

## Trace Deletion, $\Theta$ -Roles, and Cognitive Strategies

YOSEF GRODZINSKY

*Tel Aviv University, Israel, and Aphasia Research Center, Department of Neurology,  
Boston University School of Medicine*

This paper reports a rather striking distinction found in the performance of agrammatic patients: Their comprehension deficit distinguishes not only different syntactic constructions, but also verbs with different thematic structure. Thus, the coupling of a variety of sentence types with different verb types yields surprising performance patterns, demonstrating once again that the deficit these patients suffer from is highly selective from a grammatical viewpoint. This pattern of selectivity has important implications for linguistic theory, for it describes an error pattern that can be accounted for only by a theory that assumes a (normal) lexicon that encodes thematic labels and refers to a thematic hierarchy. In addition, the results argue for the necessity of a cognitive strategy (first NP = Agent) as part of the structural account of agrammatic comprehension (the Trace-Deletion Hypothesis). It is shown that, contrary to some recent claims, an account lacking such a strategy cannot derive agrammatic performance patterns properly. New data are presented, from an experiment that used an anagram task to test agrammatic comprehension of active and passive sentences containing verbs of three different thematic types. Verbs varied in that their external argument was Agent, Instrument, or Experiencer. The finding was that on all active sentences, performance was above chance, whereas on the passives, performance split: on verbs with Agent or Instrument external arguments, performance was at chance, corroborating previous findings. On Experiencer verbs, though, performance was below chance. These data argue decisively for the TDH as originally presented, namely, for an account that assumes trace deletion, coupled with a strategy. The implications of these results to the theory of brain/language relations are discussed, in the context of the theory of lexical representation. © 1995 Academic Press, Inc.

In this paper I provide data in support of the Trace-Deletion Hypothesis (TDH) for agrammatic comprehension (Grodzinsky, 1984, 1986, 1990).

The preparation of this paper was supported by NIDCD grant DC-00081 to the Aphasia Research Center, Boston University School of Medicine. Address correspondence and reprint requests to Yosef Grodzinsky, Department of Psychology, Tel Aviv University, Tel Aviv 69978, Israel. E-mail: yosef1@freud.tau.ac.il.

These data evidence a strikingly selective impairment in this syndrome, and moreover, demonstrate that agrammatics make use of a cognitive strategy (first NP = Agent) in an attempt to compensate their deficiency and fill in  $\Theta$ -roles that are missing due to the deletion of traces. This claim, made explicitly in virtually every version of the TDH, has recently come under attack. Two recent papers (Hickok, Zurif, & Canseco-Gonzales, 1993; Mauner, Fromkin, & Cornell, 1993) argue that it is redundant. They both maintain that if recent developments in linguistic theory are assumed, and in particular, the VP-internal subject hypothesis (e.g., Fukui & Speas, 1986; Kitagawa, 1986; Kuroda, 1986; Koopman & Sportiche, 1988, among many others), the TDH as is derives the comprehension patterns observed in agrammatism. The debate is interesting because it focuses on certain important issues concerning the grammatical description of language deficits, as well as on the theoretical consequences of such accounts. Thus, although cognitive strategies utilized by language-impaired individuals are not usually a central object of inquiry, it will be shown that in the present context, introducing them into the descriptive tool kit not only helps deriving the observed behavioral patterns more precisely but also sheds light on a pattern of selective impairment that would not be noticed otherwise, a pattern that has important theoretical implications.

Below, then, is an experiment that demonstrates the pattern of selectivity from a novel angle, as well as the necessity of the strategy. An analysis of those results shows that there are contrasts in agrammatic performance that cannot be explained just by a structural account, since the difference between types of stimuli that generates different performance levels is not only structural but also thematic. These findings have important theoretical implications for the theory of lexical representation in that they demonstrate that  $\Theta$ -roles must be encoded in the lexicon. An adequate deficit account must thus rely on an interaction between structural and thematic considerations. The experimental finding, in addition, documents a performance pattern that proposals such as Hickok et al. (1993) and Mauner et al. (1993) cannot explain, in principle, namely systematic reversals of  $\Theta$ -roles. The TDH indeed needs to be reformulated, given some recent data from agrammatism (especially from verb movement, see, for instance, Lonzi & Luzzatti, 1993) and other problems created by developments in linguistic theory, yet its two defining features—deletion of traces (though perhaps not all), and the compensatory strategy—are here to stay. A reformulation, which amounts to a restrictive theory of trace deletion, is proposed in Grodzinsky (1995). Thus, while there may be some additional data that bear on the TDH, they will be ignored below, and the focus will be on issues that contrast this hypothesis with alternative accounts.

## 1. THE TDH

The TDH was proposed in order to account for the syntactically selective comprehension impairment in agrammatism. On the basis of a limited data set that was available at the time (from object-gap relative clauses, actives, and passives), it was observed that the deficit is partial from a syntactic point of view, such that only constructions containing moved constituents generate comprehension errors from agrammatic aphasics. This observation made it clear that a syntactic account was in order, which was done by a modification of normal representations. The account consisted of two parts: First, it was claimed that in agrammatic representations, traces of movement are deleted from S-structure, and that as a consequence,  $\Theta$ -role transmission to moved constituents, normally done through the trace, cannot take place. A moved NP thus lacks a  $\Theta$ -role. Second, a nonlinguistic, general cognitive strategy (reminiscent of Bever's (1970) influential proposal, or of Pinker's (1984) learning procedure for children) assigns such NPs a default role, by their linear position in the sentence, which, in the instances that were considered, was always Agent. The trace deletion half of the account distinguished the impaired from the preserved structures, because those preserved (namely actives) contained no traces. Yet, mere partitioning of constructions was insufficient, because it lacked explanatory force: While it pointed to the structures that would give the patients trouble, their actual performance rates did not follow from just trace deletion. Auxiliary assumptions were necessary in order to derive chance performance on passive, object-gap relatives, and clefts. Thus, it was proposed that since the moved constituents lack a  $\Theta$ -role, a general nonlinguistic strategy assigns them the role of Agent, and that as a consequence, the thematic representation the patient has in such cases contains two Agents (one assigned grammatically, the other strategically), and the observed chance performance is derived deductively. For example, in the passive construction, which generates chance performance by agrammatics, the external argument of the verb (namely, the subject of the active) is assigned the Agent role. This means that in passive the oblique object (the NP argument of the *by* phrase) gets this role. Crucially, no syntactic movement is involved here, hence no chain mediates the assignment of this role. The subject of the passive, by contrast, being derived by movement, is linked to a trace in object position, and this link is the channel for  $\Theta$ -role transmission. In agrammatism this cannot take place, and hence the subject of a passive sentence receives no  $\Theta$ -role grammatically. It is at this point where the strategy kicks in, assigning Agent to the NP, with the result of a thematic representation with two Agents. The patient is incapable of determining the Agent of the action uniquely, he is forced to guess, performing a chance.

The unimpaired constructions contain no traces, and therefore create no comprehension problem, precisely as the data indicate.<sup>1</sup>

In sum, the derivation of the agrammatic performance rates on all constructions is done by assuming trace deletion and a strategy. The performance pattern that has been found for these patients is thus deduced from the account through either thematic *competition* or *compensation*: The strategy always assigns an Agent label to clause-initial NPs. Thus, if a moved constituent is linked to a different  $\Theta$ -role normally (as is the case in passive, object-gap relatives, object clefts and the like), this constituent now becomes Agent, and since there is another, grammatically assigned Agent in the thematic representation, the two Agents compete, thereby inducing chance performance by agrammatics. In cases where the moved NP was supposed to be Agent (such as subject-gap relative, subject clefts), this role is not assigned normally through the trace due to trace deletion, yet the strategy correctly compensates by assigning that NP the Agent role by default.

