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WHEN ARE CHAINS CONSTRUCTED?

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This paper is concerned with the processes involved in the formation of syntactic chains during sentence processing. We survey evidence in favour of the view that chain formation is delayed until the processor can form a complete sentence. The use of sentential units as points for chain formation is compared to lexically-driven gap location. We report a new experiment testing for the presence of chain formation in an Operator movement construction. The final section discusses some implications of delayed chain formation for the relation between linguistic theory and parsing procedures and the design of experiments.

1. The 'Gap non-location'/'false gap' effect

Several experimental studies have argued that the processor anticipates positions for wh-words in the incoming sentence, on occasion erroneously linking a wh-word to a position where it does not belong. (In the terminology of the literature, erroneously linking a **filler** to a **gap**). In a word-by-word self-paced reading study[1] Crain and Fodor (1985) found elevated RTS relative to a non-wh-control at the direct object position filled by us in (1),

1. Who could the little girl have forced us to sing those stupid French songs for at Christmas?

Similarly, Stowe (1986) found elevated RTs at the prepositional object position occupied by Greg's in (2),

2. The teacher asked what the team laughed about Greg's fumbling the ball for.

These effects can be explained if the processor miscontrues the direct or prepositional object position as the position to which the wh word is linked, only to discover its error when the true object is input; there is thus a **gap non-location** or **false gap** effect.

2. Which (potential) gaps produce the effect?

Not all potential gap sites appear to induce a gap non-location effect. Both subject position and positions inside syntactic islands have been argued to be immune to gap non-location effects. Stowe (1986) found no gap non-location effect at the embedded subject position in sentences such as (2) above (i.e.

reaction times were not elevated to initiate the word after the determiner of the noun phrase the team). She also found no gap non-location effect at prepositional object position in sentences such as (3),

3. The teacher asked what the silly story about Greg's fumbling the ball was supposed to mean.

where the preposition about is embedded inside an NP rather than the VP. In Stowe's experiment, the positioning of a potential gap inside an island (inside an NP) was confounded with subjecthood (as Stowe notes). This confound was eliminated in a study by Bourdages (1992), who found (using French materials) no gap non-location effect inside relative clauses in the VP, although she did find a gap non-location effect at prepositional object position in the VP.

The contrast between direct and prepositional object position and subject and island positions with respect to gap non-location effects is rather strong in the studies cited above. However, there are studies that suggest some exceptions to the claim that subject position and positions inside islands do not induce gap non-location. First, Sedivy (1991) found elevated reaction times at the subject position when the wh-phrase was lengthened. Thus reaction times to initiate the word after the determiner the were longer in sentences such as (4iii) than in (4i-ii),

4. Mary wondered i) who the boy saw
ii) which girl the boy saw
iii) which tall girl with dark hair the boy saw

Sedivy argues that the processor may erroneously fill a wh-phrase into the subject position if the processing mechanism is sufficiently taxed (in this case, by holding a complex enough wh-phrase).[2] Second, Clifton and Frazier (1989), using a grammaticality judgement task, found times were longer to judge sentences such as (5a) than sentences such as (5b),

5.a What did John think the girl who always won received?
b What did John think the girl who always excelled received?

although the effect was not strong. This difference would follow if the processor does consider the position after a potentially transitive verb (win in the example) in the relative clause as a possible location for a wh word, despite the fact that the relative clause is an island.[3]

3. Solution: Completeness and binding

We can propose the following as a descriptive account of the partially conflicting results concerning which potential gaps induce gap non-location effects (this is the gist of what is proposed in Goodluck, Sedivy and Finney 1992):

> Completeness constraint on binding: Gaps are located at all potential positions in the incoming string but are (in the normal case) bound to the antecedent only at positions that are potential ends of sentences.

