

NEUROPSYCHOLOGICAL REASONS FOR A
TRANSFORMATIONAL ANALYSIS OF
VERBAL PASSIVE*

Experimental findings from the neuropsychological study of language are used to evaluate grammatical theories. Data from tests of sentence comprehension by agrammatic aphasic patients reveal a pattern of selectivity that is used as a means for assessing competing syntactic hypotheses. In particular, it is argued that agrammatic linguistic behavior provides evidence for a transformational analysis of verbal passive. This is so because the patients failed to comprehend properly verbal passives and structures involving Wh-movement, but succeeded in tasks that required the proper comprehension of lexical passive. Grammatical theories in which such a performance pattern can be readily described – namely, theories that allow for generalizations such as Move-alpha – pass a test of psychological reality in that they are compatible with patterns of language breakdown observed following brain damage. By contrast, syntactic frameworks in which all passives are derived by lexical rules cannot account for this performance pattern without the introduction of ad hoc devices. Neurolinguistic findings are thereby shown to restrict the class of biologically feasible grammars.

1. INTRODUCTION

In this paper we demonstrate how experimental findings from the neuropsychological study of language may be used to evaluate grammatical theories. We present data from tests of sentence comprehension by agrammatic aphasics, patients whose brain damage results in a structurally selective impairment in linguistic ability. We use the observed pattern of selectivity as a means for assessing competing syntactic hypotheses. In particular, we argue here that aspects of agrammatic linguistic behavior provide evidence for a transformational analysis of verbal passive. Neurolinguistic findings are thereby shown to restrict the class of biologically feasible grammars.

We argue that the comprehension abilities of agrammatic patients point to a distinction between verbal and lexical passive, and indicate that the

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former is derived by a movement rule. This is so because patients fail to comprehend properly verbal passives and structures involving Wh-movement, but succeed in performing tasks that require the proper comprehension of the lexical passive. This pattern (which we describe precisely below) suggests that these two types of structures tap different aspects of linguistic capacity. On this basis, we argue that grammatical theories in which such a performance pattern can be readily described – namely, theories that allow for generalizations such as Move- α – pass a test of psychological reality in that they are compatible with patterns of language breakdown observed following brain damage. Having this property, they are to be contrasted with syntactic frameworks in which all passives are derived by lexical rules, rendering the patients' performance pattern impossible to describe without the introduction of ad hoc devices.

2. THE GRAMMAR OF PASSIVE

It is generally held in Government-Binding accounts that there are two types of passive formation in English, one lexical and the other transformational. We now examine the syntax of adjectival and verbal passives, drawing on work by Siegel (1973), Wasow (1977), Levin and Rappaport (1986) and many others. Both types of passive are analyzed as undergoing a preliminary lexical process, the attachment of the passive suffix to the verb. This morphological change causes the category shift $[+V, -N] \rightarrow [+V]$, affecting the inherent Case-assigning the thematic properties of the verb. In the case of the verbal passive, the suppression of both the external theta role and accusative Case results in NP-movement of the thematic object to subject position (see Chomsky, 1981; Jaeggli, 1986). An example is given in (1):

- (1)a. D-structure: e was kicked the ball
 b. S-structure: [The ball]_i was kicked t_i

Because the NP in (1a) fails to be assigned Case in its D-structure position, it moves to subject position, leaving behind a coindexed trace, as shown in (1b).

Adjectival passive formation, on the other hand, involves a further category shift in the lexicon, $[+V] \rightarrow [+V, +N]$, whereby the participle is marked as an adjective and the complement position is eliminated. In adjectival passive formation, the internal theta role is externalized. Many passive sentences are ambiguous between verbal and adjectival readings in the absence of a *by*-phrase:

- (2)a. The store was closed.
- b. Jack was impressed.
- c. The door was locked.
- d. The cat was groomed.

Others have an underlying adjectival bias. Examples include are some of the so-called *PSYCH-VERBS*, which occur in participial form more frequently than in active form and are somewhat awkward with *by*-phrases:

- (3)a. John was interested in/?* by Mary.
- b. Jack was concerned about/?* by Ellen.
- c. Sue was pleased with/? by the performance.

Adjectival passives containing participles which undergo additional morpheme affixation are also non-transformational. Certain prefixes, most commonly negative *un-*, attach to adjectives (e.g. *unskilled*, *unhappy*, *unworthy*, *unimpressed*), but not to verbs (e.g., **unconvince*, **uneat*, **unkill*, **unimpress*).¹ While these unpassive participles occur freely with *by*-phrases (4a–b), they lack active counterparts (4c), which further indicates a lexical source:

- (4)a. The athlete was unequalled by his competitors.
- b. Ellen was unimpressed by Jack.
- c. *Jack unimpressed Ellen.

