A Subject/Object Asymmetry in Parsing

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0. INTRODUCTION

Asymmetries between the grammatical occurrence of empty nodes in subject and object positions have been the focus of considerable theoretical interest in the last few years (Chomsky, 1981; Pesetsky, 1983; Rizzi, 1981). These asymmetries have been explained by appeal to general principles of human grammars (Universal Grammar). In this paper I will present behavioral evidence that an asymmetry also occurs between objects and subjects in processing WH-clauses. The parsing asymmetry may occur because the parsing mechanisms are responsive to the grammatical principles which underlie the asymmetries included in the grammar. Alternatively, an explanation based on independently motivated mechanisms of the parsing mechanism may be pursued. However, unless the grammatical principles are claimed to underlie the parsing explanation, the processing mechanism causes effects very similar to those of the grammar without the existence of any unifying principles. I make the initial assumption that the grammar is as isomorphic to the processing mechanisms as possible.[1] Taking this position, a specific proposal as to how a grammatical constraint can be expressed in the parser is suggested by the parsing evidence.

0.1 THEORETICAL BACKGROUND

An example of the type of asymmetry which we will be concerned

with is illustrated in (1).

(1) a. Who_i did John think that Mary saw t_i

b. *Who_i did John think that t_i saw Mary?

In (1a) a trace occurs in object position in an embedded clauses. However, when the trace appears in subject position, as in (1b), the sentence is ungrammatical. This asymmetry has been taken to be a consequence of a constraint on the output of transformational rules in the grammar. One well known formulation of this constraint is Chomsky's (1981) Empty Category principle (ECP). The ECP involves several parts as follows:

(2) $[e]$ must be properly governed.

This signifies that an empty node must be properly governed.

(3) α properly governs β iff α governs β and $\alpha \neq$ AGR .

Proper government is defined here as government by a subset of potential governors.

(4) α governs β in $[\ldots \alpha \ldots \beta \ldots \alpha \ldots]$ if

(i) $\alpha = X^0$ or α is coindexed with β

(ii) where ϕ is a maximal projection, if ϕ dominates β, then ϕ also dominates α, and

(iii) α c-commands β . (p. 250)

Government is thus a consequence of a particular syntactic configuration, and the governing time may have one of two categories: it may be a lexical head, as for example, the verb saw in (1a) or (5a), or it may be a coindexed phrase, like who_i in (5b).

(5) a. Who_i did Mary see t_i?

b. Who_i t_i saw Mary?

The trace in subject postion in (1b) is not governed by either a lexical head or a coindexed phrase; that does not fit either of those categories. According to this solution, there is no difference between subject and object as categories; all differences follow from the difference in syntactic structure which has the consequence that subject position but not object position may be ungoverned.[2]

1.0 THE EXPERIMENTAL EVIDENCE

The ECP as formulated by Chomsky (1981) can be used to generate predictions about behavior in processing WH-questions if the assumption is initially made that the ECP is part of the procedure which the processor employs as it is engaged in determining possible locations for a trace in processing a WH-clause. The ECP[3] provides a metric for eliminating potential but incorrecct parses. All positions that are properly governed and also meet all other conditions of well-formedness can be considered as potential gap locations by the processor at some point in its workings. Object position is always properly governed a subject may be properly governed by a coindexed phrase as in (5b) or it may be ungoverned. Thus, the ECP predicts a dichotomy between ungoverned subjects and governed subjects on the one hand and objects on the other hand. On the basis of the ECP, we would predict that if any evidence exists that people locate a gap in some governed positions, the

same type of evidence ought to exist for the location of a gap in all governed positions. However, the behavioral evidence does not bear out this prediction. People react differently to subjects and objects even when the subject position is potentially properly governed by a WH-phrase.

Crain and Fodor (1983) compared WH-questions to the corresponding declarative, as in (6).

(6) a. Who had the little child forced us to sing those French songs for last Christmas?
b. The little child had forced us to sing those stupid French songs for Cheryl last Christmas.

Crain and Fodor employed the self-paced reading task to determine where these two sentence types differ in complexity. In the self-paced reading task, subjects read sentences which appear word-by-word on a computer screen. The subject controls the pace at which words appear. The subject presses a button as soon as he or she has adequately comprehended the word which is currently appearing on the screen, and the next word appears. The computer records the time from the appearance of the word on the screen until the button is pressed. This reading time provides a measure of the complexity of understanding the word in the environment in which it occurs.

