

## A Restrictive Theory of Agrammatic Comprehension

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In this paper I propose a new, restrictive theory of Trace-Deletion in agrammatism. This theory subsumes the Trace-Deletion Hypothesis (TDH; Grodzinsky, 1984a,b, 1986, 1990), which maintains that traces are deleted from agrammatic representations and that a cognitive strategy augments the patients' performance. This claim accounts for the pattern of loss and sparing observed in these patients' comprehension of a wide variety of syntactic constructions and is thus important for our understanding of the neural representation of syntax. Yet there are reasons for revising the account and making it more precise, stemming from both recent empirical findings and new developments in the theory of syntax. The original TDH was based on observations of agrammatic comprehension of structures containing traces resulting from either NP- or Wh-movement. Nevertheless, heads (as opposed to phrasal projections) also move and leave traces behind. Head movement (of verbs, for instance) has come to play a central role in linguistic theory (which currently postulates a wider variety of empty categories than any previous theoretical framework). Recent findings suggest that verb movement is retained in agrammatism, indicating that a sweeping claim regarding the deletion of all empty categories is too strong. This motivates the first restrictive move, resulting in a theory that picks out a restricted set of traces—only those for which deficient performance is indeed observed. All other empty categories are left intact. Trace-Deletion is tied to  $\Theta$ -positions. The second restrictive move is motivated by two types of surprising asymmetries that have recently been discovered for agrammatic comprehenders: First, agrammatic comprehension on passives of psychological predicates provides an error pattern that distinguishes this construction from agentive passive, indicating that the deficit is tied to the thematic properties of the predicate; Second, asymmetries have been observed in agrammatic comprehension of questions and quantifiers. These findings motivate a modification of the augmentative strategy, whose domain of application is restricted to referential NPs. Thus, the new account amounts to the claim that only traces in  $\Theta$ -positions are deleted, and that the strategy applies to referential NPs alone. This, I argue, not only derives all the data precisely but is also conceptually superior to any previous account of agrammatism. Finally, I discuss the consequences of this account to linguistic theory, and to theories of brain/language relations. © 1995 Academic Press, Inc.

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## INTRODUCTORY REMARKS

In this paper I revise the Trace-Deletion Hypothesis (TDH), according to which all traces are deleted from S-structure representations in agrammatism (Grodzinsky, 1984a,b, 1986, 1990). Doing aphasia research is getting to be a difficult trade, as the issues are becoming increasingly subtle. This has happened due to developments that have been both empirical and theoretical in nature. Indeed, new empirical evidence has been recently accumulating, giving further indications as to the fine nature of the syntactically selective deficit in this syndrome and making such a revision necessary. New theoretical developments in linguistics force reconsideration as well. A revision, aimed at refining the account and making it more precise, will thus advance our understanding of brain/language relation and, in particular, of the neural substrate of the human syntactic capacity.

One recent development concerns verb movement, which has come to play a rather central role in linguistic theory (cf. Pollock, 1989; Chomsky, 1992) and which appears to be preserved in agrammatism (cf. Lonzi & Luzzatti, 1993, and below). This development motivates a restrictive move, which limits trace-deletion to  $\Theta$ -positions. A second development concerns two types of surprising asymmetries that have been recently discovered in the comprehension performance of agrammatic aphasics. The first comes from contrasts in performance on passive constructions that contain predicates of different thematic types (Grodzinsky, 1995a). Briefly, the finding is that while on passives of agentive predicates agrammatic comprehension is at chance level in tasks involving  $\Theta$ -role assignment, when the predicate is a psych-verb, comprehension levels of passive go down to below-chance (i.e., systematic reversals of  $\Theta$ -roles).

The second asymmetry is from agrammatic differential performance on constructions with moved constituents (i.e., antecedents of deleted traces) with different referential properties (cf. Hickok & Avrutin and Saddy, this issue). It was found that while agrammatics perform at chance when presented with object *Which* questions (as the TDH predicts), they surprisingly give a virtually normal performance on *Who* questions. In addition, they comprehend normally (above-chance) when presented with passives containing quantified subjects, although they fail in passives, whose subjects are referential.

These two types of findings thus motivate a natural reformulation of the TDH in a second respect: the nonlinguistic, cognitive strategy that augments the deficient abilities of the patients is restricted to referential expressions.

The TDH is thus restated restrictively: only traces in  $\Theta$ -positions are deleted, and NPs lacking a  $\Theta$ -role receive one strategically iff they are referential.

The reformulation has surprising implications regarding the proper

view of agrammatism, as it casts the disturbance in terms that contradict accepted ideas. Most importantly, it has the consequence that in agrammatic comprehension the deficit is limited to lexical categories and their phrasal projections, whereas functional categories are intact. This conclusion is diametrically opposed to the standard view of the deficit in this syndrome, according to which functional elements are impaired, whereas lexical ones are not.

Finally, this reformulation has important implications to linguistic theory: It strengthens the view that passive constructions contain traces in object position [cf. also Grodzinsky, Pierce, & Marakovitz (1991), for an earlier neuropsychological argument] and provides a new neurologically based diagnostic method for long Wh-movement.

This paper is structured as follows: The first three sections present the basic data and conceptual background that originally motivated the Trace-Deletion Hypothesis. Sections 4 and 5 discuss the TDH in the context of current Chain Theory and in light of recent neurological evidence regarding chain types. Section 6 proposes a reformulation of the TDH along the lines suggested above, and section 7 discusses the reformulation in light of recently discovered comprehension asymmetries. Section 8 draws some general conclusions regarding the significance of the account to various theoretical domains.

## 1. PAST VIEWS

Within the many studies carried out in the past 20 years on agrammatic aphasia, one can identify roughly three views of the agrammatic comprehension limitation. The first two views postulate a deficit whose range is very broad:

A. Complete syntactic loss—"asyntactic comprehension," according to which agrammatic patients have lost all ability to represent syntactic structure (e.g., Caramazza & Zurif, 1976; Berndt & Caramazza, 1980; Caplan, 1985; Caplan & Futter, 1986, and many others).

B. An interpretive deficit—"the mapping hypothesis," according to which agrammatics have lost all abilities involved in mapping grammatical functions onto semantic roles (cf. Schwartz, Saffran, & Marin, 1980; Linebarger, Schwartz, & Saffran, 1983a,b; Schwartz, Linebarger, Saffran, & Pate, 1987).

These early views have had, for the most part, similar empirical consequences and, given the paucity of data at the time, could not be easily distinguished from one another. Yet as experimental evidence was pouring in, it turned out that they were both too strong and that the deficit they argued for was far too wide in scope. Thus, a third view was put forth, viewing the deficit in terms that are more restricted:

C. Partial syntactic deficit—"impaired closed-class" (Bradley, Garrett, & Zurif, 1980), "Trace-Deletion Hypothesis" (e.g., Grodzinsky,

1984a,b, 1986, 1990; Mauner, Fromkin, & Cornell, 1993; Hickok, Zurif, & Canseco-Gonzales, 1993, and many others), “ $\Theta$ -constrained deficit” (Rizzi, 1985).

The trend, then, has been toward more restrictive accounts. Recent findings, however, suggest that even the narrowly defined partial syntactic deficit that the TDH postulated is too wide, and a new, restrictive theory of agrammatic comprehension needs to be constructed.