## 2. RECENT DEVELOPMENTS

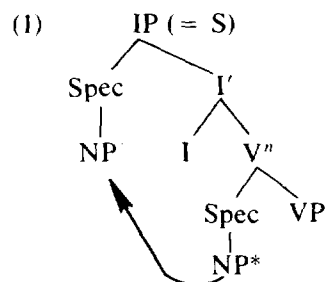
Since the TDH was proposed, there have been several important developments, in both linguistic theory and neuropsychology. First, in linguistics, a recent influential position has maintained that in fact, all subjects (including those of matrix clauses) are derived, which means that virtually every sentence in the language contains empty categories. Moreover, the most recent developments (Chomsky, 1992) maintain that virtually every NP moves (from its original position to Spec of AGR), leaving a trace behind. While it is not always clear what consequences trace deletion would have in this novel framework, it is clear that the TDH will need to be reexamined, perhaps reformulated. Second, a fairly broad range of data have been obtained from agrammatics, on a variety of syntactic constructions, which might also lead one to reconsider the validity of the TDH. Third, several alternative proposals (which are, by and large, reformulations of the TDH) have been proposed. I will now review the main points of each, and then present an experiment that provides decisive evidence for the original formulation of the TDH. Remaining problems, that indeed force a restrictive formulation of the syntactic account of agrammatism, are handled separately (see Grodzinsky, 1995).

### 2.1 VP-Internal Subjects

In the past few years, an influential position in linguistics has maintained that subjects are base generated inside the VP (Spec of some verbal

<sup>1</sup> See Zurif, Swinney, Prather, Solomon, and Bushell (1993) for a processing perspective: These authors provide evidence from an on-line study of agrammatic comprehension that shows their inability to link traces to their antecedents.

projection- $V^n$  in (1)) and get to Spec of IP (the surface subject position) by a movement operation, replacing  $NP^*$  (the deep subject) with  $NP^{\wedge}$  (the surface subject):



This proposal has become known as the VP-internal subject hypothesis (VPI henceforth), since according to it, the subject is base-generated in a position internal to VP (see Kuroda, 1986, Kitagawa, 1986, Fukui & Speas, 1986, Koopman & Sportiche, 1988, Sportiche, 1988; Burton & Grimshaw, 1992, and many others). The essence of the hypothesis, then, is that the (surface) position of subjects is always derived, even in matrix clauses. If so, then the surface position of the subject ( $NP^{\wedge}$ ) is linked (co-indexed) with the deep position ( $NP^*$ ) which is now empty, and contains a trace, as in (2):

(2)  $NP_i I t_i VP$ .

(2) would be the (annotated surface) representation of an active sentence, which would mean, in the present context, that even structures on which agrammatics have tested successfully contain traces (including not only actives but also subject gap relatives and clefts, on which agrammatics perform well above chance, too). Recasting the TDH in terms of the VPI is thus expected to have substantive empirical consequences.

## 2.2 The TDH and the VPI

Hickok, Zurif, and Canseco-Gonzales (1993), as well as Mauner, Fromkin, and Cornell (1993), have explored the consequences of the interaction of the TDH and the VPI to agrammatism. Both groups have attempted to take advantage of the fact that under the VPI, syntactic representations are richer in empty categories than under previous syntactic hypotheses, and hence, the TDH predicts more traces to be deleted, which, according to both groups of authors, makes it possible to dispense with the nonlinguistic strategy the TDH assumes.

Hickok et al. examine the consequences of the translation of the TDH into the VPI framework on an extended database from agrammatic com-

prehension. They argue for a version of the TDH without a strategy and claim that all the previous data can still be derived. Constructions containing only traces of subjects, namely active and subject-gap sentences, should give no trouble to the patients: In such cases only one  $\Theta$ -role is missing due to trace-deletion (namely the subject which is moved). The other NP—the object, is not moved, hence there is no trace associated with it, and no problem regarding thematic linking should arise.<sup>2</sup> So, given the thematic identity of one NP (the object), and the lexical representation of the predicate at issue which contains the  $\Theta$ -grid of that word (namely, the lexical encoding of the argument structure of that category, see Stowell, 1981, and below), the patients can recover sufficient structural and lexical information to link the thematically unidentified NP (the subject) with the missing  $\Theta$ -role. Hickok et al. also claim that for the rest of the structures, most notably object-gap relatives and passives, the information available to the patient is insufficient for an appropriate determination of the thematic identities of NPs. This is so because in these structures there are at least two chains (one of the moved subject, by the VPI, another between the gap and the moved object). This is a situation where no inference can be made so as to link the roles to the NPs, and hence, chance performance is predicted, precisely as observed. They also present some additional data, from aphasic failure to link the appropriate NP to a predicate adjective, which is compatible, in their opinion, with the TDH only when taken to be under the VPI.

In a similar vein, Mauner, Fromkin, and Cornell (1993) attempt to derive the comprehension results, as well as results on grammaticality judgments, from an account based on trace deletion and the VPI. Their account focuses on referential dependencies, which for all practical purposes can be viewed as trace-antecedent relations in the present context. They too criticize the original formulations of the TDH and argue that under the VPI, the processing of referential dependencies is limited to one chain in agrammatism, and in situations where there is more than one the system breaks down, and the patient offers a guess. With respect to the data discussed in this paper, at least, this claim is extensionally equivalent to that of Hickok et al., whose account has the consequences that structures containing two chains make the patients guess.<sup>3</sup>

<sup>2</sup> This approach ignores more recent developments, namely those of the minimalist program (Chomsky, 1992), in which NPs move to Spec of AGR in order to be identified. The representation of this framework contains AGR nodes for both subject and object, and these NPs move accordingly. The consequences of this approach will be ignored below, although they are currently being explored. See Grodzinsky (1995) and Gavarro (1993).

<sup>3</sup> Both groups of authors attempt to account for additional data, doing so in varying degree of success. Most of these data, however, are to a large extent peripheral to the main issues addressed by all the hypotheses discussed here, because they do not bear directly on structural issues. Thus, for instance, the fact that agrammatics can handle a predication

Yet consider the performance of agrammatics on passive, and the predictions these two accounts make regarding this structure. Despite claims to the contrary, they cannot account for the agrammatic failure on passive, although chance performance in the comprehension of this construction is one of the most central facts about agrammatism. Consider the representation of a passive sentence, when the VPI is assumed (and irrelevant notation is suppressed):

- (3) a.  $NP_i I t'_i V-en t_i$  by NP.  
 b. The lion<sub>i</sub> was t'<sub>i</sub> chased t<sub>i</sub> by the tiger.

In this representation (where *en* stands for the passive morpheme), there is only one chain (*the lion*, t', t). The subject has been moved twice: once from object position into Spec of VP, creating t, and the other from that position into the sentence initial one, creating t'.<sup>4</sup> This means that there is one NP (*the tiger*) for which a  $\Theta$ -role can be linked by the patient. According to the hypothesis (where no strategy is assumed), the patients would be able to infer the role of the subject, because they know: (a) The lexical entry of *chase* <Agent, Theme>, and (b) That the NP *the tiger* is Agent, and hence they can infer that *the lion* = Theme. This situation is not different from that of an active sentence analyzed according to the VPI:

- (4) a.  $NP_i I t_i V NP$ .  
 b. The lion<sub>i</sub> is t<sub>i</sub> chasing the tiger.

Here, too, there is one chain (*the lion*, t), and, as Hickok et al. correctly point out, the  $\Theta$ -role of the moved NP can be inferred, as indicated above. What, then, distinguishes passive from active for agrammatics, on this view? Here, Hickok et al. and Mauner et al. take off in different directions. Hickok et al. argue that the object of the *by* phrase in the passive lacks a  $\Theta$ -role, and that the thematic representation of a passive sentence contains only one such role, which cannot be linked appropriately in agrammatism, due to trace deletion. Thus, no NP in passive has a  $\Theta$ -role, and the chance performance is derived. As evidence for the lack of  $\Theta$ -role inside the *by* phrase they cite Grimshaw (1990), who claims that the

---

relation between a predicate and a subject of a simple matrix clause, but have difficulties computing such relations when a center embedding interferes (cf. Hickok et al., 1993), seems to have little to do with structure, but rather, with some general processing difficulty these patients may be suffering from. Similarly, most of the judgment data presented by Mauner et al. do not bear directly on structural issues. Thus, while the fact that a hypothesis can account for more data is always desirable, one must distinguish between core and peripheral data. In the present case the distinction is rather clear, it seems.