In sum, the central properties of the verbal passive are taken to be those in (5a), while the defining properties of adjectival passive, as motivated by their syntactic behavior, are taken to be those in (5b):

- (5)a. [NP, S] does not receive a theta role
 [NP, VP] does not receive Case within VP
- b. Internal theta role is externalized
 [NP, VP] position is eliminated

For our purposes here, the crucial observation concerning adjectival passives is that they are not derived by movement. This entails that no traces or argument chains arise in the formation of the adjectival passive construction, as opposed to the S-structure representation of the verbal passive depicted in (1b). As we will see in the next section, certain movement derived constructions, including the verbal passive, fail to be correctly interpreted by agrammatic aphasics. The characterization of the adjectival/verbal passive distinction given here leads to the prediction

¹ Negative *un-* is not to be confused with the reversative prefix *un-*, which attaches to verbs, as in *unbotton*, but not to adjectives.

that adjectival passives will not cause difficulty for the relevant patient population. We turn now to a description of the agrammatic syndrome.

3. AGRAMMATISM

Acquired aphasia is a condition that invariably results from physical damage to one or more of the language areas in the brain. Damage might be due to stroke, hemorrhage, tumor, protrusion wound and the like. The classical syndromes are Broca's aphasias, Wernicke's aphasia, conduction aphasia and global aphasia. The standard clinical literature classifies Broca's aphasia as a disturbance in speech production. Agrammatics are a subclass of Broca's aphasics (patients whose physical injury is in Broca's area or its vicinity) (Mohr, 1976).

The functional deficit in agrammatism is commonly characterized as a lack of facility with certain linguistic forms. Generally speaking, agrammatics produce telegraphic speech – short utterances in which grammatical formatives are either missing or erroneously chosen. The traditional view has held that their comprehension abilities are intact. In the past decade or so, this generalization was found to be incorrect (e.g., Caramazza and Zurif, 1976; Schwartz, Saffran and Marin, 1980). More recent studies have demonstrated that agrammatics constitute a mixed group with respect to comprehension. While the majority appear to have comprehension problems in the syntactic domain, there is a minority whose comprehension appears intact (Miceli, Mazzucchi, Menn and Goodglass, 1983; Kolk and van Grunsven, 1985).

We focus our attention here on the class of agrammatic patients that has a clear, identifiable comprehension deficit, the formal characterization of which is along syntactic lines. This subclass of agrammatics can comprehend certain syntactic constructions perfectly, and other grammatical constructions imperfectly. If the aberrant behavioral pattern observed in the relevant patient population reflected sentential complexity as computed by, say, sentence length or number of embedded clauses, then it would bear little relevance to theories of syntactic structure. But, in fact, the errors committed by these patients pattern in a syntactically principled fashion, strongly suggesting a disruption in syntactic-representational abilities. If syntactic theory is taken to characterize the basis for linguistic knowledge in the brain, then an apt description of syntactic deficits may have significant implications for the internal structure of this theory.

As we will show, two structural types that are consistently misanalyzed by the relevant patient population are verbal passives and relative clauses. The correct generalization concerning these structural types is that they

are all movement-derived constructions, i.e. sentences whose S-structure representations contain a trace. This, however, concerns just the description of the aphasic impairment. Since we are more concerned here with theoretical issues than with aphasia itself, and given that there is some variation within the group of agrammatics, our subject group is composed of those patients whose comprehension deficit is syntactically defined along these lines. There are, in fact, a significant number of aphasics that fall into this group. Further details of our selection procedure are given below, in the section on experimental method.

4. PRIOR EXPERIMENTATION

Experimental studies that test agrammatic comprehension usually ask the patient to choose, from a set of pictures, the one picture that depicts the meaning of a sentence he or she is presented with. Test sentences typically contain transitive verbs and are semantically reversible.² Presentation may be either oral or visual. The patient's task is to match the sentence to the correct picture from a set of pictures including a syntactic foil (i.e., a picture in which thematic roles are reversed) and a lexical foil (i.e., where the characters in the picture do not match the lexical items in the sentence).

In order to perform well on such a task, the patient must be able to assign thematic roles correctly in a majority of test sentences. As it turns out, the results of these experiments with agrammatic aphasics depend overwhelmingly on the structural type of the sentences being presented. Previous research reveals that agrammatics have relatively intact comprehension of the actives (Caplan and Futter, 1986; Grodzinsky, Finkelstein, Nicol and Zurif, 1988), subject-gap relatives (Grodzinsky, 1989) and subject cleft constructions (Caplan and Futter, 1986; Grodzinsky, 1989). That is, the sentence types exemplified in (6) typically elicit good or above-chance comprehension performance:

- (6)a. The girl pushed the boy.
- b. The girl who pushed the boy was tall.
- c. It was the girl who pushed the boy.
- d. Show me the girl who pushed the boy.