## 2. THE CENTRALITY OF MOVEMENT

On testing, it seems that constructions governed by most of the modules of grammar are intact in agrammatism. The one clear exception, which has stood out virtually since the beginning of the experimental investigations in the late 1960s, is syntactic movement, as indicated by marked comprehension deficiencies on movement-derived structures. The limited evidence that was available consisted mostly of patients' scores on “sentence-to-picture matching” tests, which assessed the subjects' ability to assign  $\Theta$ -roles to NPs. The range of constructions investigated was also narrow: Actives, passives, subject and object clefts, and object relative clauses (cf. Goodglass, 1968; Caramazza & Zurif, 1976; Schwartz et al., 1980a,b; Ansell & Flowers, 1982). Auxiliary evidence also existed from agrammatics' grammaticality judgment on assorted violations of grammaticality (Gardner & Zurif, 1975; Grossman & Haberman, 1982; Linebarger et al., 1983; Goodenough, Zurif, & Weintraub, 1977) and from hierarchical clustering (Zurif & Caramazza, 1976).

In light of this, and given that the main issue debated in the early 1980s was whether agrammatism is “overarching” comprehension and production, an initial attempt was made to capture all aspects of agrammatic grammatical aberrations in one descriptive generalization that would span over all the modalities. The hope was that patterns of impairment and sparing in speaking, listening, reading, and writing would all fall under the same generalization. Thus labor was invested in obtaining such a generalization—a unified deficit analysis of agrammatism. The initial proposal was, then, that all nonlexical terminals at S-structure (which were to include empty categories, as well as  $\varphi$ -features—gender, person, and number agreement) are underspecified in syntactic representations of agrammatic aphasics, and hence, the deficits in production (substitution and omission of inflectional and other nonlexical elements) and in comprehension (problems with moved constituents that could be viewed as deletion of empty categories and their indices) are accounted for uniformly (Grodzinsky, 1984a,b; Zurif & Grodzinsky, 1983).

However, it quickly turned out that this conclusion had been too optimistic. The account turned out to be both too weak and too strong: Too weak, since the idea to create S-structure representations in which all

nonlexical terminals are underspecified excludes certain impaired elements (e.g., Friederici, 1982, 1985). Too strong, because the attempt to generalize over modalities (i.e., production and comprehension) could be successful only if some data, as well as certain important linguistic distinctions, were glossed over. The pattern of selective impairment thus turned out to be more intricate and severe than this account could allow and hence, the second stage separated the modalities and proposed two descriptive statements, one for production, and the other for comprehension (Grodzinsky, 1986; and more explicitly in Grodzinsky, 1990). The consequence of this move was, quite naturally, to abandon (at least for the time being) the claim that agrammatism is an "overarching" deficit and attempt to construct separate accounts for the deficit in each modality.

Since that time, numerous empirical studies have been published, producing new evidence regarding the grammatical basis of aphasic performance by both extending the range of grammatical structures on which agrammatic patients were tested and varying the tasks with which the patients were faced. This evidence underscores the centrality of movement in the agrammatic comprehension deficit in that it documents, with very few exceptions, a rather overwhelming near-normal performance in most other domains of syntax. The state of the evidence is roughly the following, presented according to the various syntactic modules:

A. *Phrase structure*: Agrammatic patients have intact abilities in this domain (in both comprehension and production). In production they appear to construct sentences that do not violate basic sentence structure (see Lapointe, 1985), and more importantly in the present context, in comprehension they have no problem in building tree structure for sentences that do not contain intrasentential dependency relations, such as actives, for instance. They are also able to construct syntactic representations that respect the argument structure of predicates (Shapiro & Levin, 1990; Shapiro, Gordon, Hack, & Killackey, 1993) and are near-normal in detecting violations of phrase structure rules (Linebarger et al., 1983).<sup>1</sup>

B. *Lexical properties*: Agrammatics have no lexical impairment in comprehension. They detect violations of subcategorization (Linebarger et al., 1983) and demonstrate a normal time-course of lexical processing when argument structure is at issue (Shapiro & Levin, 1990; Shapiro et al., 1993). They are also virtually normal on tasks that involve lexical processing (Swinney, Zurif, & Nicol, 1989).

C. *Θ-assignment*: Agrammatics have intact abilities in this domain. This is evident from their normal performance in comprehension tasks that involve Θ-role assignment in simple structures (cf. for instance,

<sup>1</sup> One potential exception is the recent claim by Hagiwara (1994) that CP is impaired. At the time of writing, this claim could not yet be incorporated into the discussion.

Schwartz et al., 1987). In addition, they never violate the  $\Theta$ -criterion when they construct syntactic representations (Lapointe, 1985).

D. *Case assignment*: Agrammatics have virtually intact abilities in this domain. This has been shown time and again in judgment and comprehension studies in several languages (cf. Lukatela, Crain, & Shankweiler, 1988; Crain, Shankweiler, Gorell, & Tuller, 1989; Linebarger et al., 1983).

It would appear, then, that on every aspect of basic sentence structure the comprehension of these patients is virtually intact. This conclusion, coupled with the fact that agrammatics have little, if any, deficit in other linguistic domains in comprehension, is the reason, perhaps, that for almost 50 years students of agrammatism believed that there was no comprehension impairment in this syndrome. Yet when one takes dependency relations into account, the picture changes. Next, a survey of such relations is in order.

E. *Binding*: The formal aspects of binding relations are intact in agrammatism (cf. Grodzinsky, Wexler, Chien, Marakovitz, & Solomon, 1993; see also Crain & Shankweiler, 1985; and Avrutin, 1994). To the extent that certain relations among pronouns, reflexives, and their antecedents are impaired, they have to do with discourse-related aspects of pronominal reference and not with binding theory (cf. Grodzinsky & Reinhart, 1993; Avrutin, 1994).<sup>2</sup>

F. *Other syntactic domains*: Other than the list above (and movement which is discussed below), no other domains (e.g., Bounding, Control) have ever been tested systematically; hence, no data are available.

G. *Movement*: In sharp contrast with the above findings that indicate intactness of comprehension abilities we see a rather severe deficit in movement-derived constructions, as evidenced through the following familiar patterns:

- (1) Above-chance performance
  - a. The girl pushed the boy
  - b. The girl who pushed the boy was tall
  - c. Show me the girl who pushed the boy
  - d. It is the girl who pushed the boy
  - e. The boy was interested in the girl
  - f. The woman was uninspired by the man
- (2) Chance performance
  - a. The boy was pushed by the girl

<sup>2</sup> Grodzinsky and Reinhart discuss children and agrammatics' deficit in executing co-reference relations in language comprehension and claim that the deficit (identical in both groups) is not related to syntax per se, but rather to a processing component that is responsible for holding two representations concurrently and carrying out computations over them. Avrutin attempts to recast this claim in terms of the Discourse Representation Theory.

- b. The boy who the girl pushed was tall
- c. Show me the boy who the girl pushed
- d. It is the boy who the girl pushed
- e. The woman was unmasked by the man

It has also been found that the time-course of language processing in movement derived structures is impaired (Shapiro et al., 1993) and that other time-constrained tasks also reveal a deficit in this type of syntactic construction (Zurif, Swinney, Prather, Solomon, & Bushell, 1993).