We define **potential end of sentence** as a position at which filler-gap binding will result in a closed sentence with all lexical specifications met. Following Clifton and Frazier 1989 and Frazier and Clifton 1989, **potential positions** for a filler are understood as locally legitimate positions -- i.e. positions where a gap may be located under the government specifications of the language at hand, although globally the gap may be barred, as in the case of island positions. This distinction between location of gaps and binding of gaps (the latter occurring subject to completeness) allows us to accommodate the weak effect of potential gaps inside NP (relative clause) islands reported by Clifton and Frazier. The "normal case" clause allows for gap non-location without completeness when the processor is under pressure (as Sedivy proposed).[4]

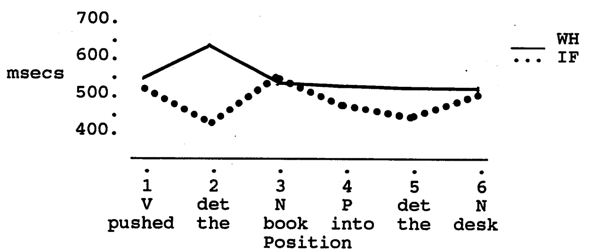
4. Sentence profiles and closure

Self-paced reading experiments show that the profile of reaction times across the sentence differs for <u>wh</u> and non-<u>wh</u> sentences. We have conducted two experiments taking reading times at the subordinate verb and subsequent five words in sentences such as (6a) and (6b),

6.a John wondered what the little boy had pushed the book into the desk for before class started.
  b John wondered if the little boy had pushed the book into the desk before class started.

The profiles of RTs for the <u>wh</u> sentences (6a) and their <u>if</u> controls (6b) from the first run of the experiment is given in Figure 1; mean RTs for the first run of the experiment, the second run of the experiment, and the experiment reported in section 6 are given in Appendix 1. The first experiment is reported in more detail in Goodluck, Finney and Sedivy (1992).

FIGURE 1
Reaction Time Profile
Experiment 1 (Long* <u>Push</u> Sentences)



*see next section

We found a rise in RTs at direct object position for the <u>wh</u> sentences (the standard gap non-location effect). For the <u>if</u> controls, the overall pattern of reaction times is quite different, with a fall in reaction times at the determiner and preposition positions and a rise at the noun positions. Overall reaction times are longer for <u>wh</u> than for <u>if</u> sentences, as is typical in such experiments.

We can list five potential sources of peaks in RT profiles (some of which may act in concert):

1. Phrasal closure
2. Sentential closure
3. Gap location
4. Gap binding
5. Gap non-location.

I.e. in each of these circumstances, RTs to initiate the next word might be expected to be slowed. Phrasal closure (completion of a phrasal unit) can be held responsible for peaks at N in the <u>if</u> profiles; presumably the processor pauses on completion of a phrasal unit to perform some type of syntactic/semantic integration.

Sentential closure (overall lengthening of reaction times at positions towards the end of a sentence) is not seen in the profiles in Figure 1, but is found in many experiments, including the experiment reported in section 6 below. As already described, gap non-location is the putative source of rise in RTs in wh profiles at positions that indicate that no gap is present (as at the first determiner position in Figure 1). Since we acknowledge that all potential gaps may be located in the incoming string, we might expect to see an effect of **gap location** at positions where a gap may immediately follow. Similarly, **binding** of a filler to a gap (a closure operation for wh-profiles) might be expected to cost some processing time, and can under the completeness constraint on binding occur at those locations that are potential ends of sentences. In principle, errors (incorrect bindings) may be expected to be more costly than correct operations, and so gap non-location/incorrect binding effects might be expected to be the source of the greatest peaks.

To make matters more complicated, it is worth considering that peaks may not necessarily be fixed with respect to the position in the sentence that initiates them. Thus, for example, gap location peaks for subjects with overall relatively fast reaction times might be expected to show up slightly to the right of the location itself; this means that gap location effects could occur in the position usually associated with gap non-location (e.g. the peak at det in Figure 1 might be interpreted as a delayed location effect rather than a correction, or non-location, effect). In addition, relatively large differences in the profiles at a given point for wh and if sentences - the comparison standardly used to infer activity in processing wh sentences - may derive as much from decline in RTs for if sentences as from elevation of RTs for wh sentences. The purpose the above observations will become clearer in the next section.