<sup>4</sup> See Burton and Grimshaw (1992) for arguments that the passive construction contains a VP internal subject position.

external  $\Theta$ -role is suppressed in passive. This assumption is necessary for her to explain, among other things, the optionality of *by*-phrases in passive (see Grimshaw, 1990, Chap. 4). Whatever the value of this account, it cannot have the consequence that oblique objects of *by* phrases (in normal grammar) are not assigned a  $\Theta$ -role somehow, because without such assignment no interpretation would be possible. There are two separate issues to be considered: The fate of the external  $\Theta$ -role of the passivized predicate and the  $\Theta$ -role of the oblique object. There seems to be agreement among linguists that the passivized predicate loses its  $\Theta$ -role (perhaps through "absorption" into the passive morpheme *en*, see, for instance, Jaeggli, 1986), yet everyone agrees that the oblique object also has a  $\Theta$ -role, and the question is how, and by what element, this role is assigned (see Pesetsky, 1994, for some interesting proposals). As for Grimshaw, although she does not specify how a  $\Theta$ -role is assigned to the object of the *by* phrase, making her account is incomplete, it is important to emphasize that nowhere in her book does she claim that there is no  $\Theta$ -role in the oblique object. She could say (although she does not) that *by* in passive has a "preposition-like nature," as Alec Marantz has proposed (and as Jaeggli, 1986, has implicitly argued,<sup>5</sup> assigning always the role of Agent or Instrument, by default, as it were, just because these roles are "inherently" associated with the lexical value of *by*. In the absence of other information, this role and no other would be assigned, the story would go. Yet such an account runs into empirical difficulties, because it breaks the connection between the  $\Theta$ -grid of the predicate and the *by*-phrase. As we can see in (5), however, that role is determined by the thematic properties of the predicate in question:

(5) a. Arkadi was shot by Gennadi.

Theme	Agent

b. Arkadi was feared by Gennadi.

Theme	Experiencer

The determination of the particular thematic labels can be done through a variety of tests. It is easy to show, for instance, that Experiencer verbs

<sup>5</sup> Jaeggli claimed that in passive nominals the *by* phrase receives a default role of Agent, as in (i): (i) The destruction of the city by the Romans. His problem was to account for such assignment on the assumption that normally, the passive morpheme absorbs the external thematic role, and transmits it to the *by* phrase somehow. The question here is how this happens in the absence of passive morphology in nominals, and he thus assumes such a default mechanism. His claim is imprecise, though, because nominals admit instruments as well, as can be seen in (ii): (ii) The destruction of the city by lightning: See Fox (1993) for discussion.



(such as (5b)) impose severe thematic restrictions on the *by* phrases in passive. Unlike their counterparts in sentences with agentive predicates, they can never be Agents (cf. (6a–b)). Also, it is easy to show that the thematic identity of *by*-phrases is determined compositionally by the predicate and the (logical) object, at least in agentive verbs (see Marantz, 1984):

- (6) a. Arkadi was killed by Gennadi on purpose.  
 b. \*Arkadi was feared by Gennadi on purpose.
- (7) a. The ball was thrown by Natasha.  
 b. A party was thrown by Natasha.

In (6), adverbs denoting purpose or intention indicate agenthood (see, for instance, Jackendoff, 1972), and as seen in (6), they cannot modify an Experiencer predicate, in neither active or passive, indicating that the thematic roles in both are the same. This means that the *by* phrase in the passive of such verbs is thematically restricted to an Experiencer  $\Theta$ -role. (7) shows that the role of the oblique object is determined compositionally, because whatever Natasha did in (7a), it was quite different from (7b), a difference that has to be encoded somehow. These facts, in sum, are mere examples to two general points: (1) that the object of *by* in passive has a  $\Theta$ -role, and (2) that this role is determined by the thematic properties of the predicate in question, and not by the preposition *by*.

If this is so, then Hickok et al.'s account cannot work for passive, because whatever the mechanism is for transmitting the role from the predicate to the *by* phrase (see Jaeggli, 1986, Baker Johnson and Roberts, 1989, Pesetsky, 1994, for some proposals), there is such a role in the oblique object, and whatever it is, no trace is involved in its assignment, and hence, by the TDH, nothing is deleted. The result is a representation with a linked  $\Theta$ -role (the one is assigned to the oblique object) and a free one (the one assigned to the trace and transmitted to the subject normally, yet deleted in agrammatic representation) and hence by Hickok et al.'s account, the missing role can be inferred from the lexical representation of the verb in question, just like in active. The strategy proposed in the original formulation of the TDH was designed precisely to prevent this situation, and distinguish between actives and passives, among other structures. Yet Hickok et al. seek to avoid the strategy, and as a result their account, once construed against an appropriate analysis of passive, predicts success on passive by agrammatics, giving the wrong result for one of the defining features of agrammatic comprehension, which casts serious doubts on the validity of the account.

Another piece of relevant evidence comes from the performance of agrammatic aphasics on structures that contain passive morphology, but

no syntactic movement of the object into subject position, namely, adjectival passives in (8a). Despite the lack of movement, the indirect object is assigned a  $\Theta$ -role by the predicate, and given that the VPI applies here, too, we get a rough analysis in (8b):

- (8) a. The man<sub>i</sub> is t<sub>i</sub> interested in the woman.  
 b. NP<sub>i</sub> I t<sub>i</sub> Part P NP.

Here Hickok et al. have the correct prediction (as does the TDH): Agrammatic aphasics perform well above chance (Grodzinsky, Pierce, & Marakovitz, 1991). Here, too, there is  $\Theta$ -role assignment to the oblique object which is done by linking to a role on the  $\Theta$ -grid of the predicate. Yet it is not clear at all what for Hickok et al. distinguishes this structure from passive. In both cases there is one chain, just like the case of actives discussed above. The TDH readily accounts for such findings, whereas Hickok et al.'s hypothesis does not distinguish the cases correctly.<sup>6</sup>

An interesting solution to the problem of agrammatic passive has been proposed by Mauner et al., who seem to realize that objects of *by* phrases do have a  $\Theta$ -role. Following Baker, Johnson & Roberts (1989) they claim that the *by* phrase is assigned a role by the passive morphology that had "absorbed" it through passivization, and that this assignment puts the oblique object in a relation to the passive morphology that is identical to a dependency between a trace and its antecedent. In other words, the representation in (9) (Mauner et al.'s 30)) contains two "thematic R-dependencies," which by their "two chain hypothesis" gives rise to the agrammatic comprehension difficulty:

- (9) a. [a boy]<sub>i</sub> is being chased + en<sub>j</sub> t<sub>i</sub> by [a girl]<sub>j</sub>.

In (9) there are two "referential dependencies": one between the moved MP and the trace t<sub>i</sub> and another between the passive morpheme *en* and the oblique object (as indicated through the index *j*). Mauner et al. argue that in this representation there are two chains: (1) (*a boy*, t) and (2) (*en*, *a girl*), and given a disruption to any referential dependency, the chance performance of agrammatics is explained. This account, were it to be correct syntactically, would indeed derive the data, because it would have the consequence that no  $\Theta$ -role is linked in the representation. Yet a look at the linguistic facts indicates quite clearly that this is an untenable position: For it would mean that chains 1 and 2 fall under some syntactically significant generalization. This is clearly not the case, as Baker, Johnson, and Roberts (1989) themselves realize. It is for this reason that these authors distinguish this relation from that holding be-

<sup>6</sup> Grodzinsky et al. (1991) do not assume the VPI, thus the above chance performance of the agrammatics follows directly. When the VPI is assumed, however, the subject of the lexical passive sentence becomes derived, and the strategy is applied. See Section 5.2.

tween a trace and its antecedent and call the relation between the passive morpheme and the oblique object "clitic doubling," which amounts to the claim (that BJR do not substantiate, though) that other clitic doubling constructions (such as those observed widely in Romance, for instance in (10a), or in Hebrew in (10b)) fall under the same generalization, which is, crucially, distinct from the relation between traces and their antecedents.

