Expectation model is most clearly supported by the data.

(Received September 23, 1990; accepted February 3, 1992)

REFERENCES

- BOLAND, J., TANENHAUS, M.K., CARLSON, G.N., and GARNSEY, S.M. (1989). Lexical projection and the interaction of syntax and semantics in parsing. *Journal of Psycholinguistic Research*, **18**, 563–576.
- CARLSON, G.N., and TANENHAUS, M.K. (1988). Thematic roles and language comprehension. In W. Wilkins (ed.), *Thematic Relations* (pp. 263–288). New York: Academic Press.
- CHOMSKY, N. (1981). *Lectures on Government and Binding*. Dordrecht: Foris.
- CLIFTON, C., and FRAZIER, L. (1989). Comprehending sentences with long-distance dependencies. In G.N. Carlson and M.K. Tanenhaus (eds.), *Linguistic Structure in Language Processing* (pp. 273–317). Dordrecht: Reidel.
- CLIFTON, C., FRAZIER, L., and CONNINE, C. (1984). Lexical expectations in sentence comprehension. *Journal of Verbal Learning and Verbal Behavior*, **23**, 696–708.
- CONNINE, C., FERREIRA, F., JONES, C., CLIFTON, C., and FRAZIER, L. (1984). Verb frame preferences: Descriptive norms. *Journal of Psycholinguistic Research*, **13**, 307–319.
- CRAIN, S., and FODOR, J.D. (1985). How can grammars help parsers? In D.R. Dowty, L. Karttunen, and A. Zwicky (eds.), *Natural Language Parsing: Psychological, Computational, and Theoretical Perspectives* (pp. 24–128). Cambridge, U.K.: Cambridge University Press.
- CRAIN, S., and STEEDMAN, M. (1985). On not being led up the garden path: The use of context by the psychological syntax processor. In D.R. Dowty, L. Karttunen, and A. Zwicky (eds.), *Natural Language Parsing: Psychological, Computational, and Theoretical Perspectives* (pp. 320–358). Cambridge, U.K.: Cambridge University Press.
- FERREIRA, F., and HENDERSON, J.M. (1990). Use of verb information in syntactic parsing: Evidence from eye movements and word-by-word self-paced reading. *Journal of Experimental Psychology: Learning, Memory and Cognition*, **16**, 555–568.
- FODOR, J.D. (1978). Parsing strategies and constraints on transformations. *Linguistic Inquiry*, **9**, 427–474.
- FORD, M., BRESNAN, J., and KAPLAN, R. (1982). A competence-based theory of syntactic closure. In J. Bresnan (ed.), *The Mental Representation of Grammatical Relations* (pp. 727–796). Cambridge, MA: MIT Press.
- FRAZIER, L., and CLIFTON, C. (1989). Identifying gaps in English sentences. *Language and Cognitive Processes*, **4**, 93–126.
- FRAZIER, L., and FLORES D'ARCAIS, G.B. (1989). Filler driven parsing: A study of gap filling in Dutch. *Journal of Memory and Language*, **28**, 331–344.
- GARNSEY, S.M., TANENHAUS, M.K. and CHAPMAN, R.M. (1988). Evoked potentials and the study of sentence comprehension. *Journal of Psycholinguistic Research*, **18**, 51–60.
- GAZDAR, G., KLEIN, E., PULLUM, G.K., and SAG, I.A. (1985). *Generalized Phrase Structure Grammar*. Cambridge, MA: Harvard University Press.

- HOLMES, V., STOWE, L.A., and CUPPLES, L. (1989). Lexical expectations in parsing complement verb sentences. *Journal of Memory and Language*, **28**, 668–689.
- JACKENDOFF, R.S., and CULICOVER, P. (1971). A reconsideration of dative movements. *Foundations of Language*, **7**, 397–412.
- KAPLAN, R., and BRESNAN, J. (1982). Lexical-Functional Grammar: A formal system for grammatical representation. In J. Bresnan (ed.), *The Mental Representation of Grammatical Relations* (pp. 173–281). Cambridge, MA: MIT Press.
- KURTZMAN, H. (1985). *Studies in Syntactic Ambiguity Resolution*. Bloomington, IN: Indiana University Linguistics Club.
- MITCHELL, D.C. (1987). Lexical guidance in human parsing: Locus and processing characteristics. In M. Coltheart (ed.), *Attention and Performance XII* (pp. 601–618). Hillsdale, NJ: Lawrence Erlbaum Associates.
- MITCHELL, D.C., and HOLMES, V. (1985). The role of specific information about the verb in parsing sentences with local structural ambiguities. *Journal of Memory and Language*, **24**, 542–559.
- NICOL, J., and SWINNEY, D. (1989). The role of structure in coreference assignment during sentence comprehension. *Journal of Psycholinguistic Research*, **18**, 5–20.
- STOWE, L.A. (1984). *Models of Gap Location in the Human Language Parser*. Bloomington, IN: Indiana University Linguistics Club.
- STOWE, L.A. (1986). Parsing WH-constructions: Evidence for on-line gap location. *Language and Cognitive Processes*, **1**, 227–245.
- STOWE, L.A. (1988). Thematic structures and sentence comprehension. In G. Carlson and M.K. Tanenhaus (eds.), *Linguistic Structure in Language Processing* (pp. 319–357). Dordrecht: Reidel.
- STOWE, L.A., and HOLMES, V. (1990). Verb information in the resolution of closure ambiguities. Unpublished manuscript.
- SWINNEY, D., FORD, M., FRAUENFELDER, U., and BRESNAN, J. (1988). On the temporal course of gap-filling and antecedent assignment during sentence comprehension. Unpublished manuscript.
- TANENHAUS, M.K., BURGESS, C., HUDSON-D'ZMURA, S., and CARLSON, G.N. (1987). Thematic roles in language processing. *Proceedings of the Ninth Annual Cognitive Science Society Meetings* (pp. 587–596). Hillsdale, NJ: Lawrence Erlbaum Associates.
- TANENHAUS, M.K., and CARLSON, G.N. (1989). Lexical structure and language comprehension. In W.D. Marslen-Wilson (ed.), *Lexical Representation and Process* (pp. 529–561). Cambridge, MA: MIT Press.
- TANENHAUS, M.K., BOLAND, J.E., GARNSEY, S.M., and CARLSON, G.N. (1989). Lexical structure in parsing long-distance dependencies. *Journal of Psycholinguistic Research*, **18**, 37–50.
- TANENHAUS, M.K., GARNSEY, S.M., and BOLAND, J.E. (1991). Combinatory lexical information and language comprehension. In G. Altmann (ed.), *Computational and Experimental Approaches to Speech and Language* (pp. 179–193). Cambridge, MA: MIT Press.