At the same time, agrammatics have been found to have relatively poor comprehension of passives (Goodglass, 1968; Schwartz, Saffran and Marin, 1980), object-gap relatives (Caramazza and Zurif, 1976; Grodzin-

² That is, the correct interpretation cannot be directly inferred from lexical content.

sky, 1989) and object cleft constructions (Caplan and Futter, 1986; Grodzinsky, 1989). That is, those sentences shown in (7) typically elicit poor or guessing performance:

- (7)a. The girl was pushed by the boy.
- b. The girl who the boy pushed was Chinese.
- c. It was the girl who the boy pushed.
- d. Show me the girl who the boy pushed.

In order to account for the performance contrast between (6) and (7), Grodzinsky (1986) argues that, for agrammatics, mechanisms responsible for associating positions vacated by movement with their respective antecedents or operators are dysfunctional. In representational terms, this amounts to the claim that either empty categories or chains relating them to their antecedents are absent. Note that the sentences in (7), but not those in (6), contain traces in object position according to a transformational analysis. Sentence (7a) contains a trace of NP-movement, while (7b–d) contain traces of Wh-movement. Sentences (6a–d) may or may not contain traces in subject position, depending upon the existence of string-vacuous Wh-movement.

According to the Trace-deletion hypothesis, as put forth in Grodzinsky (1986), agrammatics fail to represent the chain formed in the derivation of the verbal passive and the relative, or equivalently, fail to represent the relationship between a trace (whether NP- or Wh-) and its antecedent. As a result, normal theta role assignment to the subject of the passivized verb and the head of the relative (indirectly, via an operator in COMP) is blocked. The thematic representation thus contains a thematically unlabelled NP. As compensation, the agrammatic avails himself or herself of a linear cognitive strategy for thematic interpretation – one which associates clause-initial positions with agenthood, along the lines proposed in Bever (1970). The agrammatic's chance-level performance on passives and object-gap constructions, then, reflects a conflict between use of unimpaired syntactic principles, which make the object of the preposition *by* available as agent, and use of the default strategy for theta-marking clause-initial NPs.

This conflict forces the patient to guess between two possible thematic interpretations. Two NPs are identified as agent in (7a) – *the boy*, as object of *by*, receives a theta role via normal grammatical processes, and *the girl*, as the clause-initial NP, receives a theta role by default. In subject gaps (6b–d), no such conflict arises. If the linear default strategy is indeed activated, it results in the correct assignment of thematic roles. That is, the clause-initial NP is also identified as agent in these cases.

Finally, guessing performance on the rest of the structural types exhibited in (7b–d) is predicted. In (7b), for example, two NPs are agents with respect to the relative clause: *the boy* is assigned the agent theta role as the subject of the relative clause. Contrary to normal theta role assignment, however, *the girl* is also an agent according to the trace deletion analysis. The trace in object position is missing, and as a consequence, transmission via coindexing of the object theta role to the operator in COMP fails. Since this NP lacks a theta role, the default strategy is activated. The outcome, once again, is two agents, one assigned grammatically, and the other assigned by compensatory means.³

The situation is quite different for the sentences in (6). Attributing traces to the S-structure representations of (6b–d) is not essential for their correct interpretation. Even if there are traces there, and these are deleted, the missing theta role in these cases is agent because these traces are in subject position. Therefore, the strategy compensates correctly, replacing agent for agent.⁴ The S-structure traces in (7), however, are necessary for proper thematic interpretation. Our account thus exploits the subject/object asymmetry.

In sum, we hypothesize that agrammatic S-structure representations differ from those of normals in that the relationship between traces and their antecedents is rendered inaccessible. Without this record of derivational history, assignment of thematic roles is impaired.

5. EXPERIMENTAL METHOD AND PROCEDURE

5.1. *Subjects*

The selection of subjects for this study has been done carefully. Only patients with a syntactically principled deficit were admitted. In order to satisfy the precondition for inclusion in the experiment, patients had to have a testing history of performing well (i.e., above chance) on tasks involving the interpretation of active sentences and performing poorly (i.e., at chance) on verbal passives.

Eight Broca's aphasics were screened for this study. The patients were established as Broca's aphasics on the basis of clinical profiles from the Aphasia Research Center at the Boston Veterans Administration Medical

³ See Grodzinsky (1990) for an extension of both the data base and the analysis. There, non-agentive as well as subject experiencer verbs are tested, and the analysis is refined along lines that are irrelevant here.

⁴ It is for this reason that we can remain agnostic with respect to the debate on string-vacuous movement.

Center. These profiles included a medical examination and history, CT scan, aphasia assessment on the Boston Diagnostic Aphasia Examination (Goodglass and Kaplan, 1983), and the Aphasia Severity Rating Scale, and further neuropsychological evaluation. The eight Broca's aphasics were pre-tested in a sentence/picture matching task to determine comprehension of agentive active and passive sentences. Four of the eight showed the relevant agrammatic comprehension in the pre-test. That is, they performed above chance on the actives (85–100% correct) and at chance on the passives (35–75% correct). Only these four participated in the actual study. Clinical details concerning each of the four subjects can be found in appendix A.

