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THE USE OF THEMATIC RELATIONS IN SUBJECT-GAP FILLING

by

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B.A. (hons.) in Linguistics (1988)
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A Thesis
submitted to the School of Graduate Studies and Research
in partial fulfilment of the requirements of the M.A.
degree in Linguistics

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CHAPTER 1: CURRENT ISSUES IN SENTENCE PROCESSING

1.1 THE MODULARITY DEBATE

One of the central issues of psycholinguistic research has focused on the characterization of information flow in the human language processor. More specifically, there has been disagreement as to the degree of autonomy of the linguistic processor and its subcomponents. At one extreme lies the view that formally autonomous levels of linguistic representation correspond to purely autonomous levels in language processing. For instance, Forster's (1979) influential model assumes three distinct and autonomous levels within the linguistic module: a lexical processor responsible for accessing lexical entries on the basis of unsegmented input; a syntactic processor responsible for building a representation of constituent structure; and a message processor which performs such functions as identifying referents of referring expressions, making inferences from syntactic structure, and resolving ambiguities. Frazier, Clifton and Randall (1983) further break down the syntactic processor into submodules corresponding to components of formal syntactic theory, and argue for their autonomy in language processing. They suggest that phrase structure rules and information that constrains coindexing relationships (such as verb control information) operate independently, with the former being responsible for the building of syntactic structures, and the latter operating as a checking device on already-existing

structures. Although modular accounts may disagree with respect to the identification of what counts as a separate module, what is crucial to all such models is the notion of informational encapsulation, which claims that only the output of each module may be accessed by other modules, or by a central, nonlinguistic processor. In other words, modules can only process information stated in their own representational vocabularies.

Fodor (1983) argues that the notion of information encapsulation is necessary in order to account for the extremely rapid and automatic nature of language processing. The operations of the language processor are insensitive to nonlinguistic information such as expectations and beliefs about the real world, as the processing of this type of information is believed to be unduly slow. In addition, restricting the amount of information that may be consulted at each level of processing has the advantage of eliminating the need for making decisions as to what information is relevant for building a representation of the sentence at that stage. Ignoring a great deal of information that might in principle be relevant to a processing problem buys the language processor speed.

In contrast with this modular account, some researchers have argued for a language processor that is highly interactive in nature. For instance, Marslen-Wilson and Tyler propose a processor in which all sources of information may interact freely with one another such that whatever is known at a particular point in processing may be used to resolve indeterminacies in the analysis of the input. They claim that this type of processor results in

optimal processing efficiency. This claim relies on the assumption that purely linguistic knowledge sources are computationally equivalent with those that integrate real-world knowledge. Such a model denies the belief that nonlinguistic conceptual knowledge is necessarily slow and cumbersome in nature relative to linguistic knowledge.

In actual fact, empirical distinctions between the two models can be somewhat difficult to make. All modular accounts have in common the notion that the internal workings of modules are inaccessible to more general cognitive processes of a nonlinguistic nature. However, the boundaries drawn around individual modules may differ. For instance, although Forster (1979) incorporates three distinct levels of processing, he conceives of the entire linguistic system as a module that is impervious to the effects of a central processor. Fodor (1983) divides the language processor into a set of serially ordered modules roughly corresponding to grammatical subsystems. The central processor is permitted to operate on the output of each module, though with the added stipulation that the output of lower-level modules is less accessible to the central processor than is the output of higher-level modules. One way in which the central processor may work on the output of individual modules is by evaluating numerous analyses proposed in parallel by the linguistic modules, and making decisions as to which analyses to send on to higher modules. Tanenhaus, Carlson and Seidenberg (1985) identify an even weaker version of the modularity hypothesis in which individual grammatical rules make up separate modules. In this model, the

central processor operates on the output of each rule.¹ Tanenhaus et al. point out that the empirical predictions made by the latter model are virtually impossible to differentiate from those made by a fully interactive one. Most processing research currently undertaken as part of the modularity debate revolves around the viability of the second of these three accounts (i.e. the characterization of grammatical subsystems as modules).

¹ As noted above, Frazier, Clifton and Randall (1983) propose the existence of a number of highly specialized syntactic submodules (e.g. a submodule dealing with verb control information only). However, these are modules-within-a-module in the sense that they are contained by a syntactic processor that is itself an autonomous module.

1.2 THE ROLE OF THE THEMATIC PROCESSOR

Much of the psycholinguistic research that has been undertaken in the hope of shedding light on the modular/interactive issue has dealt with the interaction between syntactic and semantic or pragmatic information. The processing of thematic relations² has recently been viewed as a particularly important area of study, as thematic relations lie at the syntax/semantics interface and provide an opportunity to evaluate the interaction between syntactic and semantic information in the parser.

A substantial body of processing literature has supported a parsing model in which the autonomy between syntactic and semantic levels of interpretation are preserved. In such a model, thematic information operates on the output of a syntactic processor, and is therefore secondary to purely syntactic information in the building of structure. For instance, Rayner, Carlson and Frazier (1983) and Ferreira and Clifton (1986) maintain a view of the thematic processor as a checking device which evaluates the semantic plausibility of structures proposed by an autonomous syntactic processor on the basis of general structurally-based parsing strategies. Experimental evidence for their claim comes from the

² The use of the term "thematic relations" or "thematic roles" throughout this paper does not imply a commitment to any particular analysis of thematic relations, nor does it assume that thematic roles are theoretical primitives. The experimental predictions made in this dissertation do not depend upon a choice from among current analyses. For some diverse views on thematic relations, see Fillmore (1968), Chomsky (1981), Stowell (1981), Jackendoff (1972; 1987), Marantz (1982), Rappaport and Levin (1984) and Dowty (1991).

examination of temporarily ambiguous reduced relative clauses and prepositional phrase attachment. Sample sentences from the prepositional phrase attachment experiment by Rayner et al. are given below:

- (1) a. The spy saw the cop with binoculars.
- b. The spy saw the cop with a revolver

It is proposed that the building of these structures is guided by the strategy of Minimal Attachment, which states that incoming material is incorporated into the phrase marker using the fewest syntactic nodes possible. With respect to the above examples, the Minimal Attachment reading is one in which the prepositional phrase is attached to the verb phrase rather than the object nounphrase. Only sentence (1a) is plausible under this reading. It was found that sentences in which the only plausible reading violated Minimal Attachment (such as (1b)) were more difficult to read than sentences that were compatible with Minimal Attachment (such as (1a)). It was concluded that the semantic content of the object of the preposition does not bear on its initial attachment; this decision is made on the basis of the syntactic strategy of Minimal Attachment. When this reading turns out to be implausible, the semantic processor filters out this interpretation and sends it back to the syntactic processor for a re-parse.

Ferreira and Clifton set up an experiment with sentences temporarily ambiguous between a reduced relative clause reading and a simple past tense reading in which they tried to determine

whether animacy information could override Minimal Attachment:

- (2) a. The defendant examined by the lawyer turned out to be unreliable.
- b. The evidence examined by the lawyer turned out to be unreliable.

The past tense reading is the reading favoured by Minimal Attachment, but it is only plausible for sentences with animate subjects. It was found that subjects showed just as much difficulty upon encountering the by-phrase in sentences with inanimate subjects as animate subjects, suggesting that a Minimal Attachment reading was initially computed for both sentence types, regardless of the animacy of the subject.

However, a number of researchers have argued that the results found by these experiments were an effect not of Minimal Attachment, but of the nature of the experimental materials. For instance, Trueswell, Tanenhaus and Garnsey (submitted) suggest that a significant proportion of Ferreira and Clifton's sentences with inanimate subjects, which were assumed to favour a reduced relative clause reading (non-minimal attachment) as opposed to an active past-tense reading (minimal attachment) actually had plausible completions in the active voice. The elimination of such a possibility with sentences containing inanimate subjects in a replication experiment resulted in no effect of minimal attachment. Similarly, Taraban and McClelland (1988) argue that Rayner et. al's sentences testing prepositional phrase attachment were semantically

biased towards verbphrase (i.e. minimal) attachment. A set of sentences established by pretesting procedures to be biased towards nounphrase attachment was contrasted with the Rayner et al sentences, and it was found that attachment expectations, and not minimal attachment itself, predicted reading times. Furthermore, they proposed that difficulty with sentences that violate attachment expectations is due to the fact that such a violation co-varies with violation of the expected thematic role of the prepositional phrase. When sentences which included an unexpected thematic role for the PP, but not unexpected attachment were tested, it was found that the effect of attachment over and above the effect of unexpected thematic role was quite small.

Stowe (1989) performed an experiment using verbs ambiguous between a causative and an ergative reading in which animacy of the subject was manipulated.

- (3) Before the police/truck stopped the driver was already getting nervous.

She found that when subjects were inanimate (and therefore implausible Agents of transitive verbs) the tendency to analyze NPs immediately following the verb (e.g. the driver) as direct object of the verb rather than subjects of a new clause decreased significantly. She concluded that thematic information can override the syntactic strategy of Late Closure, which states that the parser waits for positive evidence that a clause has ended before closing it off.

1.3 THEMATIC PROCESSING AND GAP-FILLING

The processing of wh-constructions has been central to much of language processing research. At issue are the specific mechanisms by which wh-elements are related to gaps in a sentence. This can become a complex process if a number of potential gaps exist in a sentence:

- (4) What (__) did Tom want (__) his brother to sing (__)
for __?

In sentence (4), each of the sites in parentheses is a possible location for the wh-gap. Currently, there are a number of hypotheses as to the specific nature of the identification and filling of wh-gaps.

Syntactic accounts of gap-filling restrict the lexical information used by the parser to categorial and subcategorisation information. The content of lexical items is assumed to be unimportant to the initial determination of long-distance dependencies, although such information may be used at a later stage in parsing to filter out implausible analyses. Fodor (1978) proposes a Lexical Expectation Model in which the preferred subcategorisation frame of a verb is accessed, and the parser then waits to see if a lexical NP fills the subcategorised position before a gap is postulated. Frazier (1987) argues for a somewhat different account. Her Active Filler Hypothesis states that gaps

are postulated at the earliest possible gap site, without waiting to see if that position is filled by a lexical NP.