5. Completeness or lexically-based gap probability?

The main goal of the wh experiments just mentioned was to provide additional support for completeness as a factor in filler-gap processing by manipulating the argument structure specifications of the verb that supplies the potential gap locations. With verbs such as push, the locative PP in sentences such as (6) is optional. With the verb put the second argument is obligatory. Consequently, the position after the embedded verb does not constitute a potentially complete sentence in the case of put; (7a) but not (7b) is a complete sentence,

7.a John wondered what the little boy had pushed
  b John wondered what the little boy had put

The completeness constraint on binding predicts that there should be no gap non-location effect at the direct object position when put is substituted for push in sentences such as (6a).[5] The first run of the experiment provided some support for this prediction; there was indeed no gap non-location effect (rise in wh profile) for put at the direct object position, although there was such an effect at the second object position. (This was true only when four words intervened between the wh word and the embedded verb (LONG sentences); when only two words intervened (SHORT sentences) there was no gap non-location effect for put).

Although the first experiment provided promising support for subcategorially-determined completeness as a determinant of gap non-location, the second experiment has failed to nail this result down. The contrast in positions at which an effect is found did not clearly show up in the second run of the experiment, which used only long sentences. In the second experiment, 32 subjects each responding to six tokens of each sentence type (wh-push; if-push; wh-put; if-put). RT profiles for if sentences were highly similar to those in the first run of the experiment, and RTs were overall longer for wh than for if, as in previous studies. Wh-push sentences differed significantly from their if controls at first determiner position (by subject: $F(1,31)=7.20$, $p < .02$; by item: $F(1,23)=4.73$, $p < .04$) and at preposition position (by subject: $F(1,31)=8.97$, $p <.006$; by item: $F(1,23)=4.95$, $p < .05$). This latter effect is clearly not a gap non-location effect of the standard kind, although it might be attributed to gap location/binding. Moreover, an inspection of the data for subjects with overall mean RTs of 750 msecs (slow subjects) showed that these subjects tended to pause at the verb, which again might be attributed to gap location rather than to gap non-location. The wh-put sentences also differed significantly from their if controls at first determiner position (by subject: $F(1,31)=7.01$, $p < .02$; by item: $F(1,23)=4.61$, $p < .05$). At preposition position there was no hint of an effect for put. There was a weak effect at the second determiner position ($p < .05$, by subject), which an inspection of the profiles shows should be attributed to a decline in the if profile rather than an increase in the wh profile.

At first the results with put from the second experiment might seem quite damaging to the completeness constraint on binding, but we think they need not be construed that way. If the multiple sources of peaks listed above are admitted, then some gap location activity for put profiles might be expected at direct object position. In addition, it seems to be the case across the two experiments that wh-put sentences do not induce the same level of activity as those with push-type verbs, consistent with delayed chain formation in the case of put. We combined the data from the two experiments in the following way. Each position in the sentence was assigned a score. Scores were computed separately for the mean reaction times for the long and short conditions in experiment 1 and the slow and fast subjects in experiment 2. Each position thus had four chances to earn points. A position was awarded two points if both adjacent positions had a mean RT of 25 msecs or more lower than that position and one point if one adjacent position had a score 25 msecs or more lower. In essence, what this does is to assign points to peaks. The points for each position for the four sets of data (long and short in experiment 1; slow and fast in experiment 2) were then added up. The **derived profiles** that result are given in Figure 2.[6]