It thus appears that every aspect of syntax, whether pertaining to basic relations or to the more intricate dependencies, is intact in agrammatism, with one salient exception: syntactic movement.

### 3. THE ESSENCE OF THE TDH

#### 3.1. *Trace Deletion*

To accommodate these findings, it was assumed that in agrammatism, all traces of movement are deleted from S-structure representation. As a consequence,  $\Theta$ -role transmission to moved constituents, normally mediated by the chain that the trace and its antecedent constitute (and potentially, intermediate traces as well), cannot take place. A moved NP thus lacks a  $\Theta$ -role, and the hypothesis thus provides a formal means to partition the data, by saying that structures containing traces are impaired, and the rest preserved. Yet it was obvious that mere partitioning was insufficient, because it lacked explanatory force: While it pointed to the structures that gave the patients trouble, the patients' actual performance rates were not derived deductively from just trace-deletion. The deletion of traces explains why the transmission of  $\Theta$ -roles to a moved constituent is impossible, yet it does not indicate why this, in itself, prevents the patient from inferring the missing role from the rest of the information that is available to him (i.e., the  $\Theta$ -grid of the predicate, the fact that another NP is assigned a  $\Theta$ -role directly; cf. Grodzinsky, 1990, Chap. 5). Further, as we will see below, if current theory is assumed, the TDH does not even partition the data accurately.

#### 3.2. *The Default Strategy*

To remedy this situation, an auxiliary assumption was deemed necessary in order to derive chance performance on passive, object-gap relatives, and clefts. 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, for the cases tested, was always Agent. The idea was that since the moved constituents lack a  $\Theta$ -role, and since NPs must have some role in interpretation, the strategy assigns them a role by lin-

ear considerations, which for the cases discussed was always Agent. As a consequence, the thematic representation the patient has in such cases contains two Agents (one assigned grammatically and the other strategically), and the observed chance performance is deduced. 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 this NP, with the result of a thematic representation with two Agents. The patient is incapable of determining the Agent of the action uniquely, and he is forced to guess, performing at chance. The unimpaired constructions contain no traces and therefore create no comprehension problem, precisely as the data indicate.

In sum, the derivation of the agrammatic performance rates on all constructions is done by assuming trace-deletion and a strategy. Performance is thus deduced 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 relatives, subject clefts, or actives under the VP-Internal Subject Hypothesis), 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.

Direct evidence to the validity of this strategy comes from an experiment with psych-verbs (Grodzinsky, 1995a). In an experiment conducted on one type of psychological predicates, it was found that agrammatics perform below-chance on passives of psychological predicates such as in (3), below (even though they perform normally on their active counterparts). This contrasts sharply with the chance-level performance rate that patients exhibit on movement-derived structures in which the predicate is agentive.<sup>3</sup>

<sup>3</sup> An additional study to be considered in this context is Hagiwara (1993), in which psych-predicates in Japanese are discussed, and their comprehension in agrammatism is investi-



(3) Below-chance performance:

The girl was admired by the boy

This finding has been used to rule out certain variants of the TDH which have attempted to formulate it without making reference to the default strategy (Hickock et al., 1993; Mauner et al., 1993). The surprising contrast between agentive and psychological passive is explained only if the patients indeed use an agent-first strategy, which leads to differences in the thematic representations available to them. Below, normal and agrammatic  $\Theta$ -representations are given for several construction types:

(4)	<u>Agrammatic representation</u>	<u>Normal <math>\Theta</math>-representation</u>
a.	The man <sub>i</sub> is t <sub>i</sub> pushing the woman                              Agent                      Theme	(Agent, Theme)
b.	The woman <sub>i</sub> is t' <sub>i</sub> pushed t <sub>i</sub> by the man                              Agent                      Agent	(Theme, Agent)
c.	The man <sub>i</sub> is t' <sub>i</sub> hated t <sub>i</sub> by the woman                              Agent                      Experiencer	(Theme, Experiencer)

(4a) is an active sentence, in which the VP Internal Subject had moved to the Specifier of IP, leaving a trace behind (see Koopman & Sportiche, 1988; Kuroda, 1986; Kitagawa, 1986, and much related literature for arguments in favor of this hypothesis, which amounts to the claim that subjects are base-generated VP internally and are then moved to Spec of IP, leaving a trace behind as in (4a)). Given the TDH, the subject cannot receive its  $\Theta$ -role normally, yet we can see that the strategy correctly compensates for this deficit, since the NP in question is clause-initial. The normal  $\Theta$ -representation and the agrammatic one are thus identical. In (4b), however, the situation is different: here, we have the chain (woman, t', t), where t is the original position of the subject, and t' is the VP Internal Subject position to which the subject moves first before ending up in subject position (see Burton & Grimshaw (1992) for arguments from VP-ellipsis to that effect). By hypothesis, these two traces are deleted, leaving the subject without a  $\Theta$ -role, and under the scope of

gated. The results, while not exactly parallel to the English ones, must be viewed in relation to the structural differences between English and Japanese and the possibility that the strategy operates differently in the two languages. Similarly, the interesting results obtained by Beretta, Harford, Patterson, and Pinango (1994), who studied movement-derived and base-generated passives in Spanish, should be looked at, opening the way to a comparative study of aphasic syndromes (cf. Grodzinsky (1995b)).

the default strategy. The strategy assigns the subject the Agent role, which interacts with the remains of the  $\Theta$ -representation (i.e., an Agent in *by*-phrase) in a way that leads to guessing—the standard result on passive. In (4c) there is yet another situation, because the  $\Theta$ -role in the *by*-phrase is different from Agent, and in fact, lower on the thematic hierarchy. This results in a  $\Theta$ -representation that has an Agent (by default) and an Experiencer. Given the hierarchical nature of thematic relations this leads to a  $\Theta$ -representation in which the subject of the passive is more salient; hence, patients reverse the  $\Theta$ -roles, rather than guess, giving further empirical support to the validity of this extremely local strategy, applying only to NPs at an interpretive stage.<sup>4</sup>

#### 4. THE TDH AND CHAIN TYPES

The TDH was a sweeping generalization. It claimed that any trace, in any position, is deleted in agrammatism. What follows is that every structure containing a (nontrivial) chain would bring about aberrant comprehension performance in agrammatism.

Yet there are reasons to suppose that this formulation is too strong and that the trend toward more restrictive accounts of agrammatic comprehension must continue. First, empirical evidence currently available speaks against this formulation. Second, recent developments in the theory of syntactic chains (Chomsky, 1992; Rizzi, 1985, 1990; Cinque, 1991; Snyder, 1992, for example) and the extension of the ECP to cover verb movement (Pollock, 1989; Chomsky, 1991, 1992), as well as the development of economy principles in linguistic theory (Chomsky, 1991, 1992), have had implications to the description of aphasic syndromes. A rough typology of syntactic chains is thus in order. These are composed of three types:

##### 4.1. $X^0$ -Chains

A lexical category—a head—is moved, leaving a trace behind. This type of movement is distinct from others in that it is subject to the Head Movement Constraint (Travis, 1984; Chomsky, 1986), according to which a head cannot skip an intervening head between its base position and its landing site. A typical case is verb movement:

- (5) a. They could have left  
 b. Could they *t* have left?  
 c. \*Have they could *t* left?

<sup>4</sup> An additional finding is that on adjectival passives, which presumably are not derived transformationally, agrammatic patients perform rather successfully (cf. Grodzinsky, Pierce, & Marakovitz, 1991).