On the other hand, a thematically-based account of gap-filling accords a much more substantial role to lexical information associated with verbs and NPs. Tanenhaus, Carlson and Trueswell (1989) suggest that lexical access of verbs makes available sets of thematic roles which define possible gap sites. Fillers, then, may be assigned thematic roles before they have been linked with a syntactic position.

A study by Boland, Tanenhaus, Carlson and Garnsey (1989) provides support for the hypothesis that fillers are assigned roles before gaps are filled. Simple transitive verbs were compared with dative verbs and verbs taking infinitival complements. Fillers that were implausible direct objects for all verb types, but plausible indirect objects for the dative and infinitival complement verbs were contrasted with plausible direct object fillers:

- (5) a. Which star/stone did the assistant watch all through the night?
b. Which poem/baby did the woman read in a funny voice?
c. Which girl/movie did the woman remind to watch the show?

All of the fillers turned out to be direct objects of the verb. Implausibility effects (manifested by higher reading times and increased number of judgments that the sentence was implausible)

occurred at the verb itself for simple transitive sentences, but not until the word following the verb for dative and infinitival complement verbs. The results were interpreted as supportive of the hypothesis that fillers are assigned roles as soon as the verb is encountered. For dative and infinitival complement verbs, where the filler would initially be assigned the indirect object role, the role must be reassigned once it is evident that no lexical NP fills the direct object position.

These results are at odds with both the Lexical Expectation Model and the Active Filler Hypothesis. All of the verbs subcategorise for a direct object NP, therefore there should be no difference in the location of processing difficulty. If the parser waits to see if a lexical NP occupies the direct object position, all verb types should show implausibility effects at the word following the verb. If, on the other hand, fillers are assigned to the earliest possible gaps, all verb types should show an effect at the verb.

An additional experiment was carried out to examine the thematic role assignment hypothesis, using a direct object/indirect object incompatibility:

(6) Which campus party/public library did John donate some
cheap liquor to?

The sentences which contained an implausible filler (e.g. "public library") showed implausibility effects at the direct object, before the syntactic location of the gap.

All of the studies discussed so far assume that thematic role assignment takes place once the verb is accessed. Frazier (1987), in arguing against the Lexical Expectation Model, presents some evidence from Dutch, which is a head-final language, that suggests that gap-filling may take place before the verb is encountered. When sentences temporarily ambiguous between a reading involving a subject relative clause and an object relative clause were presented, subjects had slower reading times and greater error rates in the interpretation of object relative sentences, such as (7b), where disambiguation is accomplished by verbal agreement:

- (7) a. Karl hielp de mijnwerkers die __ de boswachter (*__)
vonden.
(Karl helped the mineworkers who the forester found-pl)
- b. Karl hielp de mijnwerkers die (*__) de boswachter __
vond.
(Karl helped the mineworkers who the forester found-s.)

Frazier concludes that these results support the Active Filler Hypothesis, which claims that the parser need not wait for the verb to be accessed before fillers may be assigned to potential gaps. Given that the thematic account of gap-filling formulated above depends upon verbal access, Frazier's argument would apply to this model as well as other lexically-driven theories of long-distance dependencies processing (e.g. see Ford, Bresnan and Kaplan, 1983, for an account based on Lexcial-Functional Grammar).

Frazier's claim that these results reflect a process whereby a gap is postulated and filled in subject position is somewhat unconvincing, however, given the off-line nature of the experimental task. Reaction times were measured for entire sentences rather than individual words or constituents, making it difficult to draw conclusions about the locus of difficulty with the object relative clauses.

In addition, weighing against this claim is the lack of evidence that the parser postulates gaps in subject position following a wh-filler in the same way that an object gap appears to be postulated. It is by now a fairly well-established finding that when sentences containing wh-fillers have a lexical NP direct object following a preferred transitive verb, experimental subjects show a surprise effect at the object NP, indicating that a gap was expected (e.g. Crain and Fodor, 1985; Stowe, 1986; Garnsey, Tanenhaus and Chapman, 1989; Clifton and Frazier, submitted). However, no such "filled gap" effect has been obtained for subject position. Stowe (1986) compared reading times at potential gap sites occupied by lexical material in both subject and object positions. Sample sentences from this study are provided in (8):

- (8) a. My brother wanted to know if Ruth will bring us home
to Mom at Christmas.
- b. My brother wanted to know who Ruth will bring us home
to at Christmas.

It was found that reading times at the lexical subject Ruth were no longer when following a wh-filler (as in (8b)) than they were when following the complementizer *if*. An increase in reaction times for lexical objects (*us*) however, was found in sentences with a wh-filler. She proposes that there are grammatically motivated differences in the mechanism which identifies subject gaps as opposed to the one dealing with object gaps.

Clifton and Frazier (1989; fn. 14), however, suggest that the apparent absence of a filled gap effect for the subject position may be due to insufficient time on the part of the parser to identify the filler as being in COMP, and project the S' and S which would license an NP in subject position. They maintain, therefore, that fillers are posited and filled wherever possible; there may be restrictions, however, on how quickly the parser is able to identify certain syntactic positions as possible gap sites.

1.4 THEMATIC ROLE ASSIGNMENT AND SENTENCE POSITION

Even if it turns out that gaps may be filled before lexical access of the verb, this does not rule out the possibility of a theory of gap-filling which allows a central role to the thematic processor. It is possible that thematic role assignment operates somewhat independently of the verb, with roles being provisionally assigned on the basis of the semantic content of nounphrases, and mediated by general principles linking particular syntactic positions with preferred thematic roles.

Various theories of thematic relations have attempted to capture the notion that the association of thematic roles with verbal arguments occurs in a nonrandom, principled manner. For instance, Fillmore (1968) proposes a systematic semantic principle governing subject selection in the form of a thematic relations hierarchy: if there is an Agent among the verb's arguments, it will be the grammatical subject; Instrument takes priority if no Agent exists, followed by Experiencer, and so on. In a similar vein, Pinker (1984) outlines a model of canonical mapping in which grammatical functions and thematic relations make up two tiers, as illustrated below in (9):

(9)	SUBJ	OBJ	OBLIQUE
	Agent	Theme/Patient	Goal/Source/Location

Association between tiers is subject to a constraint which states that lexical entries must link thematic roles of their arguments

with their grammatical functions without crossing links between tiers. Dowty (1990) wants to do away with traditional thematic role labels altogether, and proposes the existence of proto-roles, which, unlike discrete roles with criterial definitions, have cluster definitions consisting of sets of properties. He argues that only two proto-roles exist, that of proto-Agent and proto-Patient. Argument selection principles link arguments with the greatest number of proto-Agent properties with grammatical subject, and those with the greatest number of proto-Patient properties with grammatical object. It is argued that thematic relations are not theoretical primitives; rather, proto-Agent and proto-Patient properties are derived from human perception of cause-effect relationships.

Regardless of the specific formulation of the linking between thematic relations and sentence position, there is general agreement that in the unmarked case, subject position is correlated with the Agent role, and object position is correlated with Theme or Patient. Marantz (1982) attests to the rarity of ergative languages, in which the correspondence between thematic roles and grammatical relations is the reverse of the above generalization. As argument selection principles of the sort described here lie at the interface between syntax and semantics, they provide an interesting opportunity for studying the organization of the human parser. The two experiments carried out as part of this thesis are concerned with the relationship between sentence position and the semantic content of nounphrases in the building of sentence structure.

CHAPTER 2: THE FIRST EXPERIMENT

2.1 INTRODUCTION

The purpose of this experiment was to examine more closely the previously-found asymmetry in gap-filling at subject versus object position (Stowe, 1986). Stowe has suggested that this asymmetry may reflect fundamentally different mechanisms for gap-location for the two sentence positions. This might originate from syntactic constraints which prohibit gaps at the subject position but not object position for certain constructions. For instance, a gap is illicit in the subject position of a that-complement (10b), but not in the corresponding object position (11b).

- (10) a. John thought that Susan was foolish
 b. *Who did John think that was foolish?
- (11) a. John thought that Susan liked him.
 b. Who did John think that Susan liked?

Alternately, according to Stowe, the heightened expectation of an object gap over a subject gap may be due to the fact that at the point at which a subject gap occurs, it has no propositional content to combine with. However, the expectation of an object gap can be used to create a complete semantic proposition. Under this view, if a subject gap is falsely postulated, it is only necessary to correct a syntactic expectation; however, the false location of

an object gap necessitates not only correction of a syntactic expectation, but a semantic one as well.

Clifton and Frazier (1989), on the other hand, support a view of gap-filling as a highly automatic process in which the parser is under a great deal of pressure to assign fillers to gaps as quickly as possible. They argue that the subject/object gap-filling asymmetry is a superficial one, possibly reflecting lack of time to identify the subject position as a potential gap-site.

The present experiment set out to examine the latter possibility; it was assumed that if the time factor proposed by Clifton and Frazier were at the source of the subject/object asymmetry, lexical material intervening between the wh-word and a lexically overt subject should allow the parser time to build the expectation of a gap in subject position. To achieve this end, the length of wh-fillers was manipulated. It was predicted that as the length of the filler increased, providing the parser with more time to identify the subject position as a potential gap-site, the expectation of a gap in subject position would increase; upon finding this expectation violated by the presence of a lexical NP in subject position, reading times should be higher for longer fillers than for short ones.

In addition, this experiment was designed to see whether a semantic expectation for a subject gap could be created by manipulating the animacy of the wh-filler. It was reasoned that, if the preferred thematic role for the subject position is that of Agent, animate fillers, which make plausible Agents, should be more likely to be linked with a subject gap than inanimate fillers,

which on the whole make less plausible Agents. The filled gap effect, then, should be stronger at the subject position for animate wh-fillers than for inanimate fillers.

2.2 MATERIALS

A sample of sentence types used in Experiment 1 is given below in Table 2.1. For all conditions, the main clause contained a verb which subcategorises for a question complement (e.g. wonder, know, be sure, etc.).

TABLE 2.1
Materials for Experiment 1

Cond. 1	IF-CLAUSE Mary wondered if John saw a guy.
Cond. 2	WH-OBJ Mary wondered who John saw a guy with.
Cond. 3	WH-SUBJ-ANIMATE FILLER Mary wondered (a) who John saw (b) which guy John saw (c) which tall guy with the dark beard John saw.
Cond. 4	WH-SUBJ-INANIMATE FILLER Mary wondered (a) what John saw. (b) which ship John saw. (c) which tall ship with the dark sails John saw.