5.2. *The Design of the Test Sentences*

Six sentence types were used in the experiment, two in the active and four in the passive. Of the latter, two types were adjectival and two verbal. In (8) are examples of each type:

- (8)a. agentive active: The man is pushing the boy.
- b. reversative *un-* active: The woman unties the man.
- c. agentive passive: The boy is pushed by the man.
- d. reversative *un-* passive: The man is untied by the woman.
- e. unpassive: The policeman was unnoticed by the criminal.
- f. adjectival passive: The soldier was enraged at the boy.

Twenty sentences of each type were used in the test, for a total of 120 test items. A full listing of sentences is given in appendix B.

Note that the agentive actives, such as that in (8a), all occur in copula + present participle form, rendering them as structurally similar to the passives as possible. In effect, the active and verbal passive conditions serve as control conditions in this experiment, as the construction types of interest are the adjectival passive and the unpassive. Similarly, the reversative *un-* active and passive items serve as controls for the unpassive condition. Regarding condition (8f), it should be noted that the adjectival passives were presented without *by*-phrases in order to preserve an adjectival reading, since *by*-phrases tend to force a verbal interpretation on these constructions. The prepositions *about*, *in*, *with* and *at* were used in this condition instead.

In order to guarantee that the test sentences were of acceptable, relatively natural quality, four normal neurologically intact control subjects were tested on the materials. They were roughly matched to the actual subjects for age, education and socio-economic background. With the

exception of the unpassive, which elicited 91% correct average performance, the control subjects tested almost without error. This assured us that our test items were interpretable, including those describing mental states like 'annoyed', 'worried' and 'interested'. In short, it seems safe to assume that the performance levels elicited in the experiment do not reflect difficulties inherent to the test materials.

5.3. *The Task*

The method of choice for our purposes was a combination of the sentence/picture matching task and the anagram task, two paradigms commonly used in neuropsychological research. In this hybrid task, the subject is shown a simple line drawing and is then handed three cards, each with a sentence fragment printed on it in capital letters. Two of the cards we used contained a noun phrase, and the third card contained the rest of the sentence. The fragments for the sentence in (8c), for example, were *the man*, *the boy*, and *is pushed by*.

Each drawing depicted a scene corresponding to the target sentence. The subject was instructed to order the sentence fragment cards to form a sentence that described the depicted scene. Since there were three cards, there were six possible orderings. While two of them were syntactically and semantically well-formed, only one of the orderings was appropriate in each case.

5.4. *General Procedures*

The subjects were tested individually in a single, one-hour session. Subjects were informed that they would be shown a series of pictures and would be asked to construct a sentence describing each picture out of sentence parts. After a picture was presented, the relevant cards were placed in front of the patient in a pre-established random order. Subjects were given as much time as they needed to re-order the cards as instructed. Prior to presentation of the test items, there was a short practice session consisting of five simple active sentences. This ensured that subjects understood the task.

5.5. *Predictions*

In section 1 above, it was argued that the S-structure of the adjectival passive does not contain a trace, unlike its movement-derived verbal counterpart. Section 2 attributed the failure of the relevant patient popula-

Table I: Predictions regarding the patients' performance levels for each experimental condition

	CONDITION	PREDICTION
a.	agentive active	above-chance
b.	reversative <i>un-</i> active	above-chance
c.	adjectival passive	above-chance
d.	unpassive	above-chance
e.	agentive passive	chance
f.	reversative <i>un-</i> passive	chance

tion to comprehend the verbal passive to their inability to represent the trace or chain of NP movement. It is therefore predicted that adjectival passives will be consistently and correctly interpreted by agrammatic subjects, despite their superficial similarity to verbal passives. Moreover, ungrammatical orderings, such as NP-NP-VP-*by*, should not occur, since the patients should be aware of the overall grammatical structure of the sentence. The predictions are summarized in Table I:

6. RESULTS AND DISCUSSION

Even though the test paradigm permits ungrammatical ordering of sentence fragments, the subjects consistently ordered the cards to produce well-formed sentences. The errors were all theta role reversals. The results for each subject, given in number of errors and percent correct performance under each condition, are shown in Table II.

The agrammatic subjects performed well above chance on the active conditions (an average of 96% correct in the agentive active condition and 89% correct in the reversative *un-* active condition), while performing at chance in the two verbal passive conditions (an average of 50% correct on the agentive passives and 51% correct on the unreversative passives). These test conditions, recall, were the basis for the screening.

