The interaction of lexical expectation and pragmatics in parsing filler-gap constructions [1]

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Sentences with embedded questions in which there is a long-distance dependency between a noun phrase or filler and an empty category or gap require the parser to hold onto the filler in memory until the position of the gap can be located. Gap location is complicated by local ambiguity. For example, the filler "horse" in the fragment in (1a) could be the direct object of the verb "raced" as in (1b) or it could be the object of the preposition "toward" as in (1c). In the former case the gap follows the verb, in the latter case it follows the preposition.

(1) a. The sheriff wasn't sure which horse the cowboy raced.....
b. The sheriff wasn't sure which horse the cowboy raced __ down the hill.
c. The sheriff wasn't sure which horse the cowboy raced desperately past__.

Fodor (1978) proposed three possible models of gap detection and filling. According to a "first resort" model the parser posits a gap following any verb which can be used transitively. A parser using a first resort strategy will make the right decision with sentences such as (1b) but it will incorrectly assume a gap follows the verb in the embedded sentence in sentences such as (1c). Alternatively the parser could adopt a "last resort" strategy. A last resort parser would assume a gap analysis only when a mandatory argument was missing or when the end of a sentence was reached and the parser still had a filler which had not been assigned a grammatical role. Thus a last resort parser would not garden-path on sentences such as (1c), but it would miss the gap on the first pass through sentences such as (1b).

Fodor rejected both of these models on the basis of sentences such as (2) and (3). The gap after "about" in sentence (2) seems to come as a surprise because the filler "book" has been assigned as the direct object of the verb "read" as the first resort model would predict. However, the first resort model makes the wrong prediction for sentence (3) in which readers do not seem to be garden-pathed by the possible gap following "sing".

(2) Which book did the teacher read to the children about__?
(3) What did the teacher sing about__?

As an alternative, Fodor proposed a lexical preference model in which the verb in the embedded sentence determines whether or not the parser posits a gap. Gaps are posited following verbs which are normally used transitively and thus "expect" an object, but not following verbs which are normally used intransitively. Some evidence for the lexical expectation model was provided in a recent paper by Clifton, Frazier, and Connine (1984) who demonstrated that sentences with filler-gap constructions are understood more quickly when the correct interpretation is congruent with the lexical preference of the verb.

Stowe (1984) has recently suggested an all-resorts model as a fourth possibility. According to this model, a gap is postulated following a verb that is optionally transitive but the filler is taken as the object of the verb only if it is plausible. If the filler is not a plausible object, the gap analysis is rapidly rejected.

We conducted three experiments to test predictions made by these models using sentences in which normally transitive or intransitive verbs (e.g., "raced" and "hurried", respectively) were placed in sentences in which the filler was either the object of the verb in the embedded sentence (early gap) or the object of a preposition that ended the sentence (late gap). Transitive and intransitive expectation verbs were chosen from the norms in Connine et al. (1984). Two fillers were chosen for each sentence type: a noun which was a plausible object of the verb and a noun which was an implausible object. Example materials for a transitive and an intransitive expectation verb are presented in (4) and (5). The two nouns in parentheses are the plausible and implausible fillers, respectively. Early gap sentences are presented in (4a) and (5a) and late gap sentences in (4b) and (5b).

(4) a. The sheriff wasn't sure which (horse, rock) the cowboy raced__down the hill.
    b. The sheriff wasn't sure which (horse, rock) the cowboy raced desperately past__.

(5) a. The district attorney found out which (witness, church) the reporter asked__about in the meeting.
    b. The district attorney found out which (witness, church) the reporter asked anxiously about__.

Experiment 1 used 32 sets of materials similar to those illustrated in (4) and (5). Sixteen sets were constructed using intransitive expectation verbs and sixteen sets were constructed with transitive expectation verbs. Plausibility of the filler was crossed with the position of the gap resulting in four sentences for each transitive and intransitive expectation verb. These sentences were counterbalanced across four presentation versions. The test sentences were intermixed with ungrammatical and gramatical fillers sentences, including some ungrammatical sentences with filler-gap constructions. Twenty-four University of Rochester volunteers served as subjects. Their task was to decide whether or not they understood each sentence. The sentences were presented visually on a CRT.