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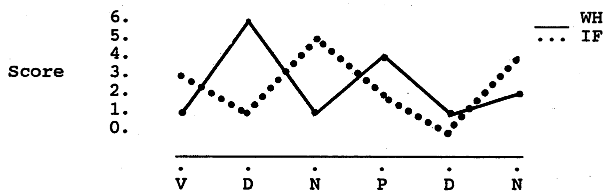
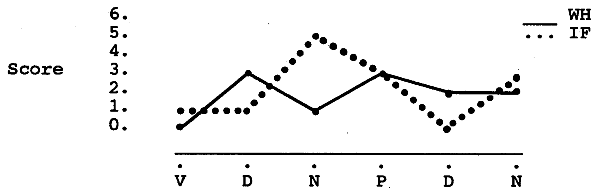
FIGURE 2
a. Derived Profile: Push Sentences, Exp. 1 & 2



b. Derived Profile: Put Sentences, Exp. 1 & 2



This algorithm is doomed to misrepresent the data to some degree (e.g. it may underrepresent activity at the verb and second N positions, since we recorded only one adjacent score for those positions). However, it gives some indication (1) that there is more activity - more pronounced peaking - for the wh push than for the wh put sentences, and (2) that this greater activity is possibly a consequence of the combination of wh syntax with particular verbs, since the if profiles for both push-type verbs and put show similar amounts of activity, except for somewhat greater peaking at the margins for push. Overall, the results of the two experiments are compatible with active gap location, plus delayed binding in the case of put. However, the results are not clear-cut, and the recognition of multiple potential sources of peaks in wh profiles, if not a positive invitation to sophistry, does make it easier to interpret the data according to one's favorite hypothesis of the moment. What we would like to see is a strong contrast in the position of major peaks for wh push and put sentences, and this we have only found once, in the long sentences in the first experiment.[7]

Other experiments on lexical sources of gap (non)-location effects can be interpreted as similarly inconclusive with respect to the role of the strength/obligatoriness of arguments in determining potential completeness and, by hypothesis, gap binding.

Using a task in which subjects are asked to decide as quickly as possible whether a fragment can be concluded grammatically, Kurtzman et al (1991) failed to find a distinction between fragments such as (8a) and (8b), which differ in that the verb in the latter but not the former strongly prefers a prepositional phrase to follow the direct object,

8.a What did John construct our
b What did John remove our

Rather, judgements were largely negative for both fragment types, in contrast to controls in which the determiner (our in the example) was replaced with a temporal preposition or similar non-argument item; this suggests gap non-location occurs even when the second argument is strongly preferred.

Goodluck, Sedivy and Finney (1992) failed to find any difference in a self-paced reading task at the prepositional object position (to Dorothy in the example) when questions such as (9a) and (9b) were compared,

9.a To whom did the smart detective shout
to Dorothy that the thief had thrown the package?
b To whom did the smart detective demonstrate
to Dorothy that the thief had thrown the package?

Verbs such as shout and demonstrate contrast in that the former does not require an S' argument when a goal PP is present. Thus the first line of the example in (9a) is a potentially complete question, while the first line of (9b) is not. We predicted a gap non-location effect at the second to in the case of (9a) but not (9b), since binding the questioned PP to the position after the verb in (9a) but not (9b) results in a complete sentence. No evidence was found that the processor identified/bound a gap after the verb in either case; rather RTs for both sentence types went down at the preposition and rose at the noun, in a manner reminiscent of the if profiles for the PP in our first two experiments comparing push and put.[8,9]

To summarize the above: our put/push experiments have not produced very strong evidence that completeness as determined by argument structure specification is an independent factor in gap location/binding; Kurtzman et al's experiment suggests that gap non-location effects may be found in the absence of a highly preferred argument; our shout/demonstrate experiment showed that potential completeness does not entail gap non-location effects.

It is possible to point to factors that allow the completeness constraint on binding to be maintained, despite the results of Kurtzman et al. and our shout/demonstrate experiment. Kurtzman et al. contrasted verbs for which the second internal argument was optional to verbs for which it was strongly preferred, rather than absolutely obligatory; in the demonstrate/shout experiment, the questioned phrase had to be linked to an optional PP position in the VP to obtain a gap non-location effect, in contrast to the standard case (Crain and Fodor, Stowe, etc), where the gap non-location effect is obtained at direct or prepositional object position for strongly transitive verbs/prepositions. And so it still possible to maintain completeness as a necessary, but not sufficient, condition on binding.