- (10) a. Juan  $la_i$  ha regalado la peseta a Maria $_i$   
           Juan CI has given the money to Maria.  
       b. dirato $_i$  shel ha-more $_i$ .  
           flat-his of the teacher.

In sum, neither BJR nor Mauner, Cornell, and Fromkin have a good solution to the mystery of  $\Theta$ -role assignment in *by* phrases (see Pesetsky, 1994, for some proposals). As a result, Mauner et al.'s account cannot derive a disruption to  $\Theta$ -role assignment to the *by* phrase and runs into the same descriptive difficulties Hickok et al. encounter.

All of these arguments seriously undermine the proposals just discussed.<sup>7</sup> Yet direct empirical evidence is always more convincing, and it is for this reason that the experiment reported in Grodzinsky et al. (1988), which was never published in full, is presented below.

We thus turn to some clear predictions each account makes, in order to find cases that distinguish the TDH in its original formulation from the accounts just reviewed. There are several such differences. The two accounts just reviewed are purely structural, and hence predict that the only relevant factor for a deficit analysis of agrammatic comprehension performance is structure. Other properties of sentences are irrelevant. In particular, variation in the thematic properties of predicates should not influence performance, if syntactic structure is held constant. This contrasts quite sharply with the TDH, as originally formulated. Given that the TDH assumes the strategy, and given that the strategy is said to assign a  $\Theta$ -role just by linear position, there must be some cases in which the thematic properties of predicates would be in conflict with the  $\Theta$ -role assigned by the strategy. The interaction between the strategy and the grid must have some concrete empirical consequences. The experiment

<sup>7</sup> I have ignored other criticisms of these two proposals, because they do not bear directly on the empirical question this paper considers. Yet such criticisms can be made, for instance, that both papers must assume a strategy in order to account for data from relative clauses. Their strategy is different from that of the TDH, though, but it is still a strategy, because the patients must select an NP that is predicated over by nonstructural considerations. This means that the supposed advantage of these two accounts—the absence of such a strategy—is not even there, and given that empirical problem just observed, the advantage of the TDH is apparent.

below explores these, focusing on the relevant cases. Crucially, these cases can serve as an empirical test to decide between the TDH and the Hickok/Mauner purely structural proposals. Indeed, the results reported below provide decisive evidence that indicates that the TDH should remain as is, and that the nonlinguistic strategy it assumes is indeed mandatory.

### 3. A CRITICAL TEST

The TDH was based on findings from sentences containing agentive verbs only—that is, verbs whose  $\Theta$ -grid contains an Agent label in the external argument position. But there are other verb types (compare *give*, *receive*, *fear*, *frighten*, *sleep*, *enter*, *seem*, and so on) associated with other  $\Theta$ -grids. Given the bipartite nature of the hypothesis (i.e., trace deletion and strategy), and especially, the fact that the strategy refers to  $\Theta$ -roles explicitly, the thematic identity of the arguments of the verb is highly relevant, because the strategy is supposed to replace one of them in constructions containing traces (namely, the one not transmitted to the moved constituent due to trace deletion), and then stand in competition with the other. It was clear at the outset that such considerations would have to be taken into account, yet for lack of empirical evidence at the time, the strategy assumed to be invoked by default was quite generic in nature—it was said to assign an Agent role under any conditions, always resulting in chance performance for the cases tested. But this is not the only type of aberrant performance possible. One could also imagine performance to be below chance—systematic reversal of  $\Theta$ -roles. So far such a result has not been encountered, yet it is certainly a logical possibility, and below we will see one instance of this result and discuss it in detail. For now, let us focus our attention on the interaction between the strategy and the thematic properties of predicates in terms of thematic labels on the  $\Theta$ -grid, and we will discover immediately that new empirical questions emerge. It is for this reason that we set ourselves to test agrammatic comprehension of sentences with and without movement, which contain nonagentive predicates. Specifically, we sought to test the interaction between the strategy and  $\Theta$ -grids that do not contain Agent, and we did that through a comparison of active and passive sentences featuring several verb types. The new sentences (all semantically reversible) came in two varieties: sentences containing predicates that allow agentive as well as nonagentive readings, where the latter is obtained when the argument in question is barred from being Agent, since it is inanimate in (11), and sentences with predicates that take animate arguments, yet the role associated with them is that of Experiencer (psychological predicates) in (12). We also used sentences of the standard, agentive type, for control in (13):

- (11) a. The car blocks the truck (\*intentionally/on purpose).  
 b. The truck is blocked by the car.  
 c. The fat man blocks the entrance (on purpose).
- (12) a. The woman desires the man (\*intentionally/deliberately).  
 b. The man is desired by the woman.
- (13) a. The woman holds the man (intentionally/deliberately).  
 b. The man is held by the woman.

We should now examine the interaction of both the TDH, and its competitors, with these tests.

### 3.1 The Test for the TDH

3.1.1. *The TDH and nonagentive passive predicates.* Consider the similarities and difference between the sentences in (11)–(13): Structurally all the *a* sentences and all the *b* sentences are identical. What distinguishes these sentences is the thematic label on the external argument. In a predicate like *block* in (11), the external  $\Theta$ -role may be agentive (cf. (11c)), yet the presence of an inanimate external argument prevents it from assigning this role. In (12) it is Experiencer, due to the nature of the verb's  $\Theta$ -grid: It is animate, but it cannot be modified by adverbs of purpose or volition, as can be seen in the parentheses in (12). We can determine quite decisively that the external  $\Theta$ -role is Experiencer (to the extent that such a role exists in our universal inventory) by the tests we used before. In (13) (a regular agentive verb with an animate subject), no issue arises in this respect.

These thematic (as opposed to structural) contrasts may be crucial in the present context. Recall that one of the leading ideas of the TDH was the derivation of performance rates either through thematic competition, or through compensation: In cases where the moved constituent had a thematic label other than Agent normally (like passive, object-gap relatives, object clefts and the like, where the moved constituent is the object, bearing the Theme  $\Theta$ -role), the strategy assigns it with the Agent role. The other NP in the structure (oblique object in passive, or subject of relatives and clefts) is linked to an Agent label grammatically (cf. Grodzinsky, 1986, 1990). As a result, the two Agents compete, thereby inducing chance performance by agrammatics, as can be seen in (14), where the subject is assigned Agent by the strategy, and the object, through the normal process of  $\Theta$ -role assignment:

- (14) The robber is shot by the guard.
- |       |       |
|-------|-------|
|       |       |
| Agent | Agent |

In cases where the moved NP is linked to Agent normally (such as subject-gap relatives, subject clefts, or actives under the VPI, where the subject moved), this role is not assigned normally through the trace due to trace deletion, yet the strategy correctly compensates by assigning that NP the Agent role by default.

In nonagentive predicates, the story changes significantly: Here, competition or compensation work quite differently. If the strategy always assigns Agent, it would replace a  $\Theta$ -role label that is not Agent by an Agent label, and new situations are about to emerge, for now the strategy creates competition among nonidentical thematic labels, and the question is how this would result in terms of the observed comprehension performance of agrammatic patients. For that, a short digression into thematic hierarchy is necessary.

*3.1.2 The syntactic significance of  $\Theta$ -roles and the thematic hierarchy.* Throughout the paper I have been assuming that  $\Theta$ -roles are part of the grammar. This is not universally agreed upon. Some linguists (e.g., Grimshaw, 1990) believe that  $\Theta$ -grids contain only positions, not thematic labels, and that in fact, there is no reason to believe that such labels do syntactic work, hence there is no need to encode them into syntactically relevant data structures. For them, thematic labels are associated with positions later, through linking, yet from the point of view of grammatical regularity, they are irrelevant. Others (e.g., Gruber, 1965; Jackendoff, 1972, 1987; Giorgi, 1984) argue that these labels are crucial for the explanation of syntactic phenomena.