Condition 1 included sentences in which no gaps occur; the embedded clause is introduced by the complementizer *if* rather than a *wh*-filler. This condition acted as a control, with reading times at the subject and object position to be used as a baseline measure, as no gaps occur in this structure.

Condition 2 consisted of sentences containing a *wh*-filler in which there is a lexical NP in object as well as subject position. All verbs were judged to be preferentially transitive (of those verbs that were included in the Connine, Ferreira,

Jones, Clifton and Frazier (1984) study on verb frame preferences, the mean transitivity rating was 0.8, ranging between 0.5 and 1.0.³ Remaining verbs not tested in the Connine et. al. study were judged to have a preferred transitive reading by myself and two naive informants. An increase in reading times at the object position for wh-clauses relative to if-clauses was predicted. This condition was included to replicate the previously-found filled gap effect for object position in order to confirm that results obtained for this experiment were not due to an unforeseen quirk in the experimental task or the subject population.

Conditions 3 and 4 were included to test the thematic role hypothesis of gap-filling. It was predicted that the Agent role would be more likely to be assigned to the animate wh-fillers in Condition 3 than the inanimate fillers in condition 4. This was expected to show up as a greater surprise effect at the lexical subject NP (e.g. John) in Condition 3 over Condition 4. In the event that a filled gap effect might not be evident until a word or two after the first word of the subject NP, half of the embedded clause subjects were lengthened, such that they began with a proper name with genitive case (e.g. Frank's boss) or a possessive pronoun (e.g. her stupid nephew), and the other half simply consisted of a proper name.

The subconditions (a,b and c) in 3 and 4 were intended to test the hypothesis that the probability of postulating a gap in subject

³ In this study, verb frame preferences of 127 English verbs were examined using sentence completion tasks. A measure of transitivity bias was computed by dividing the number of transitive completions by the number of transitive plus intransitive completions.

position is a function of the amount of time available to do so. It was expected that reading times for the subject NP would increase as the length of the filler increased from subconditions (a) to (c).

An attempt was made to vary the lexical material in Condition 3 versus Condition 4 as little as possible. In many cases, the only word that differed between the two conditions with respect to the lengthened wh-filler was the head noun, (e.g. guy/ship) which was systematically animate or inanimate. In about one quarter of the sentences, the object of the prepositional phrase within the wh-filler also varied (e.g. beard/sails) All words that differed from Condition 3 to Condition 4 were controlled for frequency (following Francis and Kucera, 1982) and for length. The mean frequencies and length in characters for noncoinciding words are given in tables 2.2 and 2.3 respectively:

TABLE 2.2

Mean Frequency Rating for Materials in Exp. 1

Head noun		Prepositional object	
animate	91	animate	54
inanimate	113	inanimate	56

TABLE 2.3

Mean Length in Characters for Materials in Exp. 1

Head noun		Prepositional object	
animate	6.73	animate	5.00
inanimate	6.18	inanimate	5.55

2.3 METHOD

Forty sets of sentences were created. The materials were rotated through a Latin square such that each subject read only one version of every sentence set. Five tokens of each condition were presented to every subject. In addition, forty filler sentences were created and randomly interspersed with the experimental sentences. The materials were presented in a series of five randomized blocks. The entire experimental session for each subject consisted of the materials described here for Experiment 1, along with the materials for Experiment 2. The order of presentation of experiments 1 and 2 was counterbalanced, and each subject received a short break between experimental lists.

A word-by-word self-paced reading task was used in which sentences are presented at the centre of a computer screen one word at a time. The subject indicates readiness to read the next word by pressing a button. The time between the presentation of a word and the button press is recorded by the computer. To ensure that subjects were reading the sentence attentively, a subordinate sentence repetition task was used. Subjects were required to repeat from memory half of the filler sentences (which occurred at random intervals) following presentation of these sentences. An audio recording was made of each subject's sentence repetitions.

All subjects received a training set of sentences, consisting of seven sentences. Feedback regarding the accuracy of performance on the subordinate task was provided for the training sentences only.

Forty-four subjects participated in the experiment. All were undergraduates at the University of Ottawa, were native speakers of English, and had normal corrected or uncorrected vision. A lottery was held amongst all participating subjects, and two cash prizes of \$100 each were awarded upon completion of the experiment.

2.4 RESULTS

First, the previously-found filled gap effect at object position was replicated in this experiment. Mean reading times at object position for Condition 1 (if-clauses) and Condition 2 (wh-clauses) are given in Table 2.4. The difference in means was marginally significant at the determiner position for both subjects ($F=3.99$; $p<0.06$) and items ($F=3.78$; $p<0.06$) and highly significant at the head noun for both subjects ($F=17.4$; $p<0.0002$) and items ($F=11.4$; $p<0.001$)

TABLE 2.4

Mean Reading Times in Milliseconds at Object Position

	Determiner	Head noun
if-clause	453	447
wh-clause	510	538

Secondly, no filled-gap effect was observed at the subject position for the shortest wh-fillers (who/what) when compared with if-clauses, replicating Stowe's (1986) findings. Mean reading times at subject position for if-clauses versus wh-clauses are given in Table 2.5:

TABLE 2.5

Mean Reading Times in Milliseconds at the Subject Position

if-clause	458
wh-clause	467

Third, the effects of filler length and animacy were examined. Mean reading times at the first words of the subject NP are given in Table 2.6. A factorial ANOVA was computed, and indicated no main effect of animacy of filler. There was a main effect of length by subjects ($F=3.39$; $p < 0.05$), but not by items. A strongly significant interaction between length and animacy was found for subjects ($F=5.84$; $p < 0.005$). An analysis by items, however, fell short of significance ($F=2.52$; $p < 0.09$) for the length by animacy interaction. Any effect of length as well as the interaction between length and animacy disappeared by the second word of the subject NP.

TABLE 2.6

Mean Reading Times in Milliseconds at Subject Position

	animate filler	inanimate filler
who/what	430	460
short which-phrase	460	487
long which-phrase	508	459

A one-way ANOVA (by subjects) was computed separately for Condition 3 (animate fillers) and Condition 4 (inanimate fillers). A significant effect of filler length was found for Condition 3 ($F=6.43$; $p < 0.005$), but not for Condition 4, supporting the hypothesis that animate fillers are more likely to be associated with gaps in the subject position than are inanimate fillers. The difference in means between short which-phrases and long which-phrases for animate fillers (Condition 3) turned out to be significant ($F=4.23$, $p < 0.05$); however, the difference between wh-words (who) and short which-phrases was not.

In addition, a series of pairwise comparisons was carried out

to compare Conditions 3 and 4 at each degree of filler length. The differences in means were found to be significant at the shortest level (who versus what: $p < 0.05$) and the longest degree of length (long which-phrases: $p < 0.05$). The results for the long-which phrases are as predicted by the thematic role hypothesis. However, the difference at the shortest degree of length is puzzling, as, contrary to the prediction made by the thematic role hypothesis, inanimate wh-fillers produced longer reading times at the subject position. I have no reasonable explanation for this result, except to suggest that the length in characters of the inanimate filler versus the animate filler (the inanimate wh-word "who" being 25% longer than the animate wh-word "what") might be slowing down processing. Unfortunately, reading times at the actual wh-words were not measured, so it is impossible to verify whether this was in fact the source of relative difficulty with inanimate wh-words.

Recall that about half of the sentences had lengthened embedded clause subjects such that the first word of the subject NP was a specifier. The other half had simple proper names as subject NPs. Table 2.7 breaks down reading times for the long which-phrases accordingly:

TABLE 2.7

Mean Reading Times in Milliseconds at the First Word of Subject NP for Long which-Phrases

	animate filler	inanimate filler
specifier	490	438
proper name	525	480

Although reading times are somewhat lower for specifiers than

for proper names (probably due to differences in word length at that position), the differences between RTs for sentences containing animate versus inanimate fillers are approximately equal.

2.5 DISCUSSION OF EXPERIMENT 1

Aside from the somewhat uninterpretable result for simple wh-words, the results in Experiment 1 indicate a surprise effect at the subject position for very long wh-fillers, but only when the filler is animate. A plausible interpretation of this data is that, given sufficient time following the identification of a wh-filler, gaps are actively postulated by the parser in subject position. That is, the parser does not wait to see if the subject position is lexically filled before resorting to hypothesizing a gap in that position. However, the process of postulating a gap appears to be selective and mediated by semantic principles, rather than purely automatic. If the filler is deemed to make an unlikely Agent, and therefore, is not a good candidate for subjecthood, the parser may refrain from postulating a gap.

Another possible account for the data is that the parser does in fact postulate a gap regardless of the semantic content of the filler, but that recovery is easier when the filler is inanimate. Presumably, the realization that the subject position is filled, contrary to expectation, would not be as distressing if the filler were a less-than-ideal subject in the first place. When the filler is animate, the parser might be more reluctant to reanalyse the string, as the first-pass parse based on associating the filler with a subject gap is a highly plausible one. Although it is impossible to rule out this account, there is no evidence for such an interpretation in the results reported above. If gaps were postulated and filled initially regardless of filler animacy, we

might expect to see an increase in reading times at the lexical subject for inanimate fillers as a function of length, though this increase could be substantially smaller than the one found for animate fillers. However, no such increase occurs. In fact, reading times at the lexical NP actually decrease from the short which-phrase inanimate fillers to the long which-phrase inanimate fillers.

A third possibility is that these results have little to do with actually postulating and filling gaps. The process captured in this experiment may be largely extra-syntactic. That is, it is possible that the parser assigns the Agent role to animate fillers, and when a lexical subject that would also make a good Agent is identified, competition for the Agent role ensues, creating processing difficulty. No such competition occurs when the filler is inanimate, and therefore an unlikely Agent. In this experiment, the NPs in subject position were all animate, and as such, good candidates for the Agent role. However, for half of the materials, the subject NP was lengthened, such that the head noun occurred one or two words following the introduction of the subject phrase. In these cases, at the first word of the subject NP, there was unambiguous evidence of the presence of a lexically overt nounphrase, but no semantic information pertaining to the head of the subject phrase. There was at least as great a difference between RTs in long which-phrases in Conditions 3 versus 4 for sentences in which the first word of the embedded subject was a specifier as there was for sentences in which the subject NP consisted of a simple proper name. Given that the effect of filler

animacy disappeared by the second word of the subject NP, which for half of the sentences was the locus of animacy information about the subject NP, this seems to suggest that what caused the difficulty for long animate fillers was in finding that the subject position was syntactically filled, rather than finding a competitor for the previously-assigned Agent role. Additional evidence for this interpretation might come from experiments which manipulate the plausibility of the subject noun as Agent.