The most interesting point of comparison found by Crain and Fodor between the WH-question and the corresponding declarative sentence is that the object NP (us in (6)) is more difficult to understand in the WH-question than in the corresponding declarative.[4] The most obvious explanation for the complexity of comprehending an object NP in a WH-question is that, at some level of processing, people expect a gap to occur in the object postion in the WH-question, while they do not have this expectation in the declarative sentence.[5] Subjects appear to have partially analyzed the sentence as containing an empty NP. The occurrence of an overt NP serves as counterevidence to this analysis. When reanalysis occurs, reading times are longer than when no reanalysis is necessary, as in the declarative.

In a replication and extension of Crain and Fodor's experiment, I examined differences between embedded WH- and if-clauses, as illustrated in (7).[6]

(7) a. My brother wonders if Ruth will bring us home to Mom at Christmas.
b. My brother wonders who t will bring us home to Mom at Christmas.
c. My brother wonders who Ruth will bring t home to Mom at Christmas.
d. My brother wonders who Ruth will bring us home to t at Christmas.

Information was collected using the self-paced reading paradigm described above. Subjects read 4 practice sentences, 68 distractor sentences and 24 target sentences; each of the four structures (a-d) shown in (7) are present in 6 of the target sentences. In order to control for order, effects sentences following the practice

sentences were presented in individually randomized orders within four blocks of 23 sentences and the blocks were rotated in order between subjects.[7] Target sentences consisted of 24 sets of sentences like the set in (7):(a), a sentence containing an embedded if-clause; (b) a corresponding sentence containing a WH-clause with a subject gap; (c) a corresponding sentence containing a WH-clause with an object gap, and (d) a corresponding sentence containing a WH-clause with a prepositional object gap. These gaps were all doubtless gaps (Fodor, 1978) in that subjects are obligatory in English, prepositions obligatorily take objects and verbs were chosen which obligatorily take an object NP[8]. Thus, at the points where the subject, object and prepositional object NPs occur in the sentence, the parsing mechanism has enough information at its disposal to determine that an NP must occur.

The comparisons relevant to the subject/object parsing asymmetry are the comparison of the overt subject NPs in the (c) and (d) versions to the if-version (a), and the comparison of the overt object NP in (d) to the object NP in (a). This data is summarized in Table 1.

Table 1: Reading Times in msec. at Subject and Object NPs in IF- and WH-clauses.

	IF	WH
SUBJECT (=Ruth)	661	689
OBJECT (=us)	755	970

The experimental data were analyzed using a standard ANOVA within subjects designed employing planned comparisons (Hays 1981): 416). The 215 msec, difference between object NPs (us in (7)) in if - vs. WH-clauses is significant ($p < .01$). However, the 28 msec. difference between subject NPS (Ruth in (7)) in if- vs. WH-clause is not significant ($p = .239$). The subject and object postions differ significantly from each other ($p < .01$)[9]

1.1 EXPLAINING THE DATA

The difference that Crain and Fodor obtained at the object position was explained above as being the result of people expecting a gap at the object position. Processing takes longer when this expectation is in error and the mistake has to be rectified. This explanation allows us to make the prediction that if a gap were expected in the subject position a reanalysis effect should also appear at that position. Since no such effect appears at this position, the possibilities are (1) that people expect a gap, but some other processing procedure prevents the reanalysis effect from occurring at this position or (2) people do not expect a gap to occur at this position. Under either type of explanation, the parsing model must provide an explanation of the discrepancy between the two NP positions.