APPENDIX

Materials for Experiments

In Experiment 1 each sentence appeared in four forms: Plausible or Implausible fillers (first and second alternative in the parentheses, respectively) and Early and Late Gap

(first and last alternative in the brackets, alternatively). All 32 sentence sets were used in this experiment.

In Experiment 2 only Late Gap versions were used. The subset of sentence sets that were employed are marked with an *. One transitive expectation sentence set was replaced; this is shown as (33). For several others, minor modifications were made for Experiment 2; none of these affect the fillers or verbs tested (tense and adverbs were modified).

Intransitive Preference Sentences:

- *1) The waiters weren't sure which (question, check) the customers debated [over their drinks, tirelessly about].
- *2) The detective hadn't known which (boy, box) the suspect rushed [into the river, carelessly into].
- *3) The air traffic controller wondered which (plane, boat) the pilot flew [over the hills, slowly over].
- *4) The biographer isn't sure which (king, taxes) the nobles fought [with all their strength, continuously against].
- *5) The editor can't discover which (answer, problem) the writer guessed [about this treatment, accurately about].
- *6) The warden can't discover which (guard, concerts) the prisoner escaped [with his pretence of illness, tracelessly from].
- *7) The trainer doesn't know which (fence, course) the horse jumped [for his blue ribbon, skillfully over].
- *8) The agent couldn't find out which (gun, flag) the terrorist pointed [at this office, dramatically at].
- *9) The elementary school principal wondered which (dog, child) the teacher walked [down the hall, briskly past].
- *10) The columnist will know which (quarrel, producer) the actors continued [with the company, stubbornly with].
- *11) The physical therapist wondered which (doctor, bed) the orderly hurried [toward the patient, rapidly toward].
- *12) The manager hadn't found out which (language, tongue) the salesman talked [into the microphone, persuasively in].
- *13) The sheriff wasn't sure which (horse, rock) the cowboy raced [down the hill, desperately past].
- *14) The man hadn't discovered which (tractor, driveway) the farmer moved [toward the edge of his property, carefully toward].
- 15) We were surprised at which (theory, choice) the philosopher believed [with a passion, passionately in].

- 16) The neighbors couldn't believe which (smell, friend) the housekeeper couldn't stand [for more than a minute, being near].

Transitive Preference Sentences:

- *17) The research director wondered which (stars, talk) the astronomer watched [for his section, privately for].
- *18) The analyst hadn't found out which (jewelry, vacation) the patient saved [for this conference, carefully for].
- *19) The librarian can't discover which (friend, library) the woman called [for her sister, daily for].
- *20) The secretary wasn't sure which (woman, book) the professor taught [with difficulty, frequently with].
- *21) The landlord couldn't discover which (table, roof) the maid cleaned [for his tenant, first under].
- *22) The salesman couldn't find out which (truck, aisle) the employees unloaded [into that storage area, directly into].
- *23) The police hadn't known which (leader, statue) the rioters followed [toward the museum, quickly after].
- *24) The dean's assistant wondered which (partner, business) the lawyer visited [with his client, yesterday with].
- *25) The instructor isn't sure which (car, house) his pupil passed [on that street, recklessly next to].
- *26) The district attorney found out which (witness, church) the reporter asked [about the meeting, anxiously about].
- *27) The judge wanted to know which (doors, music) the witness saw [through the windows, easily through].
- *28) The teacher didn't know which (book, song) the student read [about this topic, quietly about].
- *29) The other cardplayer wondered which (bet, horse) the gambler lost [at that game, recently on].
- 30) The babysitter found out which (button, shelf) the girl pushed [by mistake, accidentally against].
- 31) The judge wondered which (woman, book) the bigamist left [after the argument, yesterday with].
- 32) Nobody could figure out which (path, library) the council blocked [for political reasons, debate about].
- *33) The babysitter wasn't sure which (toys, mist) the boy pushed violently into.

Copyright of Language & Speech is the property of Kingston Press Ltd. and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.