If these results do in fact reflect gap location at subject position, this would argue against an alternate explanation of the subject/object gap-filling asymmetry, provided by Bourdages (to appear). The asymmetry is accounted for by suggesting that the tendency to hypothesize gaps over lexical NPs is strengthened at potential ends of the sentence. She contrasted French sentences such as (12a) and (12b) which differed in terms of whether a gap immediately following the verb was permitted:

(12) a. Avec qui le voisin a-t-il dit a la petite fille que sa mere est partie?

(With whom did the neighbour say to the little girl that her mother left?)

b. A qui le voisin a-t-il dit a la petite fille que son amie avait parle?

(To whom did the neighbour say to the little girl that her friend had spoken?)

The verb "dire" subcategorizes for an indirect object of the "a NP" form, therefore the filler "a qui" (to whom) may be associated with a gap following the verb. On the other hand, "avec qui" must be associated with a gap in the complement of the verb "dire", as this is not a possible indirect object of the verb. The potential gap in (12a), however, does not coincide with a possible end of the sentence, as the verb necessarily takes a complement. Bourdages found no filled gap effect for (12a) versus (12b) and concluded that postulating gaps as a first strategy is unlikely to occur except at points at which the sentence may come to an end, where the parser may be pressured to integrate unlinked material. The presence of a selective filled-gap effect at subject position, however, suggests that gaps can be postulated at points which are not potential ends of the sentence.

It is interesting, at this point, to note exactly how increasing the length of wh-fillers helps the parser to postulate gaps. One possibility, already discussed, is that the lexical material that intervenes between the wh-word and the subject position allows the parser to identify that position as a possible gap-site. In this scenario, the mechanism that builds phrase markers is constrained by time. Another possibility, however, is that what is crucial is to allow the thematic processor sufficient time to make use of semantic information to build an expectation of a gap. This is an attractive hypothesis, given that the increase in subject position reading times for animate fillers only kicks in at the highest degree of filler length (i.e. long which-phrases), and that there is no effect of length for either animate or

inanimate fillers between simple wh-words and the short which-phrases. Recall that the noun carrying animacy information occurs fairly early on in the long which-phrases, as it is always followed by a prepositional phrase (e.g. which tall guy/ship with the dark beard/sails). In the short which-phrases, however, the relevant noun occurs immediately preceding the lexical subject NP. Possibly, the short which-phrases, though they might provide sufficient time for the syntactic processor to project an argument position, and therefore a potential gap-site, do not allow the thematic processor sufficient time to integrate the semantic information available in the filler. This account implies a view of gap-filling in which the parser, though anxious to unload fillers, behaves somewhat conservatively, and delays postulating a gap if there is good reason (on semantic grounds) to believe that the wh-filler is not linked with a gap in that position. The work on the role of verb-based thematic relations in gap-filling carried out by Boland et. al. (1989) and Tanenhaus et. al (1989) using dative and infinitival complement verbs is compatible with such a model. It would be interesting to further explore the impact of filler length on gap-filling in subject position. A possible experiment might be to construct long wh-fillers in which the locus of animacy information is varied. For instance, one could compare reading times at subject position when preceded by fillers such as (8a) versus (8b):

- (8) a. which tall men/ships with dark hair/sails
b. which of the very tall men/ships

Results pointing to the late use of semantic information in parsing have generally been taken to support a modular account of processing in which the early use of semantic information is excluded in principle, falling out of the organization of the parser. Such results may be equally well explained by demonstrating that a certain amount of time is required to build a semantic representation. That is to say, semantic information may be used in the building of structure whenever such information is available and integrated. Experiments using materials such as the sentences in (8) would be useful in making a distinction between the two accounts.

CHAPTER 3: THE SECOND EXPERIMENT

3.1 INTRODUCTION

Stowe (1989) has provided some evidence that the lexical content of the surface subject nounphrase can affect the argument that it is assigned to in sentences containing verbs that are ambiguous between a causative and an ergative reading. She examined the effect of wh-filler plausibility on sentences with animate and inanimate subjects. Sample sentences are given in (13):

- (13) The reporter was unsure which luggage/entrance the man/cart moved away from ___ down the street.

For animate subjects, reading times at the verb increased when the filler was implausible as a direct object, whereas reading times at the verb decreased when the filler was an implausible direct object for sentences with inanimate subjects. This was interpreted as indicating that when encountering an animate subject, the parser assigns it an Agent role, and therefore interprets the verb as being causative rather than ergative. When the subject is inanimate, on the other hand, the parser refrains from assigning it an Agent role, and upon encountering the verb, chooses the ergative reading. Interestingly, reading times for inanimate subjects were found to be significantly higher than animate subjects beginning at

the point of the subject nounphrase itself. This suggests that when the semantic content of the subject does not fit well with the preferred thematic role for that position (i.e. Agent), processing difficulty occurs.

The goal of the current experiment was to explore the hypothesis that thematic role assignment may occur independently of the verb, mediated by the semantic content of nounphrases and expectations about preferred thematic roles for the subject position. In this experiment, the combined effects of subject animacy and wh-filler animacy were examined. Based on the hypothesis that argument selection principles are used in on-line parsing, it was predicted that sentences in which the semantic content (in terms of animacy) of the subject NP relative to the filler NP favours its receiving an Agent role should yield shorter reading times beginning at the subject position and continuing throughout the sentence when the sentence reflects a basic word order. In order to see what happens when the expectation created by argument selection principles and the content of the nounphrases is violated, passive versions of each sentence were constructed. It was predicted that the better the fit between NP content and basic word order, that is, the easier it is to assign preliminary thematic roles, the higher the reading times will be upon encountering the passive in which the role assignment expectations are violated.

3.2 Materials

A sample set of sentences used in Experiment 2 is given in Table 3.1. As in Experiment 1, each sentence contained an embedded wh-clause in which the wh-filler was immediately followed by the subject NP. All possible permutations of animacy of filler and subject were constructed, and each sentence appeared in the active and passive voice.

TABLE 3.1

Sample Materials for Experiment 2

Cond. 1 anim. filler inan. subject	Bill knew which kid the ball hit/was hit by.
Cond. 2 anim. filler anim. subject	Bill knew which kid the teacher hit/was hit by.
Cond. 3 inan. filler anim. subject	Bill knew which stick the teacher hit/was hit by.
Cond. 4 inan. filler inan. subject	Bill knew which stick the ball hit/was hit by.

Conditions 1 and 2 contain an animate filler. As this experiment was designed and run simultaneously with Experiment 1, it was predicted, as in the previous experiment, that reaction times beginning at the first word of the subject NP would be higher when the filler was animate (Conditions 1 and 2), then when it was inanimate (Conditions 3 and 4). In this experiment, the first word of the subject NP contained no semantic information, and invariably consisted of the determiner the.

Along with containing a built-in replication for filler

animacy in short which-phrases, the manipulation of filler animacy was intended to examine what effect competition for the Agent role between subject and filler might have at the head noun in subject position. It was hypothesized that, when the filler is animate, it will provisionally be assigned the Agent role, and possibly linked with the subject position. When the subject NP is encountered, the parser's argument selection principles indicate that the preferred thematic role for that position is Agent; however, the assignment of this role may be inhibited by the previous assignment of Agent to the animate filler. It is predicted, then, that reading times at the head noun in subject position will be higher when the wh-filler is animate than when it is inanimate.

Conditions 2 and 3 contain animate embedded subjects, whereas Conditions 3 and 4 have inanimate subjects. Under the hypothesis that subject selection principles are used on-line, it is predicted that reading times will be higher at the subject head noun when the subject is inanimate (and therefore an implausible Agent) than when it is animate.

Note that the predictions made for the effect of filler animacy conflict with the prediction for subject animacy with respect to Conditions 2 (animate filler, animate subject) and Condition 4 (inanimate filler, inanimate subject). The relative reading times of these two conditions will depend upon whether competition for the Agent role has a greater or lesser impact upon the assignment of thematic relations than the goodness of a subject NP as an Agent.

The active version of each sentence was included to confirm

that reading times for the subject noun reflect an expectation of the basic word order. Reading times at the subject noun were expected to pattern with RTs at the verb for active sentences, and to be the reverse for the verb in passive sentences, where the expectation of basic word order is violated.

As in Experiment 1, the frequency and length of lexical items differing from condition to condition were controlled for (see Tables 3.2 and 3.3).

TABLE 3.2

Mean Frequency Ratings for Materials for Exp. 2

wh-phrase	subject	
	frequency	frequency
animate	75	animate 77
inanimate	81	inanimate 84

TABLE 3.3

Mean Length in Characters for Materials in Exp. 2

Wh-phrase	Subject	
	length	length
animste	6.53	animate 6.97
inanimate	6.72	inanimate 6.92

3.3 THE PRETEST

3.3.1 METHOD

All materials were pretested using a written sentence completion task in which subjects were presented with the sentences described above, but with material following the subject nounphrase omitted. Subjects were required to supply the verb, thereby indicating the thematic role assigned to each nounphrase. A sample item is given in (14) below.

(14) Bill wasn't sure which kid the teacher _____.

For each item, subjects were asked to specify on a scale of one to three how difficult they felt it was to complete the item.

Each subject received only one condition from each sentence set.

Eight questionnaires were composed, each consisting of half of the forty sentence sets constructed for the purpose of the on-line task (for a total of twenty experimental sentences, with five tokens of each condition per subject) along with 30 filler sentences for a total of 50 sentence completions per questionnaire.

The subjects were 43 undergraduate students at the University of Ottawa. All reported themselves to be native speakers of English. The subjects who completed the pretest questionnaire did not participate in the on-line task.

3.3.2. PRETEST RESULTS

For all conditions, responses in the active voice were preferred to the passive voice, indicating a general preference for basic word order. The conditions differed markedly, however, with respect to the willingness with which subjects gave passive responses. For the large majority of the active responses, the preferred thematic role for the subject NP was Agent. Table 3.4 indicates the total number of responses for active sentences with subject=Agent versus passive sentences in which the subject=Patient for each condition.