The experimental data do not support the predictions of the ECP. Both subject and object positions in the experimental sentences are governed positions. The parser's implementation of the ECP does not initially seem available to explain the parsing asymmetry. However, there are obvious similarities. The ECP states that some subjects may not contain gaps, while the experimental data suggests that people do not expect gaps to occur in subject position. Thus, it seems that there might be a common underlying ground between the two sets of data. I will consider two possibilities for explaining the asymmetry between the processing of subject and object NPs. The first explanation is in terms of a parsing procedure which is totally independent of the ECP. This type of processing explanation takes its motivation from the structure of the processing mechanism itself. If this explanation is adopted, then the grammatical rules do not have to predict the subject/object asymmetry. However, on this solution, parsing rules partially reproduce the effect of grammatical rules such as the ECP for completely independent reasons. That is, any explanation based on parsing procedures unrelated to the ECP predicts that ungoverned subjects are not considered as potential gap locations because of the processing procedure, not because of the ECP. The second type of explanation that I will discuss uses the ECP to explain the parser's behavior. Although the ECP does not predict the behavior demonstrated by the experimental data, the parsing effect would be very simply explained if the parser uses a version of the ECP which states that a trace may not appear in subject position (at some level of processing); if the processing mechanism directly employs such a constraint to narrow the searchspace for a gap, it would never attempt an analysis in which a gap appeared in the subject position. I will suggest that the parser may be viewed as implementing the ECP in a way that makes this prediction.

2. A PARSING EXPLANATION

The subject/object parsing asymmetry can be accounted for in parsing terms as follows. Let us assume that the human processing mechanism is similar to Marcus' (1980) PARSIFAL in form and function. PARSIFAL consists of rules which contain a pattern and an action. If the input string matches the pattern, the parser executes the action, which builds the structure that the rule defines. No action is performed until an entire pattern in matched and a clear choice can be made between alternatives. If two patterns are matched simultaneously, a choice is made based on which pattern has greater priority (which presumably means "greater frequency").

Certain VP nodes consist of a verb followed by an NP and a PP. The pattern which must be matched before this structure can be built is shown in (8a).[10]

(8) a. [=v] [=np] [=pp]
b. [=v] [=pp]

For the corresponding structure with a gap to be constructed, the

string must contain no NP. It seems reasonable to suggest that a pattern such as the one represented in (8b) is used for this purpose. The lack of an NP is represented literally. The corresponding action will construct an empty NP node between V and PP and bind it to the WH-filler. Because the structure cannot be built before the entire pattern is met, the parser does not set up a gap hypothesis until the PP is present.

On the other hand, most VPs consist of a verb followed by a NP. The pattern for this type of node is shown in (9a).

(9) a. [=v] [=np]
b. [=v] [≠np]

When this type of constituent contains a gap, the most information that the parser has is that the constituent that follows the verb may not be a NP, as indicated in (9b). This rule differs from the one discussed earlier in that it may be executed whenever anything that is not a NP follows the verb. Note that this necessarily includes the case when nothing follows the verb.

As mentioned above, no choice is made in the PARSIFAL system between two alternative rules until the entire pattern is matched. However, sometimes two choices differ in that one choice has an additional constituent. For, example, set may appear in either of the two VP types in (10).

(10) a. V NP PP (e.g., set the glass on the table)
b. V NP (e.g., set the table)

The parser cannot execute the action associated with the pattern corresponding to (10a) until the PP is present. Nor can (10b) be constructed until a decision is made between the two rules. Therefore, a default time must exist such that if no PP is heard (or read) by that point, (10a) is discarded as an alternative, and (10b) may be constructed. The same must necessarily hold true for patterns containing gaps. The patterns for the verb phrase types occurring in the experiment are shown in

(11) a. [=v] [≠np]
b. [=v] [=np] [=pp]
c. [=p] [=np]

The gap may follow the verb immediately, as in (11a) On the other hand, an overt NP may follow the verb, while the gap occurs within a further complement, as in (11b). After the occurrence of the verb, the parser is unable to pick between these two alternatives immediately. Once the default time is reached, the parser can choose the pattern in (11a) over the pattern in (11b). In a normal reading situation, the default time is unlikely to be reached before the presence of the lexical NP allows the choice of the correct alternatives (11b). However, the reading times on the experiment which I performed are extremely slow. They might well have exceeded the default time set by the parser. Thus the parser might select the object gap for almost all of the sentences which were tested, because no overt NP had yet occurred. The appearance of the overt NP after this choice would cause reanalysis.

However, it was pointed out in connection with the first VP

rule discussed above that some rules cannot be applied until some constituent following the gap is detected. There is a dichotomy in this system between rules that may be applied when no further input appears and rules which cannot be applied until further input appears. The rule for locating a gap in subject position is necessarily one of the latter.