This case, as well as others (relating to constraints on negation, placement of adverbs in certain languages, Subject-Aux inversion, Do-support, the movement of main verbs in Germanic languages, etc.), falls under Relativized Minimality (RM; cf. Rizzi, 1990), which is an attempt to unify the relation between empty categories and their antecedents, while preserving certain distinctions among chain types.

#### 4.2. A-Chains

Covering movement resulting in chains headed by an element in A-position. This includes passive, unaccusatives (including Raising), and Psychological predicates (cf. Belletti & Rizzi, 1988). Here movement is again constrained by RM, which blocks, among other things, cases like (6):

(6) \*Mary seems that it is likely [*t* to win]

#### 4.3. A'-Chains

Headed by an element in A'-position, including questions, relative clauses, and the like. Here, RM blocks cases like (7):

(7) \*How do you wonder [*which problems to solve t t'*]  
(where *How* relates to the solution)

While each chain type is different from the others in certain respects, the three groups do not constitute totally distinct formal objects. Rizzi's Relativized Minimality is an attempt to unify the conditions that govern the relations among links in a chain and determine whether a particular link can be part of a legitimate formal object. Yet each of these chain types is distinct from others in important ways (most prominently, the "relativized" part of Relativized Minimality). With this in mind, we can proceed to examine the relevant facts regarding agrammatism. The TDH as stated, it will be recalled, claims that all traces are deleted. The implications of this hypothesis, then, are far reaching. It also leaves many questions open: for instance, while we know that if a trace of a  $\Theta$ -assigned category is deleted, the main consequence would be an inability to transmit this role properly through the chain, we do not know what would happen in chains headed by categories that are not  $\Theta$ -recipients, namely, head or  $X^0$ -chains.

### 5. A TYPOLOGY OF THE RELEVANT NEUROPSYCHOLOGICAL FACTS

Following the typology sketched above, we can now look at the empirical evidence from agrammatism, which breaks down into two general types:

### 5.1. *XP Movement (A- and A'-Chains)*

For those standard cases presented above we have empirical evidence in support of the claim that traces are deleted.

### 5.2. *X<sup>0</sup> (Head) Movement*

There are several sources of evidence which suggest that X<sup>0</sup>-chains are intact in agrammatics in comprehension (other results suggest intactness in production as well).

5.2.1. Linebarger et al. (1983) present a relevant experimental condition (their condition 3, "Subject-Aux inversion"), in which they found that all their four agrammatics were sensitive to violations of the following types, performing at near-normal levels:

- (8) a. \*Is the old boy is having a good time?
- b. Is the old boy having a good time?
- (9) a. \*Did the old man enjoying the view?
- b. Did the old man enjoy the view?

5.2.2. Lonzi and Luzzatti (1993) have presented an experiment that demonstrates the same phenomenon through an investigation of agrammatics' ability to place adverbs properly in Italian. In Italian verbs move around adverbial expressions, depending on their finiteness properties. Agrammatics were shown to be able to place adverbs correctly around the verb, an ability that indicates the availability of verb movement for them.

If this is the case, and verb movement is intact, then there are two logical possibilities: First, it could be that verbs move in agrammatism and their traces are deleted but, given that these traces have no consequences to  $\Theta$ -role assignment, the deficit caused by trace deletion is simply undetected. Were this to be the case, we would not have had data such as these just reviewed, for these data come from judgment, not interpretation, and the presence of traces in both Linebarger et al.'s and Lonzi and Luzzatti's data is crucial for correct performance. We are thus led in another direction, which is that the TDH does not cover verb movement, and that, contrary to the TDH, traces of such movement are not deleted.

Before continuing, it is worthwhile to observe an immediate, important corollary that this conclusion has:

- (10) Wh-elements are fully intact in agrammatic comprehension.

Such a corollary is important to our understanding of the nature of the agrammatic deficit in Wh-movement, so here is how it is derived. Rizzi (1991) argues for the Wh-criterion, which requires, roughly, that each

Wh-expression be in Spec-head relation with a head of the right kind and vice versa. It is this principle that accounts for, among other things, subject/object asymmetries in the English rule of Do-support (an instantiation of SAI), as in (11):

- (11) a. What did John buy?  
 b. \*What John bought?  
 c. Who bought junk?  
 d. \*Who did buy junk?

According to Rizzi, Do-support is applied only to achieve the required congruence between the Wh-expression in Spec and a lexical head. Auxiliaries thus head-move to be in a position that they can agree with a Wh-element in Spec of CP. This explains, according to Rizzi, the presence of Do-support in object questions and its absence in subject questions, because in the latter the verb is already in the appropriate head position relative to the Wh-element in Spec position, whereas in the former it must move in order to be close enough to the Wh-expression.

Consider agrammatical comprehension now. If head movement in all its variants is intact, as the evidence suggests, and if it is triggered in general solely to satisfy the Wh-criterion, then the patients are capable of applying this criterion. But in order to do so they must be aware of the existence of a Wh-expression in Spec of CP, so that congruence between it and a lexical head would force the auxiliary to move (or Do to be inserted). Hence, they must be aware of the properties of Wh-expression, and, in particular, of Wh-words like "what" and "who." This means that in Wh-constructions on which agrammatical comprehension is deficient, the reason for the deficiency cannot be lexical, namely an inability to detect the Wh-antecedent. Rather, any deficit that will be postulated for these constructions must implicate either the link between the Wh-word and the trace or the trace itself. Following, we will see the significance of this corollary. At this stage, it is appropriate to reexamine the TDH in light of these conclusions and try to make it more precise and general.

## 6. A RESTRICTIVE MOVE—A NEW GENERALIZATION

The TDH must be reformulated in a restrictive way to account for the new facts from head movement. Structures containing traces which tail A-chains and A'-chains yield erroneous performance, whereas traces of head movement (X<sup>0</sup>-chains) do not. It thus follows that this statement is descriptively correct:

- (12) *Restrictive TDH (rough version I):*  
 Traces of XP movement are deleted.

Namely deleted are traces of movement of whole phrases (as opposed to traces of heads that are retained). But this is not the only imaginable descriptive statement which may cover our data. Moreover, it is most likely that, for this description to be explained, it must be cast in other terms. For instance, if the deficit is to some processing mechanism, it will have to be stated in terms other than those in (12). Such terms are readily available. Traces of NP- and Wh-movement in the data are also in argument position, in  $\Theta$ -position, and have some other, less central, properties, which distinguish them from traces of head movement. Thus, there are several ways to restrict the TDH so that it account for the data, of which we focus on two:

- (13) *Restrictive TDH (variants):*
- a. Traces in  $\Theta$ -positions are deleted.
  - b. Traces in A-positions are deleted.

Note that the fact that an account can be cast in more than one way points to a gap in our understanding. If we seek a causal explanation to the generalization, it is advisable to distinguish these accounts, whether empirically or conceptually. These proposals are not easily distinguishable, but we can get some initial clues as to which one may be correct. We thus turn to the issue of whether the deleted traces are those in  $\Theta$ -positions or A-positions. To distinguish these empirically we have to test agrammatic comprehension on structures containing traces in A-positions which are not  $\Theta$ -positions. There are several such structures, those containing pleonastic elements (existential sentences and sentences containing weather verbs) and structures with quasiarguments (e.g., idiom chunks or measure phrases; cf. Rizzi, 1990). None of these have been tested in agrammatism, to the best of my knowledge. Empirical data bearing on this question may be hard to come by, but there are good conceptual reasons to believe that only one of these is the generalization of choice. They have to do with the following question: Are traces truly deleted from agrammatic representation? Once raised, this question opens the way to conceptual considerations that point to the  $\Theta$ -based account as the correct one.