Jackendoff (1987) presents the argument that convinced him of this need, since it shows that some syntactic problems cannot be solved without making reference to thematic relations. He points to contrasts such as the one in (15):

- (15) a. John gave<sub>i</sub> Sue<sub>j</sub> orders PRO<sub>j</sub> to leave.  
 b. John<sub>i</sub> got from Sue<sub>j</sub> orders PRO<sub>i</sub> to leave.  
 c. John<sub>i</sub> gave Sue<sub>j</sub> a promise PRO<sub>i</sub> to leave.  
 d. John<sub>i</sub> got from Sue<sub>j</sub> a promise PRO<sub>j</sub> to leave.

The problem, Jackendoff points out, "is that these are all structurally identical in the relevant respects [they have the same phrase marker], so there is no apparent syntactic condition that determines the antecedent of PRO [an abstract representation of the "logical" subject of the infinitive]" (p. 369).

Yet if one attaches  $\Theta$ -role labels to the arguments according to what each verb dictates, the story changes, since it is always the source of the promise who would have to leave. Thus, the NP carrying  $\Theta$ -role Goal (*Sue* in (15a, d) and *John* in (15b, c)) will be the antecedent of PRO. A

syntactic fact that cannot be explained otherwise is thus accounted for, and the need for thematic relations as syntactic constructs is justified.

Since the appearance of Gruber's and Jackendoff's original work, much research has been done on thematic relations. In fact, they have come to play a central role in linguistic theory in recent years. Since the introduction of the  $\Theta$ -Criterion (Chomsky 1981), the notion of  $\Theta$ -grid (Stowell 1981), and the attempt to eliminate phrase structure rules from the theory, much effort has been put into specifying the inventory of thematic relations, their exact role, the manner by which they are represented for each predicate, the rules that link them to arguments, and the general principles that constrain these rules. For instance, a well known principle that encoded  $\Theta$ -roles to account for syntactic facts is the Thematic Hierarchy Condition (THC—Jackendoff 1972). This principle was formulated to explain why some verbs passivize, whereas others do not. Thematic labels, in and of themselves, can do no grammatical work. In order to do that, structure needs to be put on them, which is precisely what the THC does. By imposing an intrinsic hierarchy among NPs bearing different thematic labels, and requiring that this hierarchy meet certain condition, important syntactic regularities are explained. Consider, for instance, the contrasts in (16) and the classic explanation given to them by the THC:

- (16) a. John paid dollars (for the potatoes).

|            |  
Agent      Theme

- b. The potatoes cost two dollars.

|            |  
Theme      Location

- c. Two dollars were paid by John (for the potatoes).

- d. \*Two dollars were cost by the potatoes.

Jackendoff proposed that a universal hierarchy holds among  $\Theta$ -roles and that the order of  $\Theta$ -roles in sentences is constrained by this hierarchy, stated in (17), and the THC in (18) (see also Pinker, 1984 for discussion):

- (17) *Thematic Hierarchy*

1. Agent
2. Experiencer
3. Location, source, goal
4. Theme

- (18) *Thematic Hierarchy Condition (THC)*

The passive by-phrase must be higher on the Thematic Hierarchy than the derived subject.

The asymmetries in (16) are thus explained. Passivization of (16a) results in a well-formed structure, where the *by*-phrase contains Agent, and Theme is the derived subject; yet passivization of (16c) would violate the THC because Location (which is used rather abstractly in this context) is higher on the Thematic Hierarchy than the Theme in the *by*-phrase. And although the THC as stated is no longer held, it serves as a good example of how thematic labels can be harnessed to do syntactic work, thus providing motivation to a theory that encodes these labels in grammatically relevant data structures. Jackendoff and others have indeed proposed extensions to the THC, and in the past few years thematic relations have been used in the effort to reduce the number of rules and rule types that constitute the theory of syntax. Lexical entries of nouns and verbs thus consist of lists of such roles, known as  $\Theta$ -grids, illustrated in (19); and a general principle (the  $\Theta$ -criterion) ensures congruence between arguments that appear in the syntactic representation and those that are listed in the grid.

- (19) a. *kill*: <Agent, Theme>  
 b. *put*: <Agent, Theme, Location>  
 c. *run*: <Theme>  
 d. *see*: <Experiencer, Theme>

- (20)  $\Theta$ -Criterion (Chomsky, 1981)

Each argument in a sentence is associated with one (and only one)  $\Theta$ -role; each  $\Theta$ -role is associated with one (and only one) argument.

3.1.3 *The TDH and thematic hierarchy.* Consider, now, the test sentences in (11)–(13), repeated below, and the representations agrammatical aphasics would have for them, according to the TDH:

- (11') a. The car blocks the truck.  
 b. The truck is blocked by the car.  
 (12') a. The woman desires the man.  
 b. The man is desired by the woman.  
 (13') a. The woman holds the man.  
 b. The man is held by the woman.

All of the *a* sentences are actives and by the VPI involve movement of the subject. If traces are deleted, then, the  $\Theta$ -role they were said to be assigned (Instrument for (11'), Experiencer for (12'b), and Agent for (13')) will not be assigned, and according to the TDH, the strategy would make all of them Agents. For (13') this would amount to true compensation; for (12'), Agent would replace Experiencer. The subject here will still have a  $\Theta$ -role higher than the object, and the patients, whose comprehension is presumably guided by considerations of thematic hierarchy,



are predicted to perform normally; in (11'), however, a problem should arise if the strategy applies blindly: Inanimate NPs cannot be Agents. Since this kind of knowledge is clearly spared in agrammatism, we can safely assume that when such a conflict arises the patient reinterprets the thematic representation, and that the strategy matches a  $\Theta$ -role that is appropriate.<sup>8</sup> It does so by going one row down the thematic hierarchy, and assign an Instrument, or Location role. This process should lead to normal performance on this sentence type.

Consider, now, the *b* cases—the passives. Again, for some of the cases all remains as before: In (13'b), the agentive case, the trace is deleted and the strategy replaces Agent for Agent; in (11'b), the inanimate subject *the truck* cannot be Agent, hence the strategy will go down one row, as before, and pick Instrument or location. The most interesting case is (12'b). Issues of hierarchy among  $\Theta$ -role arise here for the first time in a truly significant fashion. In the agentive cases discussed above, aberrant, chance performance resulted from competition of identical  $\Theta$ -roles in the same sentence. But now we have a new situation, where two different  $\Theta$ -roles (not identical to the normally assigned ones) appear. Let us then apply the TDH algorithm in detail. The normal representation for (12'b) is (21a). In it we see one three-membered chain (*the man*,  $t'$ ,  $t$ ) which is a result of NP movement from object position, into Spec of  $V''$ , followed by movement of that NP into subject position by the VPI<sup>9</sup> (and where *en* stands for the passive morphology). Next, trace deletion applies, resulting in (21b), with one missing  $\Theta$ -role. The strategy then assigns it Agent, with the thematic representation in (21c):

*The TDH algorithm in action*

- (21) a. The man<sub>*i*</sub> is  $t'$ <sub>*i*</sub> desire-*en*  $t$ <sub>*i*</sub> by the woman (normal).  
           |  |  
           Theme  Experiencer
- b. The man is \* desired-*en* \* by the woman (trace deletion).  
           |  |  
           \*  Experiencer
- c. The man is \* desire-*en* \* by the woman (strategy application).  
           |  |  
           Agent  Experiencer

<sup>8</sup> That this is so is exemplified by the patients' ability to distinguish between "semantically irreversible" sentences with inanimate agents and "implausible" sentences with animate ones (Caramazza & Zurif 1976; see Grodzinsky & Marek, 1988, for a reinterpretation of this finding).