Is there an alternative in terms of lexically-driven gap postulation? I.e. Can the occurrence of gap non-location effects be reduced to the probability of positing a gap in a given position for individual verbs (or verb classes), where these probabilities are based on a combination of grammatical specifications (argument structure/subcategorial specifications) and usage? The evidence is not in at the present time to decide whether apparent completeness effects can be subsumed under lexically-based gap postulation. The lexical account is completely compatible with the mixed results of the experiments just summarized.[10] It can be argued to do well in accounting for the absence of gap non-location effects in subject position, since at that position in English no verb has been input on which to base the computation of possible/probable gap positions. Both the lexical account and the completeness account require sensitivity to islands to apply as a filter over possible gap locations, in the case of completeness at a defined position. The two accounts differ interestingly in that the completeness account, but not the lexical account, entails apparent obedience to islands in on-line processing, without reference to islandhood.

6. Gap non-location in Operator chains

In standard Government Binding theory, an object gap in sentences with purpose clauses, such as (10), is derived by covert movement of an operator to the CP of the embedded clause,

10. Ray chose his best friend to write to.

We carried out an experiment to test for gap non-location effects in this sentence type. In this experiment, subjects first read a short context passage, which was presented sentence by sentence. The target sentence was then read word by word. An example is given in (11). The context passage was designed to create the expectation of an object gap when the target sentence contained a purpose clause. There was thus the potential for a gap non-location effect in object position in the target sentence (at the position filled by <u>Phil</u> in the example). The non-movement controls replaced the verbs used for the purpose clause condition (these were <u>choose</u> and <u>pick</u>) with a <u>tell</u>-type verb (<u>tell</u> or <u>ask</u>), for which an object gap is not permitted. The context passage was the same for both versions of the target sentence.

11. Context:
    The English class organized a writing contest.
    The students were expected to write a letter to a friend.
    The letter had to be addressed to someone in the class.

    Target:
    Ray chose his best friend to write to Phil.

Thirty two subjects (the same subjects who did the second <u>put</u>-<u>push</u> experiment and the <u>demonstrate</u>-<u>shout</u> experiment described above) responded to eight tokens each of purpose clause and complement to <u>tell</u> targets (a total of 16 sentence frames, with <u>choose</u>/<u>tell</u> versions rotated through two questionnaires). RTs were taken at the verb and the following seven words. Subjects speeded up in this experiment, compared to the second <u>put</u>-<u>push</u> experiment, perhaps because the subordinate task we used to ensure concentration was different (sentence repetition of a subset of sentences for the <u>put</u>-<u>push</u> experiment vs. a yes-no question response task for the operator gap experiment). There was basically no activity in the reaction time profiles for either the <u>choose</u> or <u>tell</u> conditions until the prepositional object position was reached, when reaction times rose for both conditions, but with a greater rise in the <u>choose</u> condition. A comparison of the two conditions at the eight positions tested is significant only at the prepositional object position (by subject: $F(1,31) = 19.80$, $p < .001$; by item: $F(1,15) = 4.83$, $p < .05$).

This experiment thus shows a gap non-location effect in Operator movement constructions. However, the reaction time profiles for the movement construction and non-movement construction are not differentiated (except at the critical position), nor are reaction times for the movement construction elevated overall, as they are in the <u>wh</u>-movement experiments. This result is compatible with the view that the elevation of RTs for <u>wh</u>-constructions should not be attributed to the mental labors of contructing a syntactic chain on-line, but rather to the processing effect of (<u>wh</u>) interrogative semantics.[11]

(Since giving the oral version of this paper, in which we interpreted the data as in the last paragraph, we have rethought the matter. It may simply be that we do not have enough positions in our materials between the putative position of the operator (between friend and infinitival to in the example) and the potential gap position for a general difference in reaction times for choose and tell to show up. More interestingly, the lack of differentiation in the profiles for choose and tell sentences is also consistent with the hypothesis that purpose clauses are not movement constructions, as linguistic analyses such as Jones 1991 argue.[12] If either of these alternatives is correct, then the data from the purpose clause experiment does not counter-indicate the elevation of reaction times in wh constructions as a symptom of chain construction; it is rather neutral on the issue).