Turning to the actual test, the performance level elicited in the adjectival passive condition confirmed our prediction. It grouped with the active and

Table II: The number of incorrect responses (and corresponding correct) for each subject

CONDITIONS	s1 (M)	s2 (S)	s3 (D)	s4 (B)	TOTAL
agentive active	0 (100%)	3 (85%)	0 (100%)	0 (100%)	3 (96%)
agentive passive	12 (40%)	13 (35%)	5 (75%)	10 (50%)	40 (50%)
reversative <i>un-</i> active	2 (90%)	4 (80%)	2 (90%)	1 (95%)	9 (89%)
reversative <i>un-</i> passive	12 (40%)	13 (35%)	8 (60%)	6 (70%)	39 (51%)
adjectival pasive	3 (85%)	10 (50%)	2 (90%)	2 (90%)	17 (79%)
unpassive	9 (70%)	9 (55%)	9 (55%)	8 (60%)	32 (60%)

Table III: Relationship of results in each condition to chance

	CONDITION	PREDICTION	STATISTIC	MATCH
a.	agentive active	above-chance	[t(3) = 12.33, p < 0.001]	+
b.	reversative <i>un-</i> active	above-chance	[t(3) = 12.31, p < 0.001]	+
c.	adjectival passive	above-chance	[t(3) = 2.98, p < 0.03]	+
d.	unpassive	above-chance	[t(3) = 2.83, p < 0.07]	-
e.	agentive passive	chance	[t(3) = 0, ns]	+
f.	reversative <i>un-</i> passive	chance	[t(3) = 0.151, ns]	+

not the verbal passive conditions. Subjects interpreted an average of 79% of all adjectival passives correctly, with a range of 50% to 90% correct performance. The outcome of the unpassive condition was less clear. Patients performed only slightly above chance, at 60% correct on average. For the results in each condition, the statistical relation to chance level performance is shown in Table III. This was done using repeated measures T-tests, comparing each score to 50%.⁵

To determine the extent of individual variation in our results, additional tests were run. Of the 24 cells in Table II (six conditions times four subjects), only three cells were significantly different from the group score. Since these three outcomes were produced by different subjects, and in different conditions, individual deviations will be ignored here.

Finally, in order to determine whether or not the difference in outcomes between conditions was statistically reliable, further comparisons were carried out. While the active and verbal passive conditions were found to differ reliably from each other ($p < 0.005$), the adjectival passive was found not to differ significantly from the active conditions. This result conforms to our predictions. Contrary to our predictions, however, the unpassive was found to differ significantly from the actives ($p < 0.002$). Accordingly, the unpassive results do not differ significantly from those of the verbal passive conditions.

In sum, the prediction of good comprehension of the adjectival passive by agrammatics was largely confirmed. Results in the adjectival passive condition group with results in the active conditions. Contrary to the stated predictions, though, the unpassive condition yielded performance levels only marginally different from chance ($p < 0.07$). It should be noted that this was the only condition in which our normal controls had difficulty (average 91% correct). If this inherent difficulty is subtracted, in order to

⁵ One-tailed tests were used in the case of above chance predicted scores. Two-tailed tests were used in the case of chance-level predicted scores.

get a hold of the patient's real deficit, the scores may reach significance.⁶ The results of the unpassive condition nonetheless deserve careful examination. We now consider several possible interpretations of the results as they stand.

7. THE UNPASSIVE

Potential accounts of the patients' unexpected performance on the unpassive condition should now be considered. First, one might be tempted to argue that agrammatics are 'insensitive' to grammatical morphemes like *un-*, given their insensitivity to closed class elements generally. If so, we might expect the patient to fail to interpret all of the closed class items in a given test sentence. For example, the subject would interpret (9a) as (9b), ignoring *un-*, the copular auxiliary *was* and the preposition *by* (and perhaps determiners, too):

- (9)a. The man was unconvinced by the woman.
- b. The man convinced the woman.

Yet we have observed no mismatches between pictures and sentences in the unpassive condition. The same holds for both the unreversative conditions, where performance conformed to our predictions. Furthermore, there is independent experimental evidence that agrammatics are sensitive to most prepositions, including *by* (Grodzinsky, 1988). Given their good performance in the adjectival passive condition, it is also impossible to argue that agrammatics have a general difficulty with the morphology of the passive. This route, it is worth noting, would eliminate the possibility of a unified account of previous findings concerning object-gap relatives and clefts, and the fact that agrammatics have difficulty with Wh-constructions as well as with syntactic passive.

Another possible explanation for poor performance on the unpassive involves the *by*-phrase. Recall that the adjectival passive condition, which produced good performance, excludes *by*-phrases. It was argued above that the agrammatics' disturbance does not affect the syntactic process which makes the object of *by* available as agent. In other words, the agrammatic is sensitive to *by* as a signal of passive voice. Thus, despite the fact that a trace is not involved, chance-level performance here is

⁶ Given that performance on passives was poorer than predicted, it appears that use of the reversative *un-* as a control was insufficient. As suggested by Beth Levin (p.c.), adjectives such as *unhappy* may have served this purpose better.

explained in the usual way. Two agents are made available, the clause-initial NP (due to the initial NP as agent strategy) and the object of *by*.