<sup>9</sup> See Burton and Grimshaw (1992) for arguments that passive has a VP-internal subject.

What performance will representation of (21c) generate in a task involving  $\Theta$ -role assignment? When we take the Thematic Hierarchy into account, the prediction is that patients would make consistent reversal errors in nonagentive passive sentences like (21), interpreting them as if they were active. This would happen because the subject of these sentences (Agent) would now be higher on the hierarchy than the object (Experiencer). Here, unlike the case of inanimate passive subjects (12'a), the subject of the psychological passive can be Agent, and (21c) is thus the final thematic representation. Agent is higher than Experiencer on the Thematic Hierarchy, and hence, consistent reversal would show up as below-chance level of performance. The patients are predicted to view the psych-passive as if it were an active sentence, and reverse the  $\Theta$ -roles systematically (see Grodzinsky, 1990, pp. 90–97).<sup>10</sup>

*3.2 The other hypotheses and nonagentive passive predicates.* Both Hickok et al. and Mauner et al. present a purely structural account of agrammatic comprehension. They attempt, as we have seen, to derive the comprehension scores of the patients by making assumptions regarding trace deletion (or two chains) and abandon the strategy. As a result, sentences having the same structure are predicted to yield identical results by agrammatic patients, regardless of their thematic properties, because thematic structure has nothing to do with their deficit, according to these authors. Thus, all of the active sentences in (11)–(13) are supposed to generate normal, above-chance performance, whereas all the passives are chance, guessing performance levels.

This result is one instance of a more general case, pointing to another crucial difference between these accounts and the TDH: Even though there are, in principle, three types of performances—above-chance, at chance, and below-chance levels in this type of experiment, the Hickok/

<sup>10</sup> One problem with this account has been observed by Barry Schein and Norbert Hornstein, among others. They point out that a semantic representation of a psychological predicate which contains an Agent  $\Theta$ -role is incoherent. The point is that normally the representation contains an Experiencer, not an Agent role, and that this role, assigned strategically, would make the semantic representation of the predicate and its arguments incoherent. I do not think that this is a problem. First, it can be shown that under a highly restricted set of conditions a passive sentence containing a psychological predicate can have an agentive reading: (i) John was misunderstood on purpose. (ii) The clown was despised deliberately. In both cases there is a reading in which the subject did something intentionally. That is, in both cases there is an interpretation similar to that in the following: (iii) John got himself misunderstood intentionally. (iv) The clown got himself despised on purpose. Hence, there is no issue of semantic incoherence. Secondly, even if there is, then it is clear that on a forced-choice task, such as the one we employed, the patient would use whatever information is available to him, and even if a representation is slightly incoherent, he would attempt to use its predicate/argument structure to come up with an answer. In this case there should not be a problem, and he has two distinct  $\Theta$ -roles, which guide his behavior.

Mauner approach can only handle the former two. This is so because the logic of their account is as follows: given a dyadic predicate (i.e., with two arguments), a patient either has the  $\Theta$ -role labels of both arguments, which should result in normal performance, or he has one, yet can infer the other, or he has none, in which case he is led to guessing. Under no circumstances can the patient be in a situation where he inverts  $\Theta$ -roles systematically.

This contrasts the Hickok/Mauner approach quite sharply with the TDH. The relevant empirical domain is, in part, that explored in the experiment presented below, for which each account has the following predictions:

	TDH	Hickok/Mauner
Active		
Agentive	Above chance	Above chance
Nonagentive	Above chance	Above chance
Psychological	Above chance	Above chance
Passive		
Agentive	Chance	Chance
Nonagentive	Chance	Chance
Psychological	Below chance	Chance

With this in mind, we can now move on to the experiment. It will be shown that only the TDH predicts the data correctly.

#### 4. EXPERIMENT

We tested the three thematic types, coupled with two structural types: agentive, nonagentive, and psychological verbs, each tested in active and passive. The agentive verbs were used for control to make sure that previous results are replicated. The experiment was thus divided into two sets of contrasts. In one condition, the contrast was established by manipulating the animacy of the arguments as in (22)–(23):

(22) The priest covers the nun.

(23) The book covers the newspaper.

The verb is ambiguous in (22), having potentially an agentive or a nonagentive reading. In (23), however, only a nonagentive reading is available, because the subject is inanimate. Thus, only in (22) could the subject be assigned an Agent thematic role, and in this respect it is identical to the standard active/passive experiment of the type done in the past. The second condition involved the use of the class of psychological predicates such as *admire* and *understand*. These verbs were chosen

because even though they must be coupled with animate arguments, they do not normally assign Agent to their external arguments, but rather a distinct thematic role, usually denoted Experiencer. These verbs denote psychological states, and as we have already seen, the distinction between Agent and Experiencer is shown by adverbs of intention or volition<sup>11</sup>:

- (24) a. \*He admired her on purpose.  
 b. He murdered her on purpose.

So, the contrast between agentive and nonagentive sentences in this study may be considered to be of two types: the first turns on sentences containing "ambiguous" verbs where the agentive or non-agentive reading is determined by the  $\pm$  animacy of their subjects; the second features sentences that differ in agentivity due to thematic properties of the verb itself, while animacy is kept constant. In all cases, we coupled this contrast with a syntactic manipulation: an active/passive contrast. In addition, we were interested in assessing the overall grammatical knowledge of the patients, knowledge that might be obscured if we had used the more usual sentence-picture matching task: Our task (but not the sentence-picture matching task) allowed us to see whether, and to what extent, these patients would order two nouns together, a performance that would indicate a severe syntactic loss. Thus, shown a picture of some relation between two people or objects (a relation always compatible with the verb types described above), patients were asked to arrange sentence fragments into a sentence which correctly described the picture. The comparisons done were of two types: performance on the sentence containing agentive verbs was compared to performance on the nonagentive sentences, and performance on active versus passive constructions was compared.

#### 4.1 Subjects

Four right-handed, male aphasic patients were tested who ranged in age from 44 to 69 years. Three normal controls, matched for age and socio-economic background were also tested. All aphasics were diagnosed as having Broca's aphasia, on the basis of results on the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1972) and neurological findings. All demonstrated agrammatism, both in production and

<sup>11</sup> These verbs are one type of psychological predicates, and in fact, the type that has received less attention in the linguistic literature. Two types of psych-predicates are commonly observed: The *fear* type and the *frighten* type. The former (that we have investigated in this study) is assumed to have a simple  $\Theta$ -grid, whereas the latter is an unaccusative, with its subject generated post-verbally: See Belletti and Rizzi (1988) and Pesetsky (1994).

in comprehension: their output was telegraphic and the variety of syntactic structures limited. CAT scan data indicate that the first aphasic patient suffered a left middle cerebral artery distribution infarct involving the left posterior frontal lobe, with minimal extension into the left parietal lobe. The second had a lesion involving the left frontal and parietal areas and extending into the temporal lobe. The third patient presented with a large lesion involving Broca's area, extending into the motor strip, and into the superior temporal gyrus. The last patient sustained damage to the inferior and middle frontal gyrus, cortical and deeper, with large superior lesion extension into the lower premotor area and lower motor cortex area. There was also a small lesion deep into the right superior frontal gyrus.

#### 4.2 Materials

Stimulus materials consisted of 56 pictures, each of which depicted two people or objects in some clear relation to each other. In addition, a set of cards showing printed sentence fragments was used. Cards varied in length according to how much text was on a card. They contained no punctuation, and all letters were upper case. See the list of sentences used and examples of the pictures in Appendix 1. Cards were presented in groups of three, such that if three cards were ordered correctly, they would form a sentence which described the picture. Each of the 56 pictures had both an active and a passive sentence associated with it.