TABLE 3.4

No. of Responses by Voice for Sentence Completion Task in
Pretest Questionnaire:

Sentence type	anim.filler inan.subj.	inan.filler inan.subj.	inan.filler anim.subj.	inan.filler inan.subj.
Active tokens	83	192	189	116
Passive tokens	42	4	6	35

Subjects were then divided into two groups according to whether they provided more passive than active responses or not. The number of subjects that had more passive than active responses are given in Table 3.5 for each condition. The largest number of subjects preferring passive responses fell into Cond. 1, in which the filler is animate, and the subject inanimate, followed by Condition 4, where both filler and subject are inanimate. Conditions 2 and 3 indicate a very strong preference for active

responses. This pattern of results confirms the hypothesis that the animacy of the subject and filler is related to the strength of the preference for the unmarked thematic grid. A chi square analysis was performed on the data, and indicated the distribution among conditions to be significantly different (chi sq.=33.12; $p < 0.001$)

TABLE 3.5

No. of subjects (N = 43) with more passive than active responses:

Sentence type	anim.filler inan.subj.	anim.filler anim.subj.	inan.filler anim.subj.	inan.filler inan.subj.
	17	1	0	10

Table 3.6 gives a more detailed breakdown of the responses to the sentence completion task. All of the categories that were set up are indicated, along with an actual sample response from the pretest questionnaire for each category. The total number of responses in each category by conditions is also indicated.

TABLE 3.6

Responses for Sentence Completion Task:

1. Subject = Agent; Filler = Patient e.g. "Darlene figured out which article the scholar had written"			
Cond. 1 62	Cond. 2 133	Cond. 3 143	Cond. 4 75
2. Subject=Agent; Filler=Object of Preposition e.g. "My aunt remembered which nurse the infant threw up on."			
Cond. 1 21	Cond. 2 59	Cond. 3 46	Cond. 4 41
3. Subject=Patient; Filler=Agent e.g. "The media found out which president the legislation had been signed by."			
Cond. 1 24	Cond. 2 4	Cond. 3 0	Cond. 4 3
4. Subject=Patient; Filler=Object of Preposition e.g. "My sister told us which mayor the announcement had been made about."			
Cond. 1 18	Cond. 2 0	Cond. 3 6	Cond. 4 28
5. Other e.g. "Arthur found out which blanket the sheet belonged with."			
Cond. 1 44	Cond. 2 7	Cond. 3 13	Cond. 4 30
6. Reversal of NPs e.g. "Paula announced which captain the yacht sailed."			
Cond. 1 13	Cond. 2 0	Cond. 3 0	Cond. 4 4
7. Alteration of Subject NP e.g. "The children read about which murder the raid officers were talking about."			
Cond. 1 8	Cond. 2 3	Cond. 3 3	Cond. 4 9
8. Semantically anomalous or ungrammatical e.g. "William told us which column the pamphlet believed."			
Cond. 1 3	Cond. 2 1	Cond. 3 0	Cond. 4 10
9. No answer supplied			
Cond. 1 22	Cond. 2 8	Cond. 3 4	Cond. 4 15

A few interesting observations can be made on the basis of the above data. First, although Conditions 2 and 3 had almost identical totals for active responses (see Table 3.?), when the filler as well as the subject was animate (Cond. 2) responses in which the filler was not the patient, but rather the indirect object of either a transitive or intransitive verb were more frequent than for Condition 3, in which the filler was inanimate. This suggests that inanimate NPs are assigned the Patient role more readily than animate NPs. Furthermore, although Conditions 1 and 4 both show greater totals for passive responses than Conditions 2 and 3, the pattern of passive responses is quite distinct for the two conditions. The majority of passive responses in Condition 1 assigned a Patient role to the inanimate subject, and an Agent role to the animate filler. In Condition 4, however, where the filler is inanimate, there was considerable unwillingness to assign the Agent role to the filler. The large bulk of passive responses were ones in which the filler was an indirect object, with the Agent being unspecified. Therefore, it appears that the animacy of the subject determines to a large degree the expectation of voice. Filler animacy, however, has an observable impact upon the thematic role that is assigned to the wh-filler within the constraints of voice preference.

The number of alterations, anomalous responses, and failures to respond is also consistent with the notion that animacy of fillers and subjects interacts with the expectation of a preferred thematic grid. Condition 1 consistently shows evidence of difficulty in reconciling the content of the subject and filler NPs

with a preferred grid, with Condition 4 following on its heels, and Conditions 2 and 3 revealing relative ease in thinking of sentences that fit the unmarked grid. An even more powerful piece of evidence about the role of preferred thematic grid expectations comes from the fact that in a number of cases, there was evidence of a misparse of the sentence. Thirteen of the responses for Condition 1 consisted of responses that would be perfectly plausible only if the subject and filler nouns were reversed. No obvious reversals appeared for Conditions 2 and 3, and Condition 4 showed evidence of 4 such reversals.

Subjects were also required to report on the perceived difficulty of concocting sentence completions for each item on a scale of one to three, with one being the easiest level, and three the most difficult. The mean degrees of difficulty for each condition are given in Table 3.7

TABLE 3/7

Means for Self-reported Degrees of Difficulty in Performing the Sentence Completion Task

Cond. 1 anim. filler inan. subj.	Cond. 2 anim. filler anim. subj.	Cond. 3 inan. filler anim. subj.	Cond. 4 inan. filler inan. subj.
1.71	1.51	1.37	1.64

The pattern of results for sentence completion difficulty reflects the number of responses in each condition that maps onto the unmarked thematic grid. A one-way ANOVA indicated the differences between conditions to be significant ($F=8.20$; $P<0.0001$).

The results of the pretest task indicate that the preferred thematic grid guides expectations of sentence structure, but that animacy of the filler and subject NPs has an impact upon the strength of these expectations. This data lends support to the hypotheses formulated in section 3.1. In addition, the pretest results suggest that animacy of the subject will have a larger influence upon expectations of basic word order than animacy of the filler. Condition 2, then, should exhibit higher reading times upon presentation of the passive construction than Condition 4.

3.4 THE ON-LINE TASK

3.4.1 METHOD

As in Experiment 1, for the purpose of the on-line task, a Latin square design was used for the presentation of stimulus sentences. The sentences were presented in a series of five blocks, with each block each consisting of one sentence of each type (a total of eight sentence types) and eight fillers. The word-by-word self-paced reading task was used for this experiment as well.. However, the subordinate task differed from the one used in Experiment 1; rather than repeating sentences, in the current experiment, subjects were required to answer yes/no reading comprehension questions that were displayed on the computer screen for half of the filler items as well as for two tokens of each experimental sentence type by pressing buttons labelled "yes" or "no" on the computer. The computer recorded whether the response was correct or incorrect, as well as the time elapsed between the presentation of the question and the subject's response. The correct answer was "yes" for half of the questions and "no" for the other half.

The materials for the on-line task were presented in a single session with the materials from Experiment 1. The subject population was therefore the same for both experiments. The order of presentation between Experiment 1 lists and Experiment 2 lists was counterbalanced. Subjects received a short break between lists

3.4.2 RESULTS AND DISCUSSION

RTs for the determiner position are given in table 3.8. Not surprisingly, the difference in means at this position for animate fillers versus inanimate fillers is not significant. This replicates the results found in Experiment 1 for the short which-phrases.

TABLE 3.8

Mean RTs in Milliseconds at the Determiner Position

animate fillers (Conds. 1 and 2)	inanimate fillers (Conds. 3 and 4)
357	345

RTs for the active versions are given in Table 3.9. Contrary to predictions made above, there was no significant effect of filler animacy or subject animacy at any sentence position. Note that the absence of an effect is in conflict with Stowe's (1989) experimental results. Furthermore, the trend in RTs is not as was expected (with Condition 1 being most difficult, Condition 3 being least difficult, and intermediate reading times for Conditions 2 and 4 predicted). In fact, Conditions 2 and 4 exhibit, in all cases, the highest RTs.

TABLE 3.9

Mean RTS for Active Versions

	Sentence Position		
	subject noun	verb	verb + 1
Cond. 1	372	399	389
Cond. 2	386	422	418
Cond. 3	360	404	387
Cond. 4	382	419	410

Table 3.10 indicates RTs for the passive versions. The only significant effect was that of subject animacy at the position of the past participle, with inanimate subjects yielding higher RTs than animate subjects. It is at this point that evidence of the passive construction first arises. Inanimate subjects NPs should facilitate reading for this position, as expectations of basic word order are expected to be weaker for these sentences. Perhaps the effect reflects a delayed reaction to finding subjects that do not fit well with the preferred role of Agent. This explanation is not satisfying, however, given the fact that no similar delayed reaction occurred at the position of the verb or beyond for the active versions.

TABLE 3.10

Mean RTs in Milliseconds for Passive Versions

	Sentence Position				
	subj. N	was	P Part.	by	by + 1
Cond. 1	372	357	427	433	399
Cond. 2	386	361	398	437	389
Cond. 3	360	338	403	404	376
Cond. 4	382	353	426	443	405

Error rates and reaction times for reading comprehension

questions were also recorded. These were included particularly because of evidence of misparses in the pretest data, in order to ensure that RTs represented accurate readings of the sentences. Condition 4 had considerably more errors for the active versions than all other conditions, and had the most errors, followed by Condition 2 for the passive versions. These figures are not consistent with the hypotheses formulated in 3.2 or the results of the pretest data. They are, however, consistent with the trend in RTs reported above in that Conditions 2 and 4 appeared to cause the greatest difficulty.

TABLE 3.11

Total no. of Errors for Comprehension Questions

Sentence type	anim.filler inan.subj. Cond. 1	anim.filler anim.subj. Cond. 2	inan.filler anim.subj. Cond. 3	inan.filler inan.subj. Cond. 4
Active version	24	21	21	38
Passive version	23	32	20	36
Overall	47	53	41	74

Reaction times for answering comprehension questions are shown in Table 3.12. Again, the pattern of results is unexpected. For the active versions, Conditions 2 and 4 indicate the greatest difficulty. RTs for all conditions are higher in the passive versions. The greatest difference in RTs between active and passive versions is at Condition 1. This is directly contradictory to the predictions laid out above. It was hypothesized that the worse the fit between NP content and the preferred thematic grid,

the smaller the difference between RTs for active and passive versions.