(12) a. [=np] [=vp]
b. [=vp]

The pattern of the rule for constructing a gap in subject position is the pattern in (12b). It cannot be applied until the VP is being processed. Therefore, if the parser uses rules of this type, no choice can be made between the alternatives in (12a) and (12b) until either the lexical NP or the VP appears. Thus, the wrong structural analysis will not be made in subject position despite long reading times. Under this account, the difference between subject and object NPs is predictable.

2.1 DRAWBACK

The parsing procedure sketched above provides a possible parsing explanation of the asymmetry between subject and object positions in processing WH-clauses. It is based solely on parsing in the sense that the grammatical rules which described the overall structure of the sentence do not entail any difference in behavior, nor does the parsing procedure implement a grammatical distinction such as ECP, even in an abstract way. Behavior differs because of the way in which the grammatical rules are translated into a processing procedure. Another drawback is that two forms of behavior which appear to be fundamentally similar are given explanations of fundamentally different kinds. The parsing explanation only serves to explain the discrepancy in processing WH-questions. It cannot be extended in any natural way to explain why a trace may not appear in an ungoverned embedded subject positon, since the pattern in (13a) could quite naturally have the alternative in (13b), containing a subject gap, just as (12a) corresponds to (12b).

(13) a. [=that] [=np] [=vp]
b. [=that] [= vp]

The only prediction that can be made based on the parsing explanation is that people will not act as if they expect a gap in embedded subject position, for the same reason that they do not expect a gap in main clause subject position. They have not been able to postulate a gap yet, because they cannot make a decision between (13a) and (13b) until after the overt NP appears. This prediction has the consequences that if a difference is discovered between ungoverned subjects and governed objects, the difference cannot be attributed to the ECP. This drawback will occur with any parsing explanation of the subject/object asymmetry which does not derive from the ECP.

3. GRAMMATICAL EXPLANATIONS

One of the goals of parsing is to construct a representation of

the syntax of the input string (potentially analogous to S-structure) from which a semantic representation may be constructed. If the competence grammar is fairly directly implemented, the information that a WH-phrase is present in the string presumably licenses some analog of the construction of a COMP node and the construction of an NP node which contains a trace coindexed with the WH-trace at some point in the phrase structure. It might further be supposed that the ECP as currently formulated is encoded in or used by the parser in such a fashion that ungoverned NP positions are never postulated to contain traces. The subject positon immediately after the WH-constituent is not excluded by the ECP since the WH-constituent can govern a coindexed trace in that position, as in

(14) I wonder $[_{S'}\ [_{COMP}\ who_i\ ]\ t_i$ came]

On the other hand, the ECP as formulated in Chomsky (1981) would block the parser from allowing a trace to be located in embedded subject position as in (15).

(15) I wonder $[_{S'}\ [_{COMP}who_i\ ]$ she thought $[_{S'}\ [_{COMP}that]\ t_i$ came]]

The subject trace in the embedded clause is not governed by the coindexed trace in COMP since that trace does not c-command it.

Although the ECP predictions are not in fact borne out, there is an obvious similarity between the grammatical data and the behavioral data from the GAP experiment. The grammatical data shows that traces may not be located in certain subject positions; the behavioral data suggests that people do not expect gaps to occur in subject positions. Because of this similarity it is very desirable to explain the behavioral data and the grammatical facts through the same general principles of the human language faculty (HLF). As I pointed out earlier, the grammatical facts do relate quite obviously to the parsing asymmetry if the grammatical constraint is that a gap cannot occur in subject position, or if the grammatical constraint is implemented in the parser in a way that makes this prediction.

Besides the motivation provided by the similarity of the grammatical and parsing asymmetries, the assumption that the grammatical constraints are encoded in or used by the parser to avoid ungrammatical parses is not one that should be immediately abandoned because the predictions of a given formulation of the constraint are not met. Evidence that the existence of a grammatical constraint may allow the parser to avoid an initial wrong parse comes from another experiment that I performed, in which PP complements to the subject NP were compared with PPs occurring within the VP, as in (16).

(16). a. I wonder who_i the silly story about Greg annoyed t_i

b. I wonder who_i the team laughed about Greg with t_i.