From a theoretical perspective, one can imagine analyses of the unpassive which differ from the one stated earlier in this paper. Assuming that the experimental results reflect an underlying difficulty with the unpassive, and not problems with the task itself, these results may be used to argue that unpassives are derived syntactically (i.e., in favor of an analysis in which the affixation of *un-* is in the syntax). This would mean that the S-structure representation of a sentence with an unpassive contains a trace and, as such, falls under the trace-deletion hypothesis stated earlier. The patients' poor performance would then follow accordingly from the deletion of the trace in the representation of the unpassive. Such an account proceeds as follows. We first assume that the two prefixes *un-* (the reversative as in *untie* and the negative as in *uninhabited*) are in fact one prefix, differing only in the level of affixation. Secondly, while the reversative affix is lexical, the other is a syntactic affix in the sense of Fabb (1984), adjoined to the VP with scope over the whole of the participial phrase. Unpassives will thus become syntactic passives. Finally, the fact that unpassives seem to pattern with adjectives in certain environments (e.g., they are able to function as complements of raising verbs) will be attributed to properties of the affix itself. This analysis is supported by additional facts. It also accounts for the fact that unpassives do not have deverbal nouns (e.g., **unimpression*). If affixation took place in the lexicon, nothing would block such a derivation. Similar considerations hold for derived nominals (e.g. **John's unconvincing by the argument*).

Finally, recall from earlier discussion that passives with *by*-phrases may only be analyzable as having a syntactic derivation, since the *by*-phrase forces a transitive reading of the participle. Thus, all passives with a *by*-phrase may well contain a trace in canonical direct object position. Under this assumption and the assumption of syntactic affixation, an unpassive like (9a) should be analyzed as having the S-structure in (10):

- (10) [The man]_i was [_{VP} un- [_{VP} convinced t_i by the woman]].

According to this analysis, the unpassive with a *by*-phrase is a case of an adjectival passive that is in fact syntactically derived.

In sum, we have suggested that guessing performance by agrammatics in the unpassive condition is attributable to syntactic derivation. Due to attachment of the relevant morphemes in syntax, unpassives with *by*-phrases may contain traces at S-structure. As a result of their grammatical deficit, agrammatics delete these traces and, in the manner described, end up with an interpretation involving two NP agents between which they

can only guess. At the very least, the results of this condition suggest that a re-evaluation of the syntax of the unpassive is in order.

8. BREAKDOWN COMPATIBILITY

The experimental study presented above forms part of a research program in which the characterization of the agrammatic deficit is taken to impose nontrivial constraints on, and may thus be used to evaluate, theories of language structure. The patterns of language breakdown observed in aphasia should be naturally statable in the theory, in readily available terms. Linguistic theory from this perspective is not only about the speaker's knowledge of his or her language. It is also held accountable for patterns of selective impairment, just as it is held accountable for patterns in the acquisition of grammar. If a theory of syntax is able to state generalizations over patterns of loss and sparing in selective language impairment, then it meets the requirement of breakdown compatibility.

There are two possible causes for the observed functional deficit in agrammatism. The deficit may reflect either a loss in grammatical knowledge per se or a disruption in the processing component that puts grammatical knowledge to use. Suppose the impairment is in the grammatical knowledge base. Then it is relevant to the theory of syntax: a theory of human grammatical knowledge must be compatible with the observed deficit, as this deficit reflects the internal organization of grammatical knowledge. On the other hand, the loss could be the result of a processing disruption (e.g., Shankweiler *et al.*, 1989). In this case, too, the observed breakdown pattern is relevant to the internal structure of the grammar, given the reasonable assumption that the relationship between the grammar and the algorithms putting it to use is other than arbitrary.

We thus have a general method for the evaluation of linguistic theories against data from aphasia. We first must determine whether a pattern of loss is structural. If it is, a descriptive generalization over the pattern of loss may be stated and its consequences examined. Finally, we must check whether the description we arrive at is readily statable in the syntactic theory under evaluation. Data from aphasia, then, may well be instrumental in restricting the class of biologically feasible theories of grammar.⁷

We have just demonstrated that a prediction emerging from a specific

⁷ In fact, we can use such data to evaluate theoretical proposals within a grammatical framework. For example, Grodzinsky, Wexler, Chien and Marakovitz (1989) propose a neuropsychological test to distinguish among different versions of Binding Theory within the Government-Binding framework.

syntactic hypothesis is borne out in neuropsychological research. The distinction between adjectival and verbal passives described in Government-Binding theory is reflected in the performance of agrammatic patients on tests of sentence comprehension. Our conclusion is that Government-Binding theory thereby meets the requirement of breakdown compatibility in two ways: (1) By upholding a distinction between adjectival and verbal passive; (2) By generalizing over verbal passives and object relatives in terms of the relationship between the empty category and its antecedent. Given the experimental results, we can now consider how other accounts of adjectival and verbal passives fail under the breakdown compatibility constraint. We turn briefly to two other models.