Sentences were broken into three fragments: two consisting of a subject or object NP each, and a third consisting of the rest of the sentence. Thus the sentence "*the soldier stopped by the policeman*" was broken into the fragments *the soldier*, *was stopped by*, and *the policeman*, each appearing on a separate card. Since we were interested in  $\Theta$ -role assignment, we were not concerned in constraining our fragmentation by considerations of constituency. It should also be noted that the fragment containing the verb was not always the longest (so as to enable some kind of "cueing"). For instance, in the sentence *the grandfather is drawn by the grandson*, the longest sentence fragment is *the grandfather*. Each three-card combination was put into four token sentences, corresponding to the two different pictures. For example, the triad *the king*, *kisses*, and *the queen* was used in the contexts necessitating the responses: (a) the king kisses the queen; (b) the queen kisses the king. Ambiguous verbs (agentive/nonagentive) appeared with two sets of NPs one animate and one inanimate. Thus each ambiguous verb appeared in a total of eight sentences. All the rest appeared four times. Each group had 14 tokens, for a total of 112 anagrams. The following table summarizes the various experimental conditions:

Condition	Example
1. Basic agentive active	The policeman stops the soldier
2. Basic agentive passive	The soldier is stopped by the policeman
3. Ambiguous agentive active (animate)	The priest covers the nun
4. Ambiguous agentive passive (animate)	The nun is covered by the priest
5. Nonagentive active (inanimate)	The book covers the newspaper
6. Nonagentive passive (inanimate)	The newspaper is covered by the book
7. Psychological active	The man admires the woman
8. Psychological passive	The woman is admired by the man

#### 4.3 Procedure

A trial consisted of the presentation of a picture and three cards containing sentence fragments. The subject's task was to arrange the cards so that they formed a sentence which described the picture. A picture-matching pretest was done to insure that the patients were able to read the nouns and verbs used in the test and match them with the pictures to which they corresponded. Only subjects who made one or no errors were included. None of the four subjects, selected for their agrammatic features, made more than one error on this preliminary task. As far as the actual anagram task was concerned, subjects were given three practice trials. All patients were presented with stimuli in the same pseudorandom order. The agrammatic patients did not seem to have any trouble understanding the task. Typically, they looked at the picture, then at the cards, at the picture again, and then they ordered the anagram. As mentioned earlier, the sentence fragments were laid out in random order, in a vertical row, and the subjects would order them horizontally. The anagram task seems to involve several steps. After looking at the picture, the subject must construct a semantic representation, then translate this representation into a thematic representation, and then match the latter with a given surface string. It is this match, we believe, that makes the subjects look back and forth at the cards and the picture, attempting to locate the correct match among the options they have. The fact that the number of solutions is small and that they are all quite transparent is what makes this task a receptive one.

#### 4.4 Results

The three normal controls had no trouble with the task. One produced no errors; the other two made one error each, occurring in different items. These appeared to be due to lapses of attention, and we therefore included all the test items in the analysis.

One striking feature of the data is the degree to which the agrammatic patients were able to arrange the three cards in an anagram with the nouns separated by the verb. Of the four subjects, only one produced any responses with the two NPs places adjacently. He only made two such responses, which were treated as errors. For individual patient data, see Appendix 2. The following table presents the group data (percentage error):

	Ambiguous agentive	Nonagentive	Basic agentive	Psychological
Active	19.63	19.63	8.93	19.63
Passive	44.65	44.65	39.28	67.83

Since the main purpose of this study was to determine how agrammatic patients would perform on various types of passive sentences, separate data analyses were done for passive and active conditions. First, with regard to the passive sentences only, a one factor analysis of variance (ANOVA) was performed. This revealed a main effect of sentence type,  $F(3, 9) = 4.37, p < .05$ . Comparisons show the basis for this effect. On the one hand, performance on the basic agentive passives was significantly better than performance on the other passives (vs. Psychological,  $F(1, 9) = 10.97, p < .01$ ; vs. ambiguous agentives,  $F(1, 9) = 7.23, p < .025$ ; vs. ambiguous nonagentives,  $F(1, 9) = 7.23, p < .025$ ). On the other hand, performance on the psychological passives was significantly worse than on any of the others (vs. basic agentives see above, vs. ambiguous agentive and nonagentive  $F(1, 9) = 10.97, p < .025$ ). Four two-tailed *t* tests, performed to determine which conditions had mean scores different from chance, reveal a perspective on this last finding. Of the four passive conditions, only the psychological one differed significantly from chance, being below chance. (ambiguous agentives,  $t(3) = .79, p > .10$ ; ambiguous agentives  $t(3) = .27, p > .50$ ; basic agentives,  $t(3) = .91, p > .10$ ; psychological,  $t(3) = 5.00, p < .02$ ). "Chance performance" is here defined as producing 50% correct responses (i.e., chance, given that the NPs are around the verb to form a grammatical sentence).

Turning to data from the four active conditions, a one-factor ANOVA revealed no main effect of sentence type  $F < 1.0$ . Although subjects made only about half as many errors in the basic agentive active and any

other active condition (vs. ambiguous agentive,  $F < 1.0$ ; vs. nonagentive,  $F < 1.0$ ). Nor was there any other significant difference among verbs in the active condition. In addition, two-tailed  $t$  tests showed that the subjects performed significantly better than chance on all four active sentence types (ambiguous agentives,  $t(3) = 3.23$ ,  $p < .05$ ; nonagentives,  $t(3) = 4.12$ ,  $p < .05$ ; basic agentive,  $t(3) = 12.01$ ,  $p < .01$ ; psychological  $t(3) = 4.98$ ,  $p < .02$ ).

## 5. ANALYSIS

### 5.1 Summary of the Findings

Here are the main findings of this experiment: (1) the patients exhibited considerable syntactic ability in that they virtually always ordered the anagrams in a sequence that resulted in a grammatical sentence. (2) This ability was deficient, in part: On actives, the patients were always above-chance; on passive sentences, they attached incorrect thematic roles to NP's. (3) A type of performance that has never been documented before was observed here, namely, below chance performance (consistent reversal of  $\Theta$ -roles) on a comprehension test involving  $\Theta$ -role assignment to passive sentences containing psychological predicates. (4) This finding is not accidental, because it correlates with thematic type: On passive sentences with agentive predicates, or with inanimate subjects, the patients performed at chance; on passive sentences with nonagentive, psychological predicates they were below chance. In sum, then, we saw all the logically possible performance levels: above-, below-, and at-chance performance rates, and the error pattern correlated with both construction type and verb type. That is, the factors contributing to aberrant performance were both the syntactic properties of the sentence in question (i.e., active vs. passive) and the thematic properties of the predicate (i.e., agentive vs. nonagentive).

### 5.2 Implications

We have seen that the selective impairment agrammatic aphasics suffer from is determined not only by grammatical structure, but also by thematic structure. This runs contrary to the predictions of the purely structural accounts, namely, those of Hickok et al. and Maunder et al. In addition to the other problems these accounts face (some of which were discussed above), we now have a kind of finding that they cannot explain in principle. The TDH, by contrast, has been corroborated. What remains now is to explore the interpretation of the findings, and its general implications.

Consider, first of all, four constructions that give rise to identical performance pattern from agrammatic aphasics:





then, is obviously trace location and thematic structure. One might argue, at this point, that the reason for the distinct performance level on psychological predicates is their special thematic structure, namely, that their having an Experiencer label is the reason for the observed error rate. Yet, on adjectival passives that denote such states, but are not derived by movement, the patients perform virtually like normals in (25b), despite the fact that in both cases the sentences contain a participle, and in both the thematic representation for the aphasic places the subject higher than the object in the thematic hierarchy. Thus neither location of trace, nor denotation of predicate can give the right distinction. Rather, the interaction of these properties with the TDH is what predicts the full array of results. Crucially, an adequate account of agrammatic comprehension, such as the one presented here, must rely on the identity of  $\Theta$ -role in the lexical representation of verbs.

This conclusion argues quite strongly for the necessity of thematic labels in the normal linguistic lexicon. Without such labels, a deficit account of patterns of selective impairment such as the one observed in agrammatism is not possible. The lexical representations these individuals have do not differ from normal, and hence, the present study provides powerful evidence in favor of the position that maintains that such labels are crucial for the explanation of syntactic regularities (for current views on this issue see, for instance, Emonds, 1991; Jackendoff, 1993).