Control sentences containing if-clauses were also tested. The results are summarized in Figure 2. As can be seen, the prepositional object in the island position (story about Greg) is

not measurely any harder to comprehend in the WH-clause than in the if-clause, unlike the prepositional object in the VP. This suggests that island constraints can be applied on-line to narrow the range of NP positions in which a trace may be located.[11]

Figure 2: Reading Times in msec. at Prepositional Objects in Islands and Non-Islands

	ISLAND	NON-ISLAND
IF	799	800
WH	782	1054

Thus there is some evidence that grammatical constraints affect the location of gaps on-line in pocessing WH-clauses. Therefore it is not unlikely that some version of the ECP can be used by the parser in a similar way.

Although the ECP as formulated by Chomsky (1981) does not make the correct predictions about where people expect to find a gap, there is nevertheless a possible explanation to be derived from it. In the definition of government on which the ECP rests, there are two clauses. The first is that a lexical head may be a governor. Secondly, a coindexed phrase may be a governor. The subject/object asymmetry in that-clauses results from the fact that neither type of governor is available for the subject. An asymmetry also exists in main clauses, even though both subject and object NPs may contain a trace, in that object NPs are licensed by lexical governors (verbs) while a trace in subject position is governed by a coindexed phrase. It would be sensible to claim that the location of a gap in the experimental data is licensed only by the presence of a lexical governor. Chomsky's (1981) formulation of the ECP makes the assumption that government is a unitary phenomenon, despite the existence of these two clauses. Perhaps this assumption is incorrect.

There are several differences to be found between these two classes of governor. Lexical government as a class is found much more widely through the grammar than government by coindexed phrases. Thus, lexical heads but not coindexed phrases assign O-roles to other phrases. Lexical heads but not coindexed phrases assign case to constitutents that they govern. Coindexed phrases appear only to play a role in proper government of empty categories.

3.1 LEXICAL GOVERNMENT SOLUTION

A first approximation of an explanation of these experimental data, then, might be to change the definition of government so coindexed phrases are not possible governors. Under this proposal, only lexical government licenses a gap. The consequences of accepting this proposal for English are minimal. Subject position is the only position in which a trace is normally licensed by a coindexed phrase. However, the behavioral evidence suggests that a

"real" gap is not expected in subject position. Rather than licensing a gap from COMP position, the WH-phrase may remain in situ, as in

(17) $[_S\ [_{NP}\text{Who}][_{VP}\text{came}]]$

Government by a coindexed phrase is unnecessary here, since there is no gap to be licensed. The subject position in an embedded clause with an overt complementizer is not governed by a lexical head, which predicts that trace in this position is ungrammatical, as it is. Another structure where it may be assumed that a coindexed phrase licenses the occurrence of a trace is illustrated

(18) I wonder $[_{S'}\ [_{COMP}\text{who}_i]$ she thought $[_{S'}\ [_{COMP}\ t_i]\ t_i$ came]]

The trace in the embedded clause following thought could license the gap in subject position. However, the trace in COMP must also be governed. Since it is contained in an S', it cannot be governed by any lexical item or coindexed phrase outside of the maximal projection S', by (4ii). Therefore the structure in (18) is ungrammatical since no governor is available. The only other possible structure is that in (19) where only an S node intervenes between the trace and the possible c-commanding governors.

(19) I wonder $[_{S'}\ [_{COMP}\ \text{who}_i]$ she thought $[_S t_i \text{came}]]$

In this configuration, the subject trace is governed by the lexical head thought and does not cause any problem for the claim that only lexical items are possible governors.

However, there is a construction which is problematic for this claim. Kayne (1979) argues that the ECP explains the asymmetry between (20a) and (20b).

(20) a. I wonder who t bought which book.
b. *I wonder which book who bought t.

As can be seen from (20a), it is perfectly permissible to have multiple questioned phrases. However, only one WH-phrase may apparently appear in COMP at S-structure. When S-structure is mapped to LF, Kayne suggests, the WH-phrase which is not in COMP at S-structure is moved there. The resulting structures are (21a), corresponding to (20a), and (21b), corresponding to (20b).