8.1. *An LFG Analysis*

LEXICAL FUNCTIONAL GRAMMAR (LFG) maintains that all passives are lexical. In order to account for the differences between adjectival and verbal passives, it assumes two sorts of lexical derivation for passives. Verbal passives are derived by a rule of grammatical function changing, in conjunction with a morphological change in the form of the verb. An example from Bresnan (1982) is given in (11):

- (11)a. Active: Mary kissed John
 | |
 SUBJ OBJ
 Functional change: SUBJ \rightarrow \emptyset /(BY OBJ)
 OBJ \rightarrow SUBJ
 Morphological change: V \rightarrow V_{Part}
- b. Passive: John was kissed (by Mary)
 | |
 SUBJ OBJ

Adjectival passives, as in (12), involve a further morphological change in addition to a condition on output:

- (12)a. The boy was kissed.
 Morphological change: V_{Part} \rightarrow [V_{part}]_A
 Operation on lexical form:
 P(...(SUBJ)...) \rightarrow STATE-OF-
 P(...(SUBJ)...)
 Condition: SUBJ = Theme of P
- b. The kissed boy

Thus, LFG accords adjectival and verbal passives a similar nontransformational analysis. Note further that in LFG, the operations involved in the derivation of passives, whether adjectival or verbal, are distinct from those applied in the derivation of questions, relative clauses, clefts and other long-distance dependencies.

8.2. GPSG Analysis

As in Lexical Functional Grammar, the passive in GENERALIZED PHRASE STRUCTURE GRAMMAR (GPSG) is not derived via syntactic transformation. Rather, the relationship between active and passive constructions is captured by a metarule. The general format for GPSG METARULES (statements which relate various rules of the grammar) is given in (13a). The passive metarule is stated in (13b) (Gazdar *et al.*, 1985):

- (13)a. $a_0 \rightarrow a_1, \dots, a_n \Rightarrow$
 $b_0 \rightarrow b_1, \dots, b_n$
- b. $VP \rightarrow W, NP \Rightarrow$
 $VP[PAS] \rightarrow W, (PP[by])$

The rule in (13b) is to be interpreted in the following way: for every rule in the grammar in which a VP immediately dominates an NP and some other material *W*, there is also a rule in the grammar which permits the passive category VP[PAS] to dominate just the other material from the original rule, optionally including a PP containing a *by*-phrase.

In general, metarules “serve solely to express generalizations about the subcategorization possibilities of lexical head” (Gazdar *et al.*, 1985, p. 59). In other words, metarules are constrained to map from one lexical rule to another. Crucially, this entails that adjectival and verbal passive are both lexically derived in this model, via the same metarule.⁸ On the other hand, unbounded dependencies are described in terms of traces. The relationship between the antecedent and the empty category in relative clauses is not expressed in terms of a metarule. According to Gazdar *et al.* (1985, p. 139), while a Slash Termination Metarule is involved in restricting the percolation of slash features, a metarule account of how slash category information is passed through a tree is “now excluded in principle” by GPSG, given the restriction of metarule application to lexical

⁸ In fact, at no place in Gazdar *et al.* (1985) is there a distinction between the two types of passive.

ID rules. Given this internal structure of the theory, a generalization of the type motivated by our findings is not possible in GPSG.

Breakdown compatibility thus proves to be a nontrivial requirement on theories of grammar. LFG and GPSG are seemingly prevented from stating a generalization that unites verbal passives and object relatives. These constructions do not form a natural class within frameworks that do not attribute a movement-based derivation to both. Instead, LFG and GPSG impose a generalization over adjectival and verbal passive, namely lexical derivation. Example (14) summarizes how the structural types we have studied in this experiment and previously pattern within the three grammatical frameworks:

(14)		GB	LFG and GPSG
	a. adjectival passive	lexical	lexical
	b. verbal passive	syntactic	lexical
	c. object relative	syntactic	syntactic

In conclusion, we have given evidence for differential agrammatic comprehension of adjectival and verbal passives. These findings support theories of grammar which can accommodate two generalizations, one drawn over structures generated directly by lexical mechanisms and the other drawn over structures involving movement. If this argument proves to be along the right lines, then neurolinguistic findings may be profitably examined by theoretical linguists, since they provide a powerful argument for the neurological feasibility of implicated syntactic devices. In particular, the evidence we have adduced strongly supports the existence of a generalization like Move-alpha.

APPENDIX A

This appendix provides some clinical and neurological details on the patients we tested and admitted to the final data analysis of the experiment.