Recall that the available data come almost exclusively from interpretive tasks, which require  $\Theta$ -role assignment. Does the pattern of impairment and sparing force a claim as strong as the TDH or is it, rather, consistent with weaker claims? The latter possibility appears more plausible. The involvement of traces in the agrammatic deficit (as far as is known) is with respect only to  $\Theta$ -role assignment. This opens the way to another possible view of the status of traces in agrammatism, somewhat reminiscent of the Visibility Hypothesis of Chomsky (1981). In this view, traces are intact, but are invisible to  $\Theta$ -role assignment. This view would mean

that every aspect of the construct trace is intact, except its involvement in  $\Theta$ -role assignment. To distinguish between complete deletion and invisibility, other experimental tasks are necessary, for instance, an examination of agrammatic sensitivity to violations of grammaticality that crucially rely on traces (e.g., ECP violations). There are no available data that bear on this issue at this point, but experiments are currently underway. In the new account, then, one would like to leave room for nondeleted, yet thematically invisible, traces. Crucially, these considerations are unstatable if an account based on A-positions is chosen, which leads us to exclude (13b) and stay with a restrictive Trace-Based Account as follows:

(14) *Trace-Based Account (TBA)*

Traces in  $\Theta$ -positions are deleted from agrammatic representation (or are invisible to  $\Theta$ -role assignment).

## 7. ASYMMETRIES IN QUESTIONS AND QUANTIFIERS AND A REFORMULATED STRATEGY

### 7.1. Questions

Hickok and Avrutin (1994) have recently tested agrammatic comprehension on four types of questions, along two dimensions: questions pertaining to subject (15b,d) vs. object (15a,c) position, and those expressed by *who* (15a,b) vs. *which* (15c,d):

- (15) a. Who did the girl push *t*?  
 b. Who pushed the girl?  
 c. Which boy did the girl push *t*?  
 d. Which boy pushed the girl?<sup>5</sup>

They obtained a surprising finding. The two patients they tested were above-chance on subject questions (15a,d), and at chance on the object question beginning with *Which* (15c) as consistent with the TBA, as well as with previous data on subject–object asymmetries (cf. Ansell & Flowers, 1982, Caplan & Futter, 1986 for cleft sentences, and Grodzinsky, 1989 for relative clauses). Yet on (15b), namely on the *who* object question, the patients were, unexpectedly, above-chance, in apparent violation of the TBA.

Hickok and Avrutin observe that there is a linguistic difference between *which* phrases and *who* phrases. *Which* phrases are “Discourse-linked,” requiring reference to previous discourse (cf. Pesetsky, 1987).

<sup>5</sup> Traces in subject position were not annotated here, because their presence or absence from the representation has no empirical consequences in the present cases (cf. Grodzinsky, 1990, p. 170).

The question in (15c), for instance, presupposes the existence of a set of boys, already mentioned in the discourse, from which one boy will be picked. It is pragmatically odd (although syntactically well-formed) to ask questions (15c,d) if there are no boys around. Thus, the interpretation of *which* questions requires both syntactic and contextual information. By contrast, no such requirements exist for *who* questions. Questions (15a,b) can be asked without presupposition, and the answer does not pick an element from a previously established set. Their interpretation is based only on intrasentential (syntactic and lexical) information. This difference, noted by Pesetsky, had led Cinque (1990) to propose a refinement to Rizzi's RM and argue in favor of the existence of two types of chains: Government (covering (15a,b) in the present context) and binding (15c,d) chains, in which only the latter are D-linked. This distinction helps Hickok and Avrutin to claim that in agrammatism only the latter type is disrupted, which presumably explains the asymmetry in the data.

Yet theirs is far from being an adequate explanation. Suppose, first and foremost, that only binding chains are disrupted. Does that account for the data from agrammatism? According to this claim, government chains are intact, which is why (15a,b) yield above-chance performance. If one makes the (rather dubious) assumption that there is no movement from subject position (i.e., no vacuous movement), then the near-normal performance on (15d) follows as well. But what about (15c)? This, indeed, is the critical case for Hickok and Avrutin. It is a case of a disrupted binding chain. Given that  $\Theta$ -roles are transmitted through the chain, and given the disruption, it follows that no  $\Theta$ -role is assigned in the wh-phrase (i.e., to *the boy*). However, the subject (i.e., *the girl*) does receive an Agent  $\Theta$ -role. Given that the patient knows the thematic structure of the verb, what then would stop him from inferring the missing role? It is precisely for this reason that the default strategy was initially assumed. Hickok and Avrutin's proposal thus does not predict their data correctly.

Second, the distinction between Government and Binding chains does not cover all the available data on agrammatism. For example, one of the most basic findings on agrammatic comprehension, namely the chance performance on passive, is not predicted. For it to be accounted for, the A-chain in passive needs to be (exclusively) a binding chain, yet as Cinque (1990, pp. 17–18) acknowledges, it is not at all clear whether his analysis assumes that. Similarly, the status of adjectival passives vis-à-vis this analysis is not clear.

It is thus advisable to seek an alternative explanation for the interesting puzzle Hickok and Avrutin have documented. It is also appropriate to ask whether the new TBA can account for this new set of data. A restrictive strategy to account for these data, as well as data on agrammatic comprehension of structures containing quantified NPs, is proposed below.



## 7.2. A Solution through the TBA

7.2.1. *The empirical problem.* At issue are asymmetries concerning agrammatic comprehension of questions, as evident from the data in (15). There are several ways to look at this data set, yet from the perspective of the TBA (and the (unmodified) Default strategy), the subject–object asymmetry (between (15c) and (15d)) is expected. What is not expected is the difference between the two types of questions, or, more accurately, unexplained is why the patients perform above-chance on (15a). As is, the TBA's prediction is incorrect for this data point: The trace is in a  $\Theta$ -position; hence, it is invisible. As a consequence, the NP *who* lacks a  $\Theta$ -role, and the strategy assigns it with Agent. Yet there is already another Agent in the representation (the subject *the girl*); hence, chance performance is predicted. How, then, can the TBA be reconciled with this result?

7.2.2. *Agrammatic knowledge of the referential properties of Wh-phrases.* Recall, first of all, the corollary derived above from Rizzi's Wh-criterion and its interaction with the results from agrammatism concerning Do-support: Given that this criterion requires a lexical head for a Wh-element in Spec of CP, Do-support in object questions, but not subject questions, was forced. In agrammatism, sensitivity to violations of Do-support has been demonstrated; hence, it follows that this group of patients is sensitive to the Wh-criterion. However, in order to be sensitive to it, one must have the Wh-element represented. It thus follows that patients are aware of the lexical properties of Wh-words, as stated in (10):

(10) Wh-elements are fully intact in agrammatic comprehension.