(21) a. I wonder $[_{S'}\ [_{COMP}\ \text{which book}_j\ \text{who}_i]\ t_i\ \text{bought}\ t_j]$
b. I wonder $[_{S'}\ [_{COMP}\ \text{who}_i\ \text{which book}_j]\ t_i\ \text{bought}\ t_j]$

$\underline{\text{Who}}_i$ c-commands $\underline{t}_i$ in (21a) but not in (21b), therefore it cannot properly govern $\underline{t}_i$ in (21b); $\underline{\text{which book}}_j$ does not c-command $\underline{t}_j$ in (21a), but $\underline{t}_j$ is properly governed by the lexical head bought, so that lack is irrelevant to the grammaticality of the sentence.

If Kayne's explanation of this subject/object asymmetry is correct, government by coindexed phrases is necessary. The assumption that subject traces do not need to be bound because the subject WH-phrase remains in situ cannot explain these examples, because even if the subject WH-phrase is assumed to remain in place as in (22) the sentence is still ungrammatical, although there is no ungoverned trace.[12]

(22) I wonder $[_{S'}\ [_{COMP}$ which book$_j]$ $[_S$ who bought $t_j]]$

3.2 AN EXPLANATION BY THE PARSER'S IMPLEMENTATION OF THE ECP

Although it seems that claiming that only lexical governors are proper governors (i.e. changing the formulation of the grammatical constraint to directly predict the behavioral data) can not be adequate to explain the grammatical facts, nevertheless the distinction between government by lexical items and coindexed phrases may still prove to be a useful one in explaining the parsing evidence. Lexical government is more pervasive in the grammar than government by coindexed phrases, as pointed out earlier, and has effects at all levels of syntax while government by coindexed phrases seems to have an effect only at LF. The ECP as formulated by Chomsky (1981), Kayne (1983) and others is argued to apply at the level of LF, since its effects are apparent in movements that take place at that level, as illustrated by (21). For the ECP to block (21b), it must apply after the subject WH-phrase has movd into COMP, therefore at the level of LF.

The relationship that holds between S-structure and LF consists of a mapping from S-structures onto LF structures by a set of rules which are not yet completely specified. Most of the differences that have been proposed between S-structure and LF seem to involve the position of a phrase of quantification and its relationship to a bound variable. Quantifiers raise in French and WH-phrases move into COMP in English. The differences between LF and S-structure thus usually seem to involve a difference in the position of a coindexed phrase between the two levels of structure, and the different positions may govern a different set of nodes at LF than in S-structure. On the other hand, the position of the lexical head vis-a-vis the positions that it governs does not apparently alter between the two levels of structure. In the case where the lexical head is moved at LF, the complements which it governs apparently move with it.

This distinction between types of governor in their mappings to LF may be a useful one in explaining why the experimental data suggest a sensitivity to lexical government rather than government by a coindexed phrase. The goal of processing is to create a complete, accurate interpretation of the sentence as quickly as possible. Thus each level of representation is constructed as soon as information is available to do so. The parser is able to construct S-structure as the sentence is heard. However, the level of LF structure is not necessarily constructible in synch with S-structure, since certain portions of LF are underdetermined until later portions of the sentence have been heard, as in the cases of quantifiers raising in French and WH-movement into COMP in English. Because the mapping between lexical head government in S-structure and LF is one to one, the processing mechanisms may apply lexical government immediately to the S-structure representation in order to determine if a trace is contained in a possible analysis of the

string. Since the criterion of lexical government can be applied immediately, it is desirable in view of the need for speed and accuracy in processing, that it should be applied immediately. Government by a coindexed phrase may not be applied until later in the parse.

The parser must posit the existence of empty categories in constructing S-structure. If we make the further assumption that the parser only posits traces,which are demmonstrably properly governed which is a reasonable assumption under the need for accuracy, the correct predictions are made. The parser does not initially posit that a trace exists in subject position because it is not necessarily a governed position. Thus the S-structure initially assigned to subject WH-questions and embedded clauses is that proposed in (17) under the hypothesis that only lexical government exists. The subject WH-phrase is located in subject position rather than COMP. The WH-phrase can be moved into COMP in the mapping to LF by the existing mechanism of movement into COMP. At object NP position, on the other hand, the existence of a lexical governor licenses the gap analysis at once, and realnalysis must occur when it is incorrect.[13]

This explanation, unlike the earlier parsing explanation, depends on an interaction between the grammatical principle of ECP and its realization in the processing mechanism. Although such an explanation does not depend on the direct implementation of the competence grammar in the processing mechanism, it strongly suggests a model of the HLF where the grammar and processing mechanism are closely aligned, and to that extent such an explanation, if it can be accepted, supports the psychological validity of the competence grammar.