7. Conclusion: chain construction in grammatical theories and parsing

The issue of when chains are constructed in the course of sentence processing is an important one in modelling the relationship between grammatical representations and parsing operations. Sentential units have a long history of making a difference with respect to sentence processing, at least in English (see, for example, Caplan 1972; cf also Hoover 1992 for cross-linguistic data). Although the evidence we have summarized is far from conclusive, it is still a viable hypothesis that potentially complete sentences are a signal for the binding of fillers to gaps. Sentential units as proposed in our account of filler-gap binding are parsing-particular units: we do not assume that the special status of complete sentences derives from the special status of some corresponding unit in the competence grammar. This of course could be wrong, and there are a lot of avenues for an alternative that derives the parsing status of complete sentences/propositional units from grammatical distinctions (e.g. a return to the traditional (NP, S) concept of bounding nodes). The resolution of this question has non-trivial consequences - e.g. as mentioned above, the completeness constraint on binding can produce the effects of obedience to island constraints in processing without reference to such constraints.

This consequence of completeness bears on debates concerning the efficacy of linguistic formalisms in on-line processing. It has been proposed in a Generalised Phrase Structure Grammar formalism that chains of slashed categories are constructed immediately in processing, as a consequence of the GPSG formalism for long distance dependencies, in which each segment of the phrase structure path between the wh phrase and the gap encodes the fact that such a dependency exists (Crain and Fodor 1985; Fodor 1983). A natural corollary of this (Fodor 1983) is that island constraints are imposed immediately, since the permissible phrase structures preclude entry into an island. If in fact there is a parsing-particular point for chain construction, as the completeness constraint on binding proposes, then both GPSG and GB formalisms for parsing may in and of themselves prove inadequate to account for the steps in construction of a mental representation for wh-sentences in real-time comprehension.

Regardless of how the question of the parsing-particular vs. grammatical basis of the completeness constraint on binding is resolved, the issue of completeness is one that psycholinguistic experimentation should not ignore. With completeness factored in, on-line experiments may in effect become off-line. For example, one of the most intriguing findings in the recent literature on filler-gap parsing is de Vincenzi's (1991) finding, in a study of Italian, that referentially relatively specific wh phrases (such as Quale bambina in 12) do not induce the same processing effects as simple wh words.

12.a Quale bambina/ ha curato/ l'uccellino/ con
il pediatra
abilita' e pazienza?
(Which young girl cured the little bird
pediatrician
with ability and patience?)

b Chi/ ha derubato/ la banca/ all'angolo/ di
il ladro
via Fiume?
(Who robbed the bank at the corner of
thief
Fiume street?)

In a phrase-by-phrase self-paced reading experiment subjects read the post-verbal NP more slowly in (12b) when it was a plausible (inverted) subject; a similar effect was not found for sentences of the type in (12a).

Assuming that two different linguistic mechanisms govern the interpretation of the two types of wh phrase, as the recent linguistic literature argues, this might seem evidence for the immediate activation of these distinct mechanisms. However, since de Vincenzi took her measurements at positions that were potential ends of sentences, the data are in fact neutral between on-line activation of two distinct mechanisms and the rapid use of referentiality at potentially complete sentences.

8. Conclusion prime.

The experimental evidence for the completeness constraint on binding is not overwhelming, and we have trodden on marshy ground in our interpretation of the self-paced reading data. For example, if gap location and possibly binding is taken as a source of peaks at verb and prepositional object position in self-paced reading profiles (as in our interpretation of data from the second push-put experiment), how is one to interpret the profiles following those positions, where no gap non-location effect is found? Perhaps the notion of gap non-location should be abandoned, since any putative gap non-location effect can also be ascribed to delayed gap location, as mentioned above (section 4). The completeness constraint on binding may still be maintained, but then there is an onus on us to tease apart simple location effects from location plus binding effects. The consequences for understanding the relationship between parsing procedures and grammatical rules seem large enough to take the such details seriously.