Now, this conclusion entails knowledge of the referential properties of Wh-elements by the patients. But what are these properties? As Pesetsky (1987) points out, there are important differences between *who* and *which* questions, in terms of the necessity to connect to previous discourse. *Who* questions do not presuppose a set in discourse; hence, they are not D(iscourse)-linked. *Which* questions are D-linked. Moreover, other syntactic differences (with respect to Superiority) lead to the following conclusions:

- (16) a. Non-D-linked phrases are quantifiers and adjoin to S' (Pesetsky's (33))  
 b. D-linked wh-phrases are not quantifiers (Pesetsky's (34))

This conclusion means that non-D-linked phrases (*who*) are not referential (since quantifiers never are), whereas D-linked phrases (*which*-NP) are referential and we have seen that this is a distinction agrammatics are aware of, since they must be aware of the Wh-criterion.

### 7.3. A Reformulated Strategy

Consider, now, the Default strategy. As is, it assigns a  $\Theta$ -role to a thematically lacking NP according to linear considerations. It does so indiscriminately, namely, regardless of whatever properties these NPs have. But why should that be? Consider the nature of cognitive strategies. They are, as is commonly held, results of inductive inferences over experience. As such, they fit words denoting entities with some semantic attribute, and critically, they do so in the absence of linguistic knowledge (since by hypothesis, when such knowledge is present, strategies are not operative). In this view, one would not expect cognitive strategies to apply to nonreferential elements.<sup>6</sup> Thus, a strategy effectively matches semantic roles to referential expressions on the basis of nonlinguistic knowledge. This is the most natural view of cognitive strategies that apply in the language domain. The strategy can thus be reformulated as follows:

(17) *R(eferential)-Strategy*

Assign a referential NP a role by its linear position iff it has no  $\Theta$ -role.

Nonreferential NPs are exempt from the strategy. In particular, quantifier-like, nonreferential Wh-expressions are outside its scope. Consider, now, the findings by Hickok and Avrutin, repeated below once again:

- (15) a. Who did the girl push *t*? (above chance)  
 b. Who pushed the girl? (above chance)  
 c. Which boy did the girl push *t*? (chance)  
 d. Which boy pushed the girl? (above chance)

The interaction between the TBA and the R-strategy gives precisely the desired results. (15c–d) are accounted for as before. In (15c) the strategy-assigned role on the NP [which boy] conflicts with that assigned to the subject NP [the girl], yielding chance performance. (15d) is a subject question; thus, if there is movement, it is correctly compensated for by the R-strategy. But consider (15a–b) now. Since *Who* is a nonreferential expression, it is exempt from the R-strategy. Thus in both cases, no role is assigned strategically to the wh-word. As a result, only one role is assigned (to the subject in (15a) and to the object in (15b)), and, given the intactness of lexical knowledge in agrammatism, the correct semantic

<sup>6</sup> Referentiality is used here in the manner common in linguistics, namely, in a sense that does not require reference in the world, but rather, in the universe of discourse. An element is thus used referentially when it refers to a member of a set that has been preestablished in discourse (cf. Chomsky, 1981; Pesetsky, 1987; Rizzi, 1990; Cinque, 1990).

role of the thematically dangling NP can be easily inferred.<sup>7</sup> Hence above-chance performance is predicted, fitting the data—old and new—precisely.

#### 7.4. *Passives with Quantified Antecedents*

What are the empirical consequences of the TBA? There are many, but a notable result is this: in movement-derived structures, with agentive predicates, one would expect chance performance if the moved constituent is extracted from object position and is referential. However, a change in one of these properties changes the prediction, along the following lines: (a) when agentive verbs are replaced by psych-predicates, performance goes down to below chance (as confirmed experimentally in Grodzinsky, 1995a); (b) when the trace is in subject position, performance goes up to normal (confirmed by many studies, e.g., Hickok & Avrutin, 1994; Grodzinsky, 1989); and (c) when the antecedent of the trace is nonreferential, performance should go up to normal levels, even though it contains an agentive predicate and a trace in object position, as we saw in (15a).

This last prediction is rather counterintuitive, yet surprisingly, there is an additional recent finding from an independent domain, precisely to that effect. This is a study by Saddy (this issue), conducted independent of the TBA, in which he shows that while Broca's patients perform at chance on passives, their performance level goes up to virtually normal if the subject of the passive is a quantified expression, even though the latter is ostensibly more "complex."<sup>8</sup>

- (18) a. The man is pushed by the boy (chance)  
 b. Every man is pushed by a boy (above chance)<sup>9</sup>

<sup>7</sup> As Na'ama Friedmann correctly points out, an additional assumption is necessary here: that the language processing device be capable of carrying out this inference in a way that has access to all the data structures that are required, namely the syntax as well as the argument structure. This is a nontrivial, yet a rather plausible, assumption.

<sup>8</sup> The result discussed here is one of several experimental results Saddy reports, mostly concerning the phenomenon of "quantifier spreading" in agrammatic comprehension, similar to children. These other effects, while interesting in their own right, are irrelevant in the present context.

<sup>9</sup> In such a sentence, when given to the patients in a sentence-to-picture matching task, as Saddy did, there can be several imaginable foils. Saddy reports having used the correct ones, namely, those involving reversal of  $\theta$ -role. Thus, the patient had to choose between a picture in which every man pushed a woman and one in which a woman was pushing every man.

This contrast is predicted by the TBA precisely: in (18a) chance performance is predicted, as we have seen above; in (18b), however, the subject *every man* is not referential and is thus exempt from the strategy. The agent role is assigned normally and transmitted to the oblique object (perhaps through clitic doubling),<sup>10</sup> yet unlike (18a), the R-strategy is blocked, and no  $\Theta$ -role is assigned to the quantified subject. As a result, its role can be easily inferred from the (available) knowledge of the lexical entry of the verb, and normal performance follows. The new restrictive account thus generalizes over the asymmetries in agrammatic performance in both questions and quantifiers.

## 8. A SHORT SUMMARY AND A FEW CONSEQUENCES

Let me summarize the claims made in this paper very briefly, before some general conclusions are drawn. The TDH has been modified, to account for the new data and to accommodate theoretical innovations in linguistics. The restrictive theory of agrammatic comprehension is this:

- (19) a. TBA: Traces in  $\Theta$ -positions are deleted from agrammatic representation (or are invisible to  $\Theta$ -assignment).  
 b. R-strategy: Assign a referential NP a role by its linear position iff it has no  $\Theta$ -role.

### 8.1. *The TBA and the Standard View of Agrammatism*

Reflect for a moment on this account. It contradicts most traditional beliefs about agrammatic aphasia: The impairment is restricted to  $\Theta$ -positions, and the strategy applies to referential expressions only, whereas functional categories are preserved. This is almost exactly the reverse of the common belief that the comprehension impairment in this syndrome involves the minor categories, and not the major ones; that the "closed class" is disrupted, whereas "open class" is intact (Bradley et al., 1980); that  $\Theta$ -assigners and assignees are intact, whereas the rest are impaired (Rizzi, 1985); and that lexical categories are preserved (Caplan, 1985). The standard conception of agrammatism has not made the necessary distinction between phrasal projections and heads in this syndrome, and it is perhaps for this reason that the accounts proposed to the deficit were incorrect. I hope to have convinced the reader of the necessity of a conceptual shift and that the data from comprehension require a

<sup>10</sup> In this respect, agrammatic comprehension is contrasted to children's abilities; as in the latter case, clitic doubling seems to be the problem (cf. Fox, 1993; Fox, Grodzinsky, & Crain, 1995).

characterization that restricts the deficit to  $\Theta$ -positions, even though this claim goes against a long tradition that should now be abandoned.