4. SUMMARY

This paper has presented some behavioral evidence for an asymmetry in parsing between subject and object positons. I have shown that it is possible to account for this asymmetry on purely processing grounds; however, it was pointed out that such an explanation must duplicate some of the effects of a grammatical constraint, the ECP, without providing any way for the two phenomena to be related. On the other hand, the grammatical principle itself can explain the behavioral data if certain minimal assumptions are made about the way in which the grammatical principle is implemented in the parser. Because the language faculty is in some sense a set of processes that must be closely related in order to achieve the common goal of language use, such an account seems to be preferable to one in which two similar phenomena are explained by unrelated mechanisms.

FOOTNOTES

1 For a more thorough discussion of the possible relationships between the competence grammar and the processing and production mechanism in a model of the human language faculty, see Stowe (1983).

2 In some formulations, coindexed phrases are included in the definition of proper government rather than government, since they do not generally have any other function as governors.

3 While it is assumed in this paper, that the ECP stems from the competence grammar and is implemented in the processing mechanism, it should be kept in mind that there is also the possibility that the ECP derives from the structure of the processing or production mechanism and is included in the competence grammar as a consequence of its existence in another portion of the human language faculty (HLF), or that the grammar is not psychologically distinct from the processing and production mechanisms.

4 Crain and Fodor (1983) analyzed their data using the increase score method. The reading time for the word preceding the target position was substracted from the average of the reading time of the target word and the word following the target word. This method is intended to factor out general differences in complexity due to differences in sentence length and sentence structure.

5 It is not currently known whether a gap is automatically expected in object position as soon as the verb is encountered or if this expectation develops in a later stage of processing. Some discussion of this point is found in section 2. The point remains valid that at whatever stage of processing the expectation develops, it only develops for postverbal NPs, not for subject NPs.

6 Additional questions investigated were what happens after the location of a doubtless gap, as in (7b) and (7c). Results appear in Stowe (1983).

7 This technique prevents the possibility that sentences appearing in a fixed order before the target sentences systematically affects the subjects' perception of the sentences.

8 Some verbs were selected which are obligatorily intransitive (disagreed). These were followed by two prepositional phrases. The first prepositional object was classed with the verbal objects in the analysis. The presence of the intransitive verb ensures that the parser does not mistakenly assume that an object gap occurs, which might affect the processing of succeeding structure in respect to gap-location procedures.

9 The interpretation of these statistics is that a difference

of the magnitude that occurs at subject postion can be expected to happen about 24 times in a hundred when data is collected, even if there is no difference underlying the behavior. The difference at object position and the difference between subject and object position, on the other hand, would be expected less than one in a hundred, if there is no real difference in behavior. Thus, these data are unlikely to be due to chance. The fact that a difference exists does not, of course, explain what causes the differences.

10 The patterns used in the illustrations of how the PARSIFAL system works assume that the pattern is matched to an existing noun phrase. PARSIFAL includes a buffer of three units. These units are crucially not words. When a word enters the buffer that matches the initial portion of the pattern of rules such as NP and PP the rule may be applied without attaching the NP or PP to anything in the existing parse stack, and the completed constituent may be reinserted in the buffer. Thus an NP can exist in the buffer to be matched to a pattern.

11 This experiment does not indicate at which stage in processing the constraint is applied, although it indicates that it is possible to use the constraint within some hundred of milliseconds after the position is perceived.

12 It is possible that this solution could be salvaged by a different explanation of the Kayne counterexample: for instance independently motivated principles that prevent extraction of any WH-phrase in a multiple WH-question.

13 The parsing "procedure" sketched here should not be taken too literally. It has a number of possible implementations, depending on whether it is viewed as a procedure accessed from the competence grammar on integral to the parser. The point is that an abstract level, the procedure being applied _is_ one part of what we, as linguists, formalize as the ECP.

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