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Notes

1. In self-paced reading studies subjects read sentences word-by-word or phrase-by-phrase on a computer screen pressing a button in initiate each new word/phrase. Unless otherwise noted, the experiments described below are word-by-word self-paced reading studies.

2. The effect of length in Sedivy's experiment was found only when the wh-phrase was animate; Sedivy attributes this to the processor's use of a default assignment of animate NPs to subject position.

3. We omit from our discussion the quite extensive debate between K. Forster and J. D. Fodor and their colleagues concerning whether or not the results of sentence matching experiments demonstrate the presence of a stage in processing in which island constraints are not obeyed. Stowe (1992) provides a review of the literature, concluding that the debate is largely inconclusive.

4. P. Culicover asks if completeness can account for the very strong preference in most dialects for construing the question word in a double NP dative questions such as "Who did the doctor send the nurse?" as referring to the second possible position for the trace. The answer would seem to be no: although completeness might account for the deferment of binding to one position or another, it cannot in and of itself account for the choice made between the two possible locations.

5. Only the verb put was used as the obligatory second argument condition in these experiments; in the push condition, the strongly transitive verbs push, lift, pull and throw were used. We chose these verbs and put as matching in thematic structure in a fairly exact way, eliminating thematic preference as a source of gap non-location effects (cf. Tanenhaus et al.1989). At the time of constructing our experimental materials, put was the only verb we could think of for our purposes that required two arguments in the VP; cf. fn. 9.

6. The profiles are very similar if the calculation is done on 50 msecs differences, in which case the data from fast subjects in experiment 2 makes no contribution to the derived profiles.

7. A group of 9-11 year old children we have tested on the second push-put experiment show a differentiation of peaks for push-type verbs and put, with the main peak for push occurring at the verb and the main peak for put occurring at the preposition.

8. This experiment is an extension of a test for sensitivity to potential ends of sentences in Bourdages (1992), whose results show that in other contexts a preposition identical to that in a pied-piped wh phrase can induce gap non-location effects.

9. We have tested 18 subjects on a third experiment that contrasts push-type verbs with put and tuck, which like put requires a second argument in the VP ("*The busy housewife tucked the papers"; "The busy housewife tucked the papers behind the cushion"). Wh questions with real gaps in direct object and prepositional object position were used as fillers in the hope of priming the subjects for gaps, a prime we hoped would be resisted at direct object position for put type verbs. The test sentences all had real gaps in prepositional object position. Put but not tuck

showed a small peak at direct object position; the main activity for both verb types was at the real gap.

10. A study of usage would be useful. Frequency of lexical items alone seems unlikely to account for the difference in activity for the wh-put profiles as compared to the wh profile for the other verbs, since put is by far the most frequent of the verbs we used in the Francis and Kučera corpus (Francis and Kučera 1982). A small amount of elicitation (sentence completion) work we have done shows that the verbs in our studies for which a PP is optional differ in the likelihood with which the PP is used, and that for push at least a PP following the direct object is highly preferred in declarative sentences. A study of usage would plainly most profitably be directed towards the distribution of gaps in wh questions.

11. The elevation might also be attributed to gap location (without chain formation).

12. There were five subjects in the operator gap experiment who had overall mean reaction times over 750 msecs; these subjects had more "active" profiles than the group as a whole, and they too did not differentiate between choose and tell at any point before the critical prepositional object position.

References

Bourdages, J. 1992 "Parsing complex NPs in French". In H.Goodluck and M. Rochemont (eds) Island Constraints: Theory, Acquisition and Processing, Kluwer Academic Publishers.

Caplan, D. 1972 "Clause boundaries and recognition latencies for words in sentences". Perception and Psychophysics, 12, 73-73.

Clifton, C. and L. Frazier 1989 "Comprehending sentences with long-distance dependencies". In G. Carlson and M. Tanenhaus (eds) Linguistic Structure in Language Processing, Kluwer Academic Publishers.

Crain, C. and Fodor, J. D. 1985 "How can grammar help parsers?". In D. Dowty, L. Karttunen and A. Zwicky (eds) Cambridge, England: Natural Language Parsing, Cambridge University Press.