TABLE 3.12

Mean Reaction Times (in Seconds) for Correct Responses to Comprehension Questions

Sentence type	anim filler inan subj. Cond. 1	anim filler anim. subj. Cond. 2	inan.filler anim. subj. Cond. 3	inan.filler inan. subj. Cond. 4
Active version	2.89	3.25	2.79	3.39
Passive version	3.79	3.41	3.51	4.00
Passive - Active	0.9	0.16	0.72	0.61

The general failure of the on-line task results to pattern with the pretest results is somewhat puzzling. Of course, one possible interpretation is that argument selection principles and the semantic content of lexical items are not consulted in on-line processing. The conflict between these results and those obtained by Stowe (1989) may be reduced to methodological differences: Stowe's on-line task used a word-by-word grammatical judgment task in which subjects were required to indicate upon presentation of each new word whether the sentence was grammatical to that point. RTs in Stowe's experiment were approximately twice as long as in the current experiment. It is possible that the results reported in the former study did not reflect a first-pass parse, and tapped into processes available only at a later stage in parsing.

This interpretation is, however, somewhat more difficult to reconcile with the results from Experiment 1 in the present study, which showed evidence of the use of semantic information about wh-fillers in gap-filling. The experimental task was essentially the same for both experiments, with the same subject pool performing both experiments in a single session. Recall that the effect of animacy was not evident in Experiment 1 except for very long fillers. If this reflects the amount of time the parser requires to process information about the semantic content of nouns, it is possible that the materials in Experiment 2 did not provide sufficient time for the effects of filler and subject animacy to show up. Experiments with length manipulations such as the one performed in Experiment 1, and in the studies suggested for future research in section 2.5 may well be useful in determining to what extent and under what time constraints mapping from lexical content to thematic grid may take place.

A further, and admittedly speculative, possibility is suggested by recent experimental findings by Just (1991). These results report a correlation between individuals' memory capacity, and the degree of modularity in language processing; individuals with lower memory capacity exhibited a less interactive style of processing, showing evidence for a primary role of an autonomous syntactic parser. The majority of the subjects that participated in the present study indicated that they felt the second experimental task to be more demanding than the first. Error rates for questions relating to the experimental sentences were generally much higher than those for questions pertaining to filler

sentences. One might speculate that individuals may have available to them more than one processing strategy, or a continuum of strategies ranging from highly modular to highly interactive. If this task required a particularly high memory load, subjects may have adopted a more conservative, modular strategy of processing. If this is the case, identical sets of materials could be expected to yield different patterns of results for individuals depending upon the memory requirements imposed by the experimental task.

CHAPTER 4: CONCLUDING REMARKS

The purpose of this pair of experiments was to examine the psychological role of argument selection principles and the ways in which they interact with the semantic content of nouns in language processing. The pretest data in Experiment 2 shows evidence of the psychological reality of such principles. In addition, there is some evidence from Experiment 1 that subject selection principles, at least, are used in on-line parsing, combined with a semantic analysis of nounphrases. The interaction of these components may be used not only to evaluate competing analyses, but to make structural predictions about the probable location of gaps in a sentence. In this sense, the parser operates in a top-down fashion with respect to gap-filling.

The benefit of a top-down mechanism which consults semantically related information is an increased probability of arriving at a correct interpretation on a first parse relative to the use of a highly automatized syntax-driven parser which may initially generate implausible interpretations. On the other hand, Fodor (1983) gives a detailed argument against an interactive approach to language processing, claiming that strong restrictions on the types of information that may be consulted by linguistic subprocessors are necessary to account for the speed and automatic nature of language processing.

The present study provides some evidence against a model that is as informationally encapsulated as that proposed by Forster (1979), Fodor (1983) and Frazier and colleagues. It is entirely

possible, however, that even when semantic information is permitted to influence the building of structure, restrictions on the nature of semantic content that can be used in this manner may apply. For instance, animacy information has been a frequently-manipulated factor in numerous studies examining the role of semantic content in parsing; it may turn out that broad features such as animacy enjoy a privileged status with respect to on-line parsing.

Apart from increasing the odds of getting the interpretation of a sentence right on the first try, the use of a parser that relies on argument selection principles could be advantageous for the acquisition of language. A number of researchers have stressed the role of rules linking semantic function with syntactic position in discussing how the child arrives at building a syntactic structure based on a representation of the meaning of a sentence. Grimshaw (1979) and (Pinker(1984) suggest that the starting point for this mapping lies in identifying the Agent, and linking the nounphrase carrying this role with the subject position. Lebeaux (1988), on the other hand, argues for the importance of relating nouns branded with the feature [+Affected] to the verb's internal argument. It is also possible to formulate a model based on Dowty's (1990) proto-role account, in which neither the subject nor the object position has priority in syntax/semantics mapping; in such a model, all NPs are evaluated as to their proto-Agent and proto-Patient features, and the winner is slotted in subject and object position respectively.

Next to nothing is know about the relationship between parsing mechanisms in adults and children; almost all work in on-line

processing is carried out with adults. The examination of the use of argument selection principles in processing may turn out to be a particularly fruitful area of inquiry, as there is reason to believe that a parsing mechanism that makes use of such principles would be especially useful for children acquiring language.

Thus far, the underlying assumption of work on human language processing has been that the purpose of a language processor is to arrive at a correct linguistic representation quickly. Further research may indicate that apart from getting it right, and doing it fast, processing mechanisms may have some role in learning language in the first place.

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APPENDIX A
MATERIALS FOR EXPERIMENT 1

1. Mary wondered...
 - (1) if John's wife saw a guy...
 - (2) who John's wife saw a guy with...
 - (3a) who John's wife saw...
 - (3b) which guy John's wife saw...
 - (3c) which tall guy with the dark beard John's wife saw...
 - (4a) what John's wife saw...
 - (4b) which ship John's wife saw...
 - (4c) which tall ship with the dark sails John's wife saw...
...last summer at the seaside.

2. Fred couldn't tell...
 - (1) if his new girlfriend liked her sister.
 - (2) what his new girlfriend liked her sister for.
 - (3a) who his new girlfriend liked.
 - (3b) which sister his new girlfriend liked.
 - (3c) which stylish sister with the blue jacket his new girlfriend liked.
 - (4a) what his new girlfriend liked.
 - (4b) which car his new girlfriend liked.
 - (4c) which stylish car with the blue paint his new girlfriend liked.

3. We asked...
 - (1) if Dave's friend sketched a dancer...
 - (2) who Dave's friend sketched a dancer beside...
 - (3a) who Dave's friend sketched...
 - (3b) which dancer Dave's friend sketched...
 - (3c) which beautiful dancer with long legs Dave's friend sketched...
 - (4a) what Dave's friend sketched...
 - (4b) which chair Dave's friend sketched...
 - (4c) which beautiful chair with long legs Dave's friend sketched...
...while waiting at the restaurant.

4. Max didn't know...
 - (1) if Donna's daughter watched his movie.
 - (2) who Donna's daughter watched his movie with.
 - (3a) who Donna's daughter watched.
 - (3b) which patient Donna's daughter watched.
 - (3c) which sad patient with cancer Donna's daughter watched.
 - (4a) what Donna's daughter watched.
 - (4b) which movie Donna's daughter watched.
 - (4c) which sad movie with subtitles Donna's daughter watched.

5. Tracy wasn't certain...
- (1) if her daring brother followed her cab.
 - (2) what her daring brother followed her cab in.
 - (3a) who her daring brother followed.
 - (3b) which thief her daring brother followed.
 - (3c) which speedy thief with the yellow coat her daring brother followed.
 - (4a) what her daring brother followed.
 - (4b) which cab her daring brother followed.
 - (4c) which speedy cab with the yellow wheels her daring brother followed.
6. Bill wanted to know...
- (1) if Janet's mother kicked her phone...
 - (2) what Janet's mother kicked her phone for...
 - (3a) who Janet's mother kicked...
 - (3b) which neighbour Janet's mother kicked...
 - (3c) which annoying neighbour with the loud laugh Janet's mother kicked...
 - (4a) what Janet's mother kicked...
 - (4b) which phone Janet's mother kicked...
 - (4c) which annoying phone with the loud ring Janet's mother kicked...
 ...right after she had promised to control her temper.
7. Norma wasn't sure...
- (1) if her professor hated his student.
 - (2) what her professor hated his student for.
 - (3a) who her professor hated.
 - (3b) which student her professor hated.
 - (3c) which dull student of art history her professor hated.
 - (4a) what her professor hated.
 - (4b) which book her professor hated.
 - (4c) which dull book on art history her professor hated.
8. Harry asked...
- (1) if his fiancée noticed a painting...
 - (2) what his fiancée noticed a painting behind...
 - (3a) who his fiancée noticed...
 - (3b) which baby his fiancée noticed...
 - (3c) which pretty baby in the yellow dress his fiancée noticed...
 - (4a) what his fiancée noticed...
 - (4b) which painting his fiancée noticed...
 - (4c) which pretty painting in the yellow frame his fiancée noticed...
 ...when she visited him at his parents' house.

9. Celia couldn't remember...
- (1) if her stupid nephew hit the policeman.
 - (2) who her stupid nephew hit the policeman for.
 - (3a) who her stupid nephew hit.
 - (3b) which policeman her stupid nephew hit.
 - (3c) which large policeman with the red shirt her stupid nephew hit.
 - (4a) what her stupid nephew hit.
 - (4b) which building her stupid nephew hit.
 - (4c) which large building with the red bricks her stupid nephew hit.
10. Ian wasn't certain...
- (1) if Rachel's best friend heard a singer...
 - (2) who Rachel's best friend heard a singer with...
 - (3a) who Rachel's best friend heard...
 - (3b) which singer Rachel's best friend heard...
 - (3c) which famous singer from northern England Rachel's best friend heard...
 - (4a) what Rachel's best friend heard...
 - (4b) which song Rachel's best friend heard...
 - (4c) which famous song from northern England Rachel's best friend heard...
- ... at the most popular nightclub in New York.
11. Jane wondered...
- (1) if Brian's teacher admired his sculpture.
 - (2) what Brian's teacher admired his sculpture for.
 - (3a) who Brian's teacher admired.
 - (3b) which actress Brian's teacher admired.
 - (3c) which elegant actress from Paris Brian's teacher admired.
 - (4a) what Brian's teacher admired.
 - (4b) which sculpture Brian's teacher admired.
 - (4c) which elegant sculpture from Paris Brian's teacher admired.
12. Jim wanted to know...
- (1) if his clever sister investigated the suspect.
 - (2) what his clever sister investigated the suspect for.
 - (3a) who his clever sister investigated.
 - (3b) which suspect his clever sister investigated.
 - (3c) which bizarre suspect from Pine Avenue his clever sister investigated.
 - (4a) what his clever sister investigated.
 - (4b) which accident his clever sister investigated.
 - (4c) which bizarre accident on Pine Avenue his clever sister investigated.