#	AGE	DATE OF ONSET	LESION SITE	CLINICAL SIGNS	SPEECH
1.	71	1976	decreased density in the posterior portion of the L frontal lobe and L temporal lobe	R hemiparesis	non-fluent dysarthric dysprosodic agrammatic

2.	61	1979	fronto-parietal-temporal region of R Broca's & Wernicke's area	L hemiplegia	agrammatic dysprosodic dysarthric
3.	57	1985	Large lesion in L Broca's area	R hemiparesis	telegraphic agrammatic single words
4.	71	1976	two L frontal lesions in Broca's area, and L temporal lobe (1/2 Wernicke's area)	mild R weakness	non-fluent telegraphic

APPENDIX B: TEST SENTENCES ACCORDING TO CONDITION

Agentive Active

1. The cowboy is killing the Indian.
2. The Indian is killing the cowboy.
3. The boy is pushing the man.
4. The man is pushing the boy.
5. The boy is hitting the soldier.
6. The soldier is hitting the boy.
7. The nurse is photographing the girl.
8. The girl is photographing the nurse.
9. The boy is grabbing the teacher.
10. The teacher is grabbing the boy.
11. The crow is catching the cat.
12. The cat is catching the crow.
13. The man is pulling the kid.
14. The kid is pulling the man.
15. The woman is stabbing the man.
16. The man is stabbing the woman.
17. The man is serving the woman.
18. The woman is serving the man.
19. The boy is dragging the girl.
20. The girl is dragging the boy.

Reversative un- Active

1. The mother unzips the daughter.
2. The daughter unzips the mother.
3. The girl un.masks the mother.
4. The mother un.masks the girl.
5. The men unbalanced the boys.
6. The boys unbalanced the men.
7. The priest uncovers the nun.
8. The nun uncovers the priest.
9. The boy unnerved the mother.
10. The mother unnerved the boy.
11. The nurse undresses the girl.
12. The girl undresses the nurse.
13. The mother unbuttoned the child.
14. The child unbuttoned the mother.
15. The guards unarmed the boys.
16. The boys unarmed the guards.
17. The woman unties the man.
18. The man unties the woman.
19. The man unchains the woman.
20. The woman unchains the man.

Agentive Passive

1. The cat is caught by the crow.
2. The crow is caught by the cat.
3. The boy is dragged by the girl.
4. The girl is dragged by the boy.
5. The kid is pulled by the man.
6. The man is pulled by the kid.
7. The man is served by the woman.
8. The woman is served by the man.
9. The man is pushed by the boy.
10. The boy is pushed by the man.

11. The soldier is hit by the boy.
12. The boy is hit by the soldier.
13. The man is stabbed by the woman.
14. The woman is stabbed by the man.
15. The boy is grabbed by the teacher.
16. The teacher is grabbed by the boy.
17. The nurse is photographed by the girl.
18. The girl is photographed by the nurse.
19. The Indian is killed by the cowboy.
20. The cowboy is killed by the Indian.

Reversative un- Passive

1. The woman is untied by the man.
2. The man is untied by the woman.
3. The girl is unmasked by the mother.
4. The mother is unmasked by the girl.
5. The girl is undressed by the nurse.
6. The nurse is undressed by the girl.
7. The man is unchained by the woman.
8. The woman is unchained by the man.
9. The child is unbuttoned by the mother.
10. The mother is unbuttoned by the child.
11. The daughter is unzipped by the mother.
12. The mother is unzipped by the daughter.
13. The boys were unbalanced by the men.
14. The men were unbalanced by the boys.
15. The boys are unarmed by the guards.
16. The guards are unarmed by the boys.
17. The nun is uncovered by the priest.
18. The priest is uncovered by the nun.
19. The mother is unnerved by the boy.
20. The boy is unnerved by the mother.

Unpassive

1. The man was unchallenged by the woman.
2. The woman was unchallenged by the man.
3. The man was unseduced by the woman.
4. The woman was unseduced by the man.
5. The cook was unconvinced by the policeman.
6. The policeman was unconvinced by the cook.
7. The mother was unappreciated by the son.
8. The son was unappreciated by the mother.
9. The policeman was unnoticed by the criminal.
10. The criminal was unnoticed by the policeman.
11. The woman was unimpressed by the man.
12. The man was unimpressed by the woman.
13. The queen was unmoved by the king.
14. The king was unmoved by the queen.
15. The woman was uninspired by the man.
16. The man was uninspired by the man.
17. The man is untouched by the priest.
18. The priest is untouched by the man.
19. The father is unexcited by the son.
20. The son is unexcited by the father.

Adjectival Passive

1. The mother is worried about the daughter.
2. The daughter is worried about the mother.
3. The father was disappointed with the son.
4. The son was disappointed with the father.
5. The woman is obsessed with the man.
6. The man is obsessed with the woman.
7. The doctor was interested in the soldier.
8. The soldier was interested in the doctor.
9. The doctor was annoyed with the patient.
10. The patient was annoyed with the doctor.

11. The boy is bored with the father.
12. The father is bored with the boy.
13. The boy is disgusted with the man.
14. The man is disgusted with the boy.
15. The girl is pleased with the mother.
16. The mother is pleased with the girl.
17. The woman was concerned with the girl.
18. The girl was concerned with the woman.
19. The soldier was enraged at the boy.
20. The boy was enraged at the soldier.

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