The logic of the experiment was as follows. The early gap model predicts that sentences with late gaps should be more difficult to understand than sentences with early gaps, because readers should initially assume that the filler is the object of the verb. In contrast, the late gap model assumes that sentences with early gaps will be more difficult to understand than senences with late gaps because the readers will initially miss the gap following the verb. The all-resorts model predicts that late gap sentences with plausible fillers should be more difficult than late gap sentences with implausible fillers because readers will have chosen the

early gap analysis for the plausible fillers (recall that plausibility refers to the plausibility of the filler as an object of the verb). In contrast the lexical expectation model makes the same prediction as the early gap model for the transitive expectation verbs and the late gap model for the intransitive expectation verbs.

Table 1 presents the percentage of sentences judged comprehensible for each of the conditions. For the intransitive expectation verbs early gap sentences were less frequently understood than late gap sentences. Plausibility of the filler affected comprehension of the early but not the late gap sentences. For the transitive expectation sentences, early gap sentences more more likely to be understood than late gap sentences. In addition, plausibility of the filler affected both the early and late gap sentences suggesting that with transitive expectation verbs readers attempted to associate the filler with the verb even for the late gap sentences. Surprisingly, late gap sentences with plausible fillers were understood more easily than late gap sentences with implausible fillers, suggesting that readers do not find it easier to recover from an early gap misanalysis when the filler is implausible.

TABLE 1

	Verb Expectation			
	Transitive		Intransitive	
	Early Gap	Late Gap	Early Gap	Late Gap
Plausible Filler	76%	65%	66%	85%
Implausible Filler	58%	51%	45%	81%

The results of Experiment 1 strongly support Fodor's lexical expecation model. They suggest that readers attempt to associate fillers with transitive expectation verbs but not intransitive expectation verbs. Experiments 2 and 3 examined the on-line processing of the sentences used in Experiment 1 in order to test these predictions. In both of these experiments subjects read sentences one word at a time pressing a response key when they were ready to read the next word. After approximately 30% of the sentences, the subject was asked to repeat the sentence aloud. The subject was also required to answer a true-false question following about 30% of the sentences. The prediction was that reading times would be longer following implausible fillers than following plausible fillers if subjects attempted to associate the filler with the verb. For late gap sentences plausibility effects should only obtain with transitive expectation verbs. For early gap sentences plausibility effects should be observed earlier for transitive expectation verbs. Experiment 2 used early gap sentences and Experiment 3 used late gap sentences. Tables 2 and 3 present the mean reading time per word for Experiments 2 and 3, respectively. There were 33 subjects in Experiment 2 and 28 in Experiment 3.

TABLE 2

Condition	Position in Sentence: Verb (raced)	Preposition (down)	Object 1 (the)	Object 2 (hill)
Transitive Plausible	506	515	502	738
Transitive Implausible	569	569	541	758
Plausibility effect	63	54	39	20
Intransitive Plausible	554	561	536	734
Intransitive Implausible	538	576	555	766
Plausibility effect	-16	25	19	32

TABLE 3

Condition	Position in Sentence: Subject1 (the)	Subject2 (cowboy)	Verb (raced)	Adverb (quickly)	Preposition (towards)
Transitive Plausible	484	498	496	555	683
Transitive Implausible	472	494	569	548	716
Plausibility effect	-12	-4	73	-7	33
Intransitive Plausible	445	487	517	651	724
Intransitive Implausible	458	484	513	648	734
Plausibility effect	13	-3	-4	-3	10

The results of Experiments 2 and 3 confirm the predictions made by the lexical expectation model. For early gap sentences a plausibility effect was found for sentences with transitive expectation verbs beginning with the verb, whereas the effect was weaker and did not begin until later for sentences with intransitive expectation verbs. For late gap sentences there was a plausibility effect for the sentences with transitive expectation verbs but not for the sentences with intransitive expectation verbs. Taken together the results of these experiments clearly demonstrate that lexical expectation controls initial gap detection and gap filling in the processing of sentences with long-distance filler-gap dependencies. This is in accord with the general claims about the importance of lexical structure in parsing made by Ford, Bresnan and Kaplan (1983).

References

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