13. The secretary couldn't remember...
- (1) if Frank's boss brought the salad...
 - (2) what Frank's boss brought the salad in...
 - (3a) who Frank's boss brought...
 - (3b) which lady Frank's boss brought...
 - (3c) which strange lady with the unpleasant odour Frank's boss brought...
 - (4a) what Frank's boss brought...
 - (4b) which salad Frank's boss brought...
 - (4c) which strange salad with the unpleasant odour Frank's boss brought...
- boss ... to last year's Christmas party.
14. The photographer didn't know...
- (1) if Lori's assistant positioned a reporter.
 - (2) who Lori's assistant positioned a reporter behind.
 - (3a) who Lori's assistant positioned.
 - (3b) which reporter Lori's assistant positioned.
 - (3c) which ugly reporter with the broken teeth Lori's assistant positioned.
 - (4a) what Lori's assistant positioned.
 - (4b) which furniture Lori's assistant positioned.
 - (4c) which ugly furniture with the broken legs Lori's assistant positioned.
15. Helen wasn't certain...
- (1) if her husband paid their bill.
 - (2) what her husband paid their bill with.
 - (3a) who her husband paid.
 - (3b) which clerk her husband paid.
 - (3c) which unreasonable clerk from the hardware store her husband paid.
 - (4a) what her husband paid.
 - (4b) which bill her husband paid.
 - (4c) which unreasonable bill from the hardware store her husband paid.
16. I wondered...
- (1) if Marg's niece expected a gift...
 - (2) who Marg's niece expected a gift from...
 - (3a) who Marg's niece expected...
 - (3b) which guest Marg's niece expected...
 - (3c) which fashionable guest from Sweden Marg's niece expected...
 - (4a) what Marg's niece expected...
 - (4b) which gift Marg's niece expected...
 - (4c) which fashionable gift from Sweden Marg's niece expected...
- ...at the grand birthday party she gave herself.

17. Ben couldn't tell...
- (1) if Kate's sister loved a soldier...
 - (2) what Kate's sister loved a soldier for...
 - (3a) who Kate's sister loved...
 - (3b) which soldier Kate's sister loved...
 - (3c) which sweet soldier from his homeland Kate's sister loved...
 - (4a) what Kate's sister loved...
 - (4b) which dish Kate's sister loved...
 - (4c) which sweet dish from his homeland Kate's sister loved...
...after she returned from Europe.
18. Dana didn't find out...
- (1) if Sam's advisor rejected her theory.
 - (2) what Sam's advisor rejected her theory for.
 - (3a) who Sam's advisor rejected.
 - (3b) which applicant Sam's advisor rejected.
 - (3c) which idiotic applicant from Harvard University Sam's advisor rejected.
 - (4a) what Sam's advisor rejected.
 - (4b) which theory Sam's advisor rejected.
 - (4c) which idiotic theory from Harvard University Sam's advisor rejected.
19. Jeff didn't know...
- (1) if Laura's student observed his patient.
 - (2) who Laura's student observed his patient with.
 - (3a) who Laura's student observed.
 - (3b) which patient Laura's student observed.
 - (3c) which sickly patient with brown spots Laura's student observed.
 - (4a) what Laura's student observed.
 - (4b) which plant Laura's student observed.
 - (4c) which sickly plant with brown spots Laura's student observed.
20. Kelly wasn't certain...
- (1) if Jack's cousin found a doctor...
 - (2) who Jack's cousin found a doctor beside...
 - (3a) who Jack's cousin found...
 - (3b) which doctor Jack's cousin found...
 - (3c) which brilliant doctor of family medicine Jack's cousin found...
 - (4a) what Jack's cousin found...
 - (4b) which paper Jack's cousin found...
 - (4c) which brilliant paper on family medicine Jack's cousin found...
...after searching throughout the whole building.

21. Peter wondered...
- (1) if Amy's daughter-in-law chose her dress.
 - (2) who Amy's daughter-in-law chose her dress with.
 - (3a) who Amy's daughter-in-law chose.
 - (3b) which lawyer Amy's daughter-in-law chose.
 - (3c) which smart lawyer from London Amy's daughter-in-law chose.
 - (4a) what Amy's daughter-in-law chose.
 - (4b) which dress Amy's daughter-in-law chose.
 - (4c) which smart dress from London Amy's daughter-in-law chose.
22. Sally wasn't sure...
- (1) if Donald and Glen praised her worker.
 - (2) what Donald and Glen praised her worker for.
 - (3a) who Donald and Glen praised.
 - (3b) which worker Donald and Glen praised.
 - (3c) which new worker at the shoe factory Donald and Glen praised.
 - (4a) what Donald and Glen praised.
 - (4b) which machine Donald and Glen praised.
 - (4c) which new machine at the shoe factory Donald and Glen praised.
23. None of us knew...
- (1) if Gail discussed her policy.
 - (2) what Gail discussed her policy at.
 - (3a) who Gail discussed.
 - (3b) which employee Gail discussed.
 - (3c) which troublesome employee from the personnel department Gail discussed.
 - (4a) what Gail discussed.
 - (4b) which policy Gail discussed.
 - (4c) which troublesome policy from the personnel department Gail discussed.
24. The ushers asked...
- (1) if Larry photographed his bride...
 - (2) who Larry photographed his bride with...
 - (3a) who Larry photographed...
 - (3b) which bride Larry photographed...
 - (3c) which radiant bride at the head table Larry photographed...
 - (4a) what Larry photographed...
 - (4b) which flower Larry photographed...
 - (4c) which radiant flower at the head table Larry photographed...
- ...after the wedding.

25. It was hard to tell...
- (1) if Lucy appreciated her assistant.
 - (2) what Lucy appreciated her assistant for.
 - (3a) who Lucy appreciated.
 - (3b) which assistant Lucy appreciated.
 - (3c) which considerate assistant in her department Lucy appreciated.
 - (4a) what Lucy appreciated.
 - (4b) which message Lucy appreciated.
 - (4c) which considerate assistant from her department Lucy appreciated.
26. Beth wondered...
- (1) if George blessed an infant...
 - (2) who George blessed an infant for...
 - (3a) who George blessed...
 - (3b) which infant George blessed...
 - (3c) which tiny infant with the pink hat George blessed...
 - (4a) what George blessed...
 - (4b) which cottage George blessed...
 - (4c) which tiny cottage with the pink shutters George blessed...
- ...before drinking several bottles of wine at the family gathering.
27. We wanted to know...
- (1) if Patty accepted a gift...
 - (2) who Patty accepted a gift from...
 - (3a) who Patty accepted...
 - (3b) which uncle Patty accepted...
 - (3c) which generous uncle from the foreign embassy Patty accepted...
 - (4a) what Patty accepted...
 - (4b) which gift Patty accepted...
 - (4c) which generous gift from the foreign embassy Patty accepted...
- ...after she overcame her initial misgivings.
28. Louise didn't find out...
- (1) if Brian left his lover.
 - (2) who Brian left his lover for.
 - (3a) who Brian left.
 - (3b) which lover Brian left.
 - (3c) which snotty lover with impossible standards Brian left.
 - (4a) what Brian left.
 - (4b) which club Brian left.
 - (4c) which snotty club with impossible standards Brian left.

29. The producer wasn't certain...
- (1) if Joanne discovered an actor...
 - (2) who Joanne discovered an actor with....
 - (3a) who Joanne discovered...
 - (3b) which actor Joanne discovered...
 - (3c) which exceptional actor from Belgium Joanne discovered...
 - (4a) what Joanne discovered...
 - (4b) which symphony Joanne discovered.
 - (4c) which exceptional symphony from Belgium Joanne discovered...
- ...on the talent hunt she had organized.
30. Pat wouldn't tell us...
- (1) if Tom criticized her proposal...
 - (2) what Tom criticized her proposal for...
 - (3a) who Tom criticized...
 - (3b) which professor Tom criticized...
 - (3c) which muddled professor of Canadian media Tom criticized...
 - (4a) what Tom criticized...
 - (4b) which proposal Tom criticized...
 - (4c) which muddled proposal for Canadian media Tom criticized...
- ...in his usual sarcastic manner.
31. I wondered...
- (1) if Sandy recommended her student.
 - (2) who Sandy recommended her student to.
 - (3a) who Sandy recommended.
 - (3a) which student Sandy recommended.
 - (3c) which efficient student with an outstanding reputation Sandy recommended.
 - (4a) what Sandy recommended.
 - (4b) which computer Sandy recommended.
 - (4c) which efficient computer with an outstanding reputation Sandy recommended.
32. Lisa didn't remember...
- (1) if Patrick answered his teacher.
 - (2) what Patrick answered his teacher with.
 - (3a) who Patrick answered.
 - (3b) which teacher Patrick answered.
 - (3c) which demanding teacher of American history Patrick answered.
 - (4a) what Patrick answered.
 - (4b) which question Patrick answered.
 - (4c) which demanding question on American history Patrick answered.