### 8.2. *Agrammatic Comprehension, Referentiality, and Long Wh-Movement*

Consider the R-strategy now. If it is restricted to referential expressions (referentiality being defined relative to a discourse), then it provides us with a powerful test for the referentiality of antecedents and of linguistic accounts that make use of this concept. Specifically, the distinction between long and successive cyclic wh-movement has been linked to referentiality (Rizzi, 1990, with further refinements in Cinque, 1990). The validity of such a claim can thus be readily tested in agrammatic aphasia: Just as we saw a distinction in the agrammatic comprehension system between *Which* and *Who* questions, we expect each case involving long wh-movement to result in impaired performance (to the extent that the strategy would compensate incorrectly for the loss of one  $\Theta$ -role). We also expect every case of cyclic movement to remain intact in agrammatism. We thus provide another instance in which evidence from aphasia can be used for a direct evaluation of the biological feasibility of grammatical theory.

### 8.3. *Agrammatic Comprehension and the Syntactic Analysis of Passive*

The proper analysis of the passive construction has long been a subject of an unresolved debate. In previous work (Grodzinsky et al., 1991), arguments were given for a movement-based analysis, in that a distinction between the patients' performance on adjectival vs. verbal passive was observed, in which the latter patterned with Wh-movement cases, generating erroneous performance, and adjectival passive yielded normal performance. We now observe another piece of data that leads to a similar conclusion: the contrast between passives with and without quantified subjects cannot be explained unless one assumed that the subject binds a trace (and that the R-strategy operates the way it does). We thus find ourselves in the interesting situation in which different types of passive generate virtually every possible performance type in agrammatism, as can be observed in (20):

- (20) a. verbal passive:     The man is pushed by the woman     (chance)  
       b. adjectival passive: The man is interested in the woman   (above chance)  
       c. psych passive:    The man is loved by the woman     (below chance)  
       d. quantified passive: Every man is pushed by a woman   (above chance)

This rich pattern and the theory that accounts for it argue quite strongly for traces in the post-participial position in passive.

#### 8.4. *Simplicity, Canonicity, and the Neural Representation of Grammatical Processes*

For several years there has been an intuitive suggestion floating around, according to which any deviation from canonical ordering of constituents is bound to cause comprehension problems to agrammatic patients. The notion underlying this idea is that brain damage results in a difficulty to analyze complex constructions, and given that canonically ordered sentences are simple and hence the easiest, we would expect our patients to succeed there and fail elsewhere. The current status of the data shows rather decisively that this view is incorrect: First, there are noncanonical arrangements that yield normal performance—*who* questions in which extraction is from object position and passives with quantified antecedents (which seem, in fact, to be more complex than regular passives which yield chance performance). Second, head movement, which sometimes results in surface noncanonical ordering, is intact. We can thus reject this type of account and direct our attention to another, according to which the problem in agrammatism is one of indirect projection of thematic structure. In this view (first proposed in Grodzinsky, 1984b, and now refined and substantiated), Broca's area and its vicinity are the loci of processes responsible for projecting lexical material onto sentence structure and linking  $\Theta$ -roles to NPs. It is this type of process, and nothing else, that is disrupted in agrammatic comprehension. Given the rich database that is currently available (for instance, the intactness of binding relations, of head movement, etc.) such a localizing statement can be confidently made.<sup>11</sup>

#### 8.5. *Cognitive Strategies*

Nongrammatical guidelines for analysis of input strings have occupied psycholinguists for a long time. Bever's (1970) well-known proposals generated a huge literature on strategies for linguistic analysis. These strategies, as is well-recognized by now, divide into those which help the parser to choose among grammatical representations (such as right association, for instance) and those which presumably compete with the parser (such as first NP = agent, etc.). With the former type linguists have no quarrel, for it is clear that in states of uncertainty (whether temporary or not) there must be some principles that direct the parser in its action. Yet the latter case, namely, when strategies come to direct conflict with the pars-

<sup>11</sup> This statement opens the way to a whole host of new questions: What is the nature of this grammatical process? How is its disruption related to other language-deficient populations, like children (normal and dysphasic)? What is the relation between this evidence and evidence from other measures of cerebral activity in language comprehension (e.g., ERP and PET)? Obviously, none of these questions can be handled in one pass.

ing device, is problematic, for it casts doubts on the necessity of such strategies, as well as their mode of operation.

In the present case, however, the proposal is much more restricted: A nonlinguistic, cognitive strategy operates just in case the parsing mechanism is under duress. This, in fact, is a rather natural assumption: that the deficient language faculty, for want of more information, would do anything it can to get at the analysis of the input string and that it would do so systematically. In particular, it is bound to use whatever information is available to it that is related to its past experiences, for instance, that words appearing sentence-initially are usually agents. It is also quite plausible that since the strategy is not linguistically motivated and operates over content, it would be restricted to elements that are referential.

#### 8.6. A Final Word

The linguistic investigation of aphasia is maturing rapidly. One can only hope that this development will bring with it harder problems, and lots of intellectual challenges that will attract young, adventurous investigators to come and study the neural representation of grammar.

### REFERENCES

- Ansell, B., & Flowers, C. 1982. Aphasic adults' use of heuristic and structural linguistic cues for analysis. *Brain and Language*, 16, 61-72.
- Avrutin, S. 1994. *Psycholinguistic aspects of establishing reference*. Ph.D. thesis, Department of Brain and Cognitive Sciences, MIT.
- Belletti, A., & Rizzi, L. 1988. Psych-verbs and th-theory. *Natural Language and Linguistic Theory*, 6, 291-352.
- Beretta, A., Harford, C., Patterson, J., & Pinango, M. 1994. *The proper description of comprehension deficits in agrammatic aphasia*. Paper presented at TENNET V, Montreal.
- Berndt, R. S., & Caramazza, A. 1980. A redefinition of the syndrome of Broca's aphasia: Implications for a neuropsychological model of language. *Applied Psycholinguistics*, 1, 225-278.
- Bever, T. G. 1970. The cognitive basis of linguistic structures. In J. R. Hayes (Ed.), *Cognition and the development of language*. New York: Wiley.
- Bradley, D. C., Garrett, M. F., & Zurif, E. B. 1980. Syntactic deficits in Broca's aphasia. In D. Caplan (Ed.), *Biological studies of mental processes*. Cambridge, MA: MIT Press.
- Burton, S., & Grimshaw, J. 1992. Coordination and VP-internal subjects. *Linguistic Inquiry*, 23, 305-313.
- Caplan, D. 1985. Syntactic and semantic structures in agrammatism. In M.-L. Kean (Ed.), *Agrammatism*. New York: Academic Press.
- Caplan, D., & Futter, C. 1986. Assignment of thematic roles by an agrammatic aphasic patient. *Brain and Language*, 27, 117-135.
- Caramazza, A., & Zurif, E. B. 1976. Dissociation of algorithmic and heuristic processes in sentence comprehension: Evidence from aphasia. *Brain and Language*, 3, 572-582.
- Cinque, G. 1990. *Types of A'-dependencies*. Cambridge, MA: MIT Press.
- Chomsky, N. 1981. *Lectures on government and binding*. Dordrecht: Foris Publications.