We have thus provided yet another instance where neurological evidence can be used for theoretical linguistic purpose. The findings, then, not only demonstrate how highly selective the deficit is in agrammatism but also give rise to yet another neurological constraint on linguistic theory, in the spirit of constraints proposed before (cf. Grodzinsky, 1990). Both angles show, in my view, the immense value of the study of aphasic syndromes for linguists and neuropsychologists alike.

#### APPENDIX 1

Below are the stimulus sentences used in this experiment, listed by condition with four versions per sentence

The butler serves the maid	(active - basic)
The maid serves the butler	(active - $\Theta$ -role reversal)
The butler is served by the maid	(passive - basic)
The maid is served by the butler	(passive - $\Theta$ -role reversal)

Thus, there are 14 sentences in each of the conditions, and for each of the four verb types there were two conditions—active and passive—a total of 112 sentences in 8 conditions, listed by verb type:

*Basic agentive*

1. The child dries the mother
2. The butler serves the maid
3. The Queen kisses the King
4. The Indian kills the cowboy
5. The boy drags the girl
6. The grandson draws the grandfather
7. The nurse examines the doctor

*Ambiguous Agentives*

1. The girl blocks the boy
2. The woman holds the man
3. The girl hides the boy
4. The child supports the fireman
5. The policeman stops the soldier
6. The wife shelters the husband
7. The priest covers the nun

*Nonagentives*

1. The car blocks the truck
2. The pot holds the bowl
3. The rock hides the tree
4. The television supports the book
5. The log stops the rock
6. The house shelters the tree
7. The newspaper covers the book

*Psychological*

1. The woman understands the man
2. The man desires the woman
3. The soldier hates the boy
4. The princess loves the prince
5. The boy trusts the girl
6. The woman admires the man
7. The father hears the son

## APPENDIX 2

Below are the individual patient raw scores, listed by percentage error per condition

Patient condition	Active				Passive			
	Basic agentive	Ambiguous agentive	Nonagentive	Psych	Basic agentive	Ambiguous agentive	Nonagentive	Psych
1	0	7.1	28.5	7.1	71.4	64.3	42.8	71.4
2	14.3	35.7	7.1	35.7	35.7	35.7	57.1	71.4
3	14.3	35.7	35.7	21.9	35.7	35.7	42.8	71.4
4	7.1	0	7.1	14.3	14.3	42.8	35.7	57.1

## REFERENCES

- Baker, M., Johnson, K., & Roberts, I. 1989. Passive arguments raised. *Linguistic Inquiry*, 20, 219–251.
- Belletti, A., & Rizzi, L. 1988. Psych verbs and  $\Theta$ -theory. *Natural Language & Linguistic Theory*, 6, 291–352.
- Bever, T. 1970. The cognitive basis of linguistic structures. In J. R. Hayes (Ed.), *Cognition and the development of language*. New York: Wiley.
- Burton, S., & Grimshaw, J. 1992. Coordination and VP-internal subjects. *Linguistic Inquiry*, 23(2), 305–313.
- Caramazza, A., & Zurif, E. B. 1976. Dissociation of algorithmic and heuristic processes in language comprehension: evidence from aphasia. *Brain and Language*, 3, 572–582.
- Chomsky, N. 1981. *Lectures on government and binding*. Dordrecht: Foris Publications.
- Chomsky, N. 1992. *A minimalist program for linguistic theory*. MIT: MITWPL 11.
- Emonds, J. 1991. Subcategorization and syntax-based theta-role assignment. *Natural Language & Linguistic Theory*, 9, 369–429.
- Fox, D. 1993. *The get-passive, implicit arguments and passive acquisition*. M.A. thesis, Tel Aviv University.
- Fukui, N., & Speas, M. 1986. *Specifiers and projections*. MITWPL 8, pp. 128–172.
- Gavarró, A. 1993. *A note on agrammatism and the minimalist program*. Unpublished manuscript, Universitat Autònoma de Barcelona.
- Giorgi, A. 1984. Toward a theory of long-distance anaphora: A GB approach. *The Linguistic Review*, 3, 307–361.
- Goodglass, H., & Kaplan, E. 1972. *The assessment of aphasia and related disorders*. Philadelphia: LEA & Febiger.
- Grimshaw, J. 1990. *Argument structure*. Cambridge, MA: MIT Press.
- Grodzinsky, Y. 1984. *Language deficits and linguistic theory*. Doctoral dissertation, Brandeis University.
- Grodzinsky, Y. 1986. Language deficits and the theory of syntax. *Brain and Language*, 27, 135–159.
- Grodzinsky, Y. 1990. *Theoretical perspectives on language deficits*. Cambridge, MA: MIT Press.
- Grodzinsky, Y. 1995. *A restrictive theory of trace deletion in agrammatism*. Paper presented in a symposium on Linguistic Approaches to Agrammatism, TENNET, Montreal. *Brain and Language*.
- Grodzinsky, Y., Finkelstein, D., Nicol, J., Zurif, E. B. 1988. *Agrammatic comprehension and the thematic structure of verbs*. Paper presented at the Academy of Aphasia, Montreal.

- Grodzinsky, Y., & Marek, A. 1988. Algorithmic and heuristic strategies revisited. *Brain & Language*, **33**, 216–225.
- Grodzinsky, Y., Pierce, A., & Marakovitz, S. 1991. Neuropsychological reasons for a transformational derivation of syntactic passive. *Natural Language & Linguistic Theory*, **9**, 431–453.
- Gruber, J. 1965. *Studies in lexical relations*. Doctoral dissertation, MIT.
- Hickok, G., Zurif, E. B., & Canseco-Gonzales, E. 1993. Structural description of agrammatic comprehension. *Brain & Language*, **45(3)**, 371–395.
- Jackendoff, R. 1972. *Semantic interpretation in generative grammar*. Cambridge, MA: MIT Press.
- Jackendoff, R. 1987. The status of thematic relations in linguistic theory. *Linguistic Inquiry*, **18(3)**, 369–411.
- Jackendoff, R. 1993. On the role of conceptual structure in argument selection: A reply to Emonds. *Natural Language & Linguistic Theory*, **11(2)**, 279–312.
- Jaeggli, O. 1986. Passive. *Linguistic Inquiry*, **17**, 587–622.
- Kitagawa, Y. 1986. *Subjects in English and Japanese*. Doctoral dissertation, UMass. at Amherst.
- Koopman, H., & Sportiche, D. 1988. *Subjects*. Unpublished manuscript, UCLA.
- Kuroda, S.-Y. 1986. *Whether we agree or not*. Unpublished ms., USC.
- Lonzi, L., & Luzzatti, C. 1993. Relevance of adverb distribution for the analysis of sentence representation in agrammatic patients. *Brain & Language*, **45(3)**, 306–317.
- Marantz, A. 1984. *On the nature of grammatical relations*. Cambridge, MA: MIT Press.
- Maurer, G., Fromkin, V., & Cornell, T. 1993. Comprehension and acceptability judgments in agrammatism: disruption in the syntax of referential dependency. *Brain & Language*, **45(3)**, 340–370.
- Pesetsky, D. 1994. *Zero syntax*. Cambridge, MA: MIT Press.
- Pinker, S. 1984. *Language learnability and language acquisition*. Cambridge, MA: Harvard University Press.
- Sportiche, D. 1988. A theory of floating quantifiers and its corollaries for constituent structure. *Linguistic Inquiry*, **19(3)**, 425–449.
- Stowell, T. 1981. *Origins of phrase structure*. Doctoral dissertation, MIT.
- Zurif, E. B., Swinney, D., Prather, P., Solomon, J., Bushell, C. 1993. An on-line analysis of syntactic processing in Broca's and Wernicke's aphasia. *Brain & Language*.