33. The investigator couldn't find out...
- (1) if Claudia betrayed a secret.
 - (2) who Claudia betrayed a secret to.
 - (3a) who Claudia betrayed.
 - (3b) which colleague Claudia betrayed.
 - (3c) which important colleague from the Chinese consulate Claudia betrayed.
 - (4a) what Claudia betrayed.
 - (4b) which secret Claudia betrayed.
 - (4c) which important secret about the Chinese consulate Claudia betrayed.
34. Lauren didn't know...
- (1) if Jason feared his examination.
 - (2) what Jason feared his examination for.
 - (3a) who Jason feared.
 - (3b) which grandfather Jason feared.
 - (3c) which intimidating grandfather from the Marines Jason feared.
 - (4a) what Jason feared.
 - (4b) which examination Jason feared.
 - (4c) which intimidating examination for the Marines Jason feared.
35. Luke wasn't certain...
- (1) if Ruth carried a bottle...
 - (2) what Ruth carried a bottle in...
 - (3a) who Ruth carried...
 - (3b) which daughter Ruth carried...
 - (3c) which slender daughter in the pink dress Ruth carried...
 - (4a) what Ruth carried...
 - (4b) which bottle Ruth carried...
 - (4c) which slender bottle in the pink box Ruth carried...
... to her friend's home.
36. The chairman wanted to know...
- (1) if Eric corrected a minister.
 - (2) what Eric corrected a minister about.
 - (3a) who Eric corrected.
 - (3b) which minister Eric corrected.
 - (3c) which inaccurate minister of External Affairs Eric corrected.
 - (4a) what Eric corrected.
 - (4b) which document Eric corrected.
 - (4c) which inaccurate document from External Affairs Eric corrected.

37. Derek wasn't sure...
- (1) if Jill forgot her book...
 - (2) who Jill forgot her book with...
 - (3a) who Jill forgot...
 - (3b) which friend Jill forgot...
 - (3c) which fascinating friend from the Philippines Jill forgot...
 - (4a) what Jill forgot...
 - (4b) which book Jill forgot...
 - (4c) which fascinating book from the Philippines Jill forgot...
- ...as she rushed from the lecture to see her sick mother.
38. Frances didn't find out...
- (1) if Bob replaced his technician.
 - (2) who Bob replaced his technician with.
 - (3a) who Bob replaced.
 - (3b) which technician Bob replaced.
 - (3c) which useless technician with no skills Bob replaced.
 - (4a) what Bob replaced.
 - (4b) which automobile Bob replaced.
 - (4c) which useless automobile with no engine Bob replaced.
39. Anita couldn't remember...
- (1) if Tim described his photograph...
 - (2) who Tim described his photograph to...
 - (3a) who Tim described...
 - (3b) which leader Tim described...
 - (3c) which sinister leader of the Klu Klux Klan Tim described...
 - (4a) what Tim described...
 - (4b) which photograph Tim described...
 - (4c) which sinister photograph of the Klu Klux Klan Tim described...
- ...in his class on human ethics.
40. Doug wouldn't say...
- (1) if Joyce defended her client.
 - (2) who Joyce defended her client against.
 - (3a) who Joyce defended.
 - (3b) which client Joyce defended.
 - (3c) which controversial client from the marine research centre Joyce defended.
 - (4a) what Joyce defended.
 - (4b) which report Joyce defended.
 - (4c) which controversial report from the marine research centre Joyce defended.

APPENDIX B
MATERIALS FOR EXPERIMENT 2

1. Bill knew...
 - (1) which kid the ball...
 - (2) which kid the teacher...
 - (3) which stick the teacher...
 - (4) which stick the ball...

...hit/was hit by at the school playground.

2. Greg remembered...
 - (1) which cyclist the truck...
 - (2) which cyclist the cop...
 - (3) which wagon the cop...
 - (4) which wagon the truck...

...blocked/was blocked by at the busy intersection.

3. Marlene guessed...
 - (1) which salesman the trailer...
 - (2) which salesman the tourist...
 - (3) which cart the tourist...
 - (4) which cart the trailer...

...bumped/was bumped by.

4. Amanda figured out...
 - (1) which instructor the lifeboat...
 - (2) which instructor the teenager...
 - (3) which canoe the teenager...
 - (4) which canoe the lifeboat

...towed/was towed by.

5. Doris reported...
 - (1) which driver the tree.
 - (2) which driver the poet...
 - (3) which vehicle the poet...
 - (4) which vehicle the tree...

...on the night of the awful rainstorm.

6. Paula announced...
 - (1) which captain the yacht...
 - (2) which captain the sailor...
 - (3) which ship the sailor...
 - (4) which ship the yacht...

...rescued/was rescued by.

7. William told us...
 - (1) which chairman the pamphlet...
 - (2) which chairman the bureaucrat...
 - (3) which column the bureaucrat...
 - (4) which column the pamphlet...

...cited/was cited by.

8. Arthur found out...
 (1) which baby the sheet...
 (2) which baby the guest...
 (3) which blanket the guest...
 (4) which blanket the sheet...
 ...covered/was covered by.
9. Colleen knew...
 (1) which foreman the boxes...
 (2) which foreman the worker...
 (3) which beam the worker...
 (4) which beam the boxes...
 ...knocked down/ was(were) knocked
 down by in a careless accident.
10. Andrew remembered...
 (1) which agent the taxi...
 (2) which agent the spy...
 (3) which limousine the spy...
 (4) which limousine the taxi...
 ...tracked/was tracked by in the
 adventure movie we saw last week.
11. Grant guessed...
 (1) which toddler the carriage...
 (2) which toddler the babysitter...
 (3) which bicycle the babysitter...
 (4) which bicycle the carriage...
 ...dragged/was dragged by.
12. Howard figured out...
 (1) which senator the ministry...
 (2) which senator the businessman...
 (3) which newspaper the businessman...
 (4) which newspaper the ministry...
 ...supported/was supported by.
13. Danielle wanted to know...
 (1) which reporter the conference...
 (2) which reporter the director...
 (3) which performance the director...
 (4) which performance the conference...
 ...delayed/was delayed by.
14. Nancy reported...
 (1) which producer the song...
 (2) which producer the actor...
 (3) which monologue the actor...
 (4) which monologue the song...
 ...drowned out/was drowned out by at the arts festival.

15. Joey stated...
 (1) which boss the boat...
 (2) which boss the worker...
 (3) which van the worker...
 (4) which van the boat...
 ...transported/was transported by to the new location.
16. Tess told us...
 (1) which corporal the freighter...
 (2) which corporal the admiral...
 (3) which warship the admiral...
 (4) which warship the freighter...
 ...stopped/was stopped by in a tense
 encounter off the Atlantic Coast.
17. Brad knew...
 (1) which refugee the office...
 (2) which refugee the priest...
 (3) which agency the priest...
 (4) which agency the office...
 ...traced/was traced by.
18. The guide reminded us...
 (1) which musician the poem...
 (2) which musician the writer...
 (3) which painting the writer...
 (4) which painting the poem...
 ...inspired/was inspired by.
19. The broadcaster announced...
 (1) which judge the commission...
 (2) which judge the governor...
 (3) which report the governor...
 (4) which report the commission...
 ...investigated/was investigated by
 with regards to a public scandal.
20. My sister told us...
 (1) which mayor the announcement...
 (2) which mayor the alderman...
 (3) which rumour the alderman...
 (4) which rumour the announcement ...
 ...silenced/was silenced by.
21. My receptionist knew...
 (1) which lady the sedan...
 (2) which lady the executive...
 (3) which sportscar the executive...
 (4) which sportscar the sedan...
 ...chased/was chased by along Sunset Boulevard.

22. No one could have guessed...
 (1) which victim the building...
 (2) which victim the general...
 (3) which fence the general...
 (4) which fence the building...
 ...concealed/was concealed by.
23. My aunt remembered...
 (1) which nurse the sponge...
 (2) which nurse the infant...
 (3) which cloth the infant...
 (4) which cloth the sponge...
 ...soaked/was soaked by in the hospital nursery.
24. Darlene figured out...
 (1) which scientist the journal...
 (2) which scientist the scholar...
 (3) which article the scholar...
 (4) which article the journal...
 ...reviewed/was reviewed by last month.
25. The media found out...
 (1) which president the legislation...
 (2) which president the politician...
 (3) which business the politician...
 (4) which business the legislation...
 ...discouraged/was discouraged by.
26. My sister wanted to know...
 (1) which editor the survey...
 (2) which editor the expert...
 (3) which publication the expert...
 (4) which publication the survey...
 ...discredited/was discredited by.
27. The evening news reported...
 (1) which king the army...
 (2) which king the general...
 (3) which village the general...
 (4) which village the army...
 ...liberated/was liberated by in a surprise coup.
28. Gertrude remembered...
 (1) which speaker the celebration...
 (2) which speaker the protester...
 (3) which broadcast the protester...
 (4) which broadcast the celebration...
 ...interrupted/was interrupted by on Canada Day.

29. The president demanded to know...
(1) which attorney the corporation...
(2) which attorney the manager...
(3) which bank the manager...
(4) which bank the corporation...
...swindled/and was swindled by.
30. Lenore eventually found out...
(1) which rebel the bus...
(2) which rebel the lieutenant...
(3) which tank the lieutenant...
(4) which tank the bus...
...encountered/was encountered by.
31. None of us remembered...
(1) which professor the study...
(2) which professor the researcher...
(3) which textbook the researcher...
(4) which textbook the study...
...described/was described by.
32. It was impossible to tell...
(1) which sheriff the convertible...
(2) which sheriff the crook...
(3) which motorcycle the convertible...
...pursued/was pursued by.
33. The press found out...
(1) which killer the note...
(2) which killer the girl...
(3) which photograph the girl...
(4) which photograph the note...
...identified/was identified by.
34. Jean reported...
(1) which artist the administration...
(2) which artist the dictator...
(3) which novel the dictator...
(4) which novel the administration...
...condemned/was condemned by in the repressive republic.
35. The sales clerk forgot...
(1) which owner the warehouse...
(2) which owner the customer...
(3) which store the customer...
(4) which store the warehouse...
...contacted/was contacted by regarding the spring sale.

36. My uncle reported...
(1) which lawyer the testimony...
(2) which lawyer the witness...
(3) which evidence the witness...
(4) which evidence the testimony...
...contradicted/was contradicted by.
37. The children read about...
(1) which emperor the raid...
(2) which emperor the knight...
(3) which murder the knight...
(4) which murder the raid...
...avenged/was avenged by.
38. Karen found out...
(1) which official the debate...
(2) which official the candidate...
(3) which investigation the candidate...
(4) which investigation the debate...
...hindered/was hindered by.
39. The secretary knew...
(1) which clerk the memo...
(2) which clerk the accountant...
(3) which comment the accountant...
(4) which comment the memo...
...addressed/was addressed by.
40. It was evident...
(1) which author the magazine...
(2) which author the publisher...
(3) which contract the publisher...
(4) which contract the magazine...
...exploited/was exploited by.