De Vincenzi, M. 1991 Syntactic Parsing Strategies in Italian. Dordrecht, Holland: Kluwer Academic Publishers.

Fodor, J. 1983 "Phrase structure parsing and the island constraints" Linguistics and Philosophy, 6, 163-223.

Francis, W. N. and H. Kučera 1982 Frequency Analysis of English Usage. Boston, MA: Houghton Mifflin Company.

Frazier, L. and C. Clifton 1989 "Successive cyclicity in the grammar and the parser" Language and Cognitive Processes, 4, 93-126.

Freedman, S. and K. Forster 1985 "Sentence matching and well-formedness" Cognition, 26, 171-186.

Goodluck, H., M. Finney and J. Sedivy 1992a "Sentence completeness and filler-gap dependency parsing". In P. Coopmans, B.Shouten and W. Zonneveld (eds), OTS Yearbook, University of Utrecht, Holland.

Goodluck, H., J. Sedivy and M. Finney 1992b "Sentence completeness and the understanding of long-distance dependencies in natural language" Proceedings of ECCOS '92, Orsay, France, 99-108.

Hoover, M. 1992 "Processing strategies in Spanish and English". Journal of Psycholinguistic Research, 21, 275-299.

Jones, C. 1991 Purpose Clauses, Dordrecht, Holland: Kluwer Academic Publishers.

Kurtzman, H. L. Crawford and C. Nychis-Florence 1991 "Locating wh-traces". In B. Berwick, A. Abney and C, Tenny (eds) Principle-

Based Parsing: Computation and Psycholinguistics. Dordrecht, Holland: Kluwer Academic Publishers.

Sevidy, J. 1991 The Use of Thematic Relations in Subject Gap Filling. Masters Thesis, University of Ottawa.

Stowe, L. 1984 Models of Gap Location in the Human Parsing Mechanism. Ph.D. Thesis, University of Wisconsin.

Stowe, L. 1986 "Parsing wh-constructions: evidence for on-line gap location" Language and Cognitive Processes, 1, 227-245.

Stowe, L. 1992 "The processing implementation of syntactic constraints: the sentence matching debate" in H. Goodluck and M. Rochemont (eds), Island Constraints: Theory, Acquisition and Processing, Kluwer Academic Publishers.

Tanenhaus, M., G. Carlson and J. Trueswell 1989 "The role of thematic structures in interpretation and parsing", Language and Cognitive Processes, 4, 211 - 234.

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Appendix 1

put-push Experiments 1 & 2
Mean Reaction Times (msecs)

Position	1 V push/ put	2 det the	3 NP book	4 P into	5 det the	6 N desk
Exper. 1 (n=23)						
LONG						
push-wh	550	645	547	530	527	527
push-if	523	431	550	486	443	513
put-wh	517	509	510	597	623	589
put-if	511	454	558	467	440	533
SHORT						
push-wh	490	633	468	585	554	489
push-if	516	456	503	513	454	553
put-wh	489	532	510	513	512	529
put-if	416	496	555	487	457	510
Experiment 2						
All subjects (n=32)						
push-wh	757	752	738	778	675	731
Push-if	676	655	679	667	641	705
Put-Wh	690	743	734	727	679	739
Put-if	634	634	709	720	640	714
Slow subjects (n=14)						
Push-wh	1164	1105	1092	1215	1010	1070
Push-if	985	925	1068	975	928	1034
Put-wh	1015	1118	1066	1070	1002	1082
Put-if	900	882	1068	1085	929	1080
Fast subjects (n=18)						
push-wh	440	477	463	438	414	467
Push-if	436	441	412	427	418	449
Put-wh	437	450	475	460	427	452
Put-if	428	441	429	436	417	430

Operator gap experiment
Mean Reaction Times (msecs); n = 32

Position	1 V chose/ told	2 det his	3 Adj best	4 N friend	5 to to	6 V write	7 P to	8 N Phil
Choose	547	506	519	537	529	522	533	715
Tell	543	516	524	544	534	526	534	617