- Chomsky, N. 1986. *Barriers*. Cambridge, MA: MIT Press.
- Chomsky, N. 1991. Some notes on the economy of derivation and representation. In A. Kasher (Ed.), *The Chomskyan turn*. Cambridge, MA: Blackwell.
- Chomsky, N. 1992. A minimalist program for linguistic theory. MITWPL 1.
- Crain, S., & Shankweiler, D. 1985. *Comprehension of relative clauses and reflexive pronouns by agrammatic aphasics*. Paper presented at the Academy of Aphasia, Pittsburgh.
- Crain, S., Shankweiler, D., Gorrell, P., & Tuller, B. 1989. Reception of language in Broca's aphasia. *Language and Cognitive Processes*, **4**, 1–33.
- Fox, D. 1993. *The get-passive. implicit arguments and passive acquisition*. M.A. thesis, Tel Aviv University.
- Fox, D., Grodzinsky, Y., & Crain, S. Forthcoming.
- Friederici, A. 1982. Syntactic and semantic processes in aphasic deficits: The availability of prepositions. *Brain and Language*, **15**, 249–258.
- Friederici, A. 1985. Levels of processing and vocabulary types: Evidence from on-line processing in normals and agrammatics. *Cognition*, **19**, 133–166.
- Gardner, H., & Zurif, E. B. 1975. Critical reading at the sentence level in aphasia. *Cortex*, **11**, 60–72.
- Goodenough, C., Zurif, E. B., & Weintraub, S. 1977. Aphasics' attention to grammatical morphemes. *Language and Speech*, **20**, 11–19.
- Goodglass, H. 1968. Studies in the grammar of aphasics. In S. Rosenberg & J. Koplin, (Eds.), *Developments in applied psycholinguistics research*. New York: Macmillan.
- Grodzinsky, Y. 1984a. The syntactic characterization of agrammatism. *Cognition*, **16**, 99–120.
- Grodzinsky, Y. 1984b. *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. 1995a. Trace-deletion,  $\Theta$ -roles, and cognitive strategies. *Brain and Language*, in press.
- Grodzinsky, Y. 1995b. Comparative aphasiology. Paper presented at RUG-SAN-VKL Conference on Aphasiology, Groningen.
- Grodzinsky, Y., Pierce, A., & Marakovitz, S. 1991. Neuropsychological reasons for a transformational derivation of syntactic passive. *Natural Language & Linguistic Theory*, **9**, 431–453.
- Grodzinsky, Y., & Reinhart, T. 1993. The innateness of binding and coreference. *Linguistic Inquiry*, **24**, 69–102.
- Grodzinsky, Y., Wexler, K., Chien, Y. C., Marakovitz, S., & Solomon, J. 1993. The breakdown of binding relations. *Brain and Language*, **45**, 396–422.
- Grossman, M., & Haberman, S. 1982. Aphasics' selective deficits in appreciating grammatical agreements. *Brain and Language*, **16**, 109–120.
- Hagiwara, H. 1993. Nonagentive predicates and agrammatic comprehension. *Metropolitan Linguistics*, **13**, 127–142.
- Hickok, G., Zurif, E. B., & Canseco-Gonzales, E. 1993. Structural description of agrammatic comprehension. *Brain and Language*, **45**, 371–395.
- Kitagawa, Y. 1986. *Subjects in English and Japanese*. Doctoral dissertation, University of Massachusetts at Amherst.
- Koopman, H., & Sportiche, D. 1988. *Subjects*. Unpublished manuscript, UCLA.
- Kuroda, S.-Y. 1986. *Whether we agree or not*. Unpublished manuscript, UCSD.
- Lapointe, S. G. 1985. A theory of verb form use in agrammatism. *Brain and Language*, **24**, 100–155.



- Linebarger, M. C., Schwartz, M., & Saffran, E. 1983. Sensitivity to grammatical structure in so-called agrammatic aphasics. *Cognition*, **13**, 361–393.
- Lonzi, L., & Luzzatti, C. 1993. Relevance of adverb distribution for the analysis of sentence representation in agrammatic patients. *Brain and Language*, **45**, 306–317.
- Lukatela, K., Crain, S., & Shankweiler, D. 1988. Sensitivity to closed-class items in Serbo-Croat agrammatics. *Brain and Language*, **13**, 1–15.
- Mauner, G., Fromkin, V., & Cornell, T. 1993. Comprehension and acceptability judgments in agrammatism: Disruption in the syntax of referential dependency. *Brain and Language*, **45**, 340–370.
- Pesetsky, D. 1987. *Wh*-in situ: Movement and unselective binding. In E. Reuland & A. ter Meulen (Eds.), *The representation of (in)definiteness*. Cambridge, MA: MIT Press.
- Pinker, S. 1984. *Language learnability and language development*. Cambridge, MA: Harvard University Press.
- Pollock, J.-Y. 1989. Verb movement, universal grammar and the structure of IP. *Linguistic Inquiry*, **20**, 365–424.
- Rizzi, L. 1985. Two notes on the linguistic interpretation of aphasia. In M.-L. Kean (Ed.), *Agrammatism*. New York: Academic Press.
- Rizzi, L. 1990. *Relativized minimality*. Cambridge, MA: MIT Press.
- Rizzi, L. 1991. Residual verb second and the *Wh*-criterion. Unpublished manuscript, University of Geneva.
- Schwartz, M., Saffran, E., & Marin, O. 1980a. The word-order problem in agrammatism. I. Comprehension. *Brain and Language*, **10**, 249–262.
- Schwartz, M., Saffran, E., & Marin, O. 1980b. The word-order problem in agrammatism. II. Comprehension. *Brain and Language*, **10**, 263–280.
- Schwartz, M. F., Linebarger, M. C., Saffran, E. M., & Pate, D. C. 1987. Syntactic transparency and sentence interpretation in aphasia. *Language and Cognitive Processes*, **2**, 85–113.
- Shapiro, L. P., & Levin, B. A. 1990. Verb processing during sentence comprehension in aphasia. *Brain and Language*, **38**, 21–47.
- Shapiro, L. P., Gordon, B., Hack, N., & Killackey, J. 1993. Verb-argument structure processing in complex sentences in Broca's and Wernicke's aphasia. *Brain and Language*, **45**, 423–447.
- Snyder, W. 1992. *Chain formation and crossover*. Unpublished manuscript, MIT.
- Swinney, D., E. B. Zurif, & J. Nicol. 1989. The effects of focal brain damage on sentence processing. An examination of the neurological organization of a mental module. *Journal of Cognitive Neuroscience*, **1**, 25–37.
- Travis, L. 1984. *Parameters and effects of word order variation*. Ph.D. dissertation, MIT.
- Zurif, E. B., & Caramazza, A. 1976. Linguistic structures in aphasia: Studies in syntax and semantics. In H. Whitaker & H. H. Whitaker (Eds.), *Studies in neurolinguistics*. New York: Academic Press. Vol. 2.
- Zurif, E. B., & Grodzinsky, Y. 1983. Sensitivity to grammatical structure in agrammatism: A reply to Linebarger *et al.* *Cognition*, **15**, 207–213.
- 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 and Language*, **45**, 448–464.