Aphasia and the Theta System

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Introduction

Aphasia is an impairment that affects only the language faculty of the patient, whereas the rest of cognitive functions remain unimpaired. This has been used to study the relationship between language and the brain, namely, the localization of language in the brain and the neuronal circuits related to it. Aphasia has been used, furthermore, as an argument for the modularity hypothesis of language, which considers language as an independent module different from other cognitive systems such as reasoning, problem solving or memory.

Aphasiology needs a theoretical background regarding the structure of the language, on which it can rely. Theoretical Linguistics offers such a support. All the work commented and developed in this paper relies on Linguistic Theory, more concretely on the framework of Government and Binding (G&B henceforth, Haegeman 1994, Shapiro 2000) and early stages of the Minimalist Program (MP henceforth, Chomsky 1995; Hornstein et al. in progress) within the Generative Grammar. Aphasiology and Linguistics, as Avrutin (2001) points out, may benefit from each other. Nevertheless, it is still possible nowadays to see many studies on aphasia that largely ignore the linguistic background of the impairment they are addressing.

This work is structured as follows. The first chapter aims to give a brief theoretical background that is necessary to the understanding of the rest of the paper. The notions of aphasia and agrammatism are introduced here as well as the foundations of the G&B framework.

The chapter 2 is a literature review of several accounts for agrammatism based on G&B and MP. I have classified the different hypothesis depending on which module of the language is being focused: syntactic movement, Theta (thematic roles) Theory and Case Theory.

In chapter 3, I introduce an alternative hypothesis for the performance of agrammatics on passive sentences, namely the Lack of Merging hypothesis. This is based on Reinhart's (2002) Theta System, and tries to account for the predictions made by Grodzinsky's (1995a) Trace Based Account without applying to the notions of neither trace nor movement.

Chapter 4 presents the results of an experiment carried out in the Rehabilitation Center De Hoogstraat in Utrecht, in order to empirically contrast the predictions of the Lack of Merging Indexes hypothesis against the predictions of the Trace Based Account. At the end of this chapter, the general conclusions of the present work are summarized and I point out some directions that might be interesting for further research.

Chapter 1
Theoretical Background

In this chapter, I shall introduce the theoretical background necessary in order to understand both the literature discussed in chapter 2, and the new proposal introduced in the subsequent chapters.

First, two concepts will be distinguished: on the one hand *aphasia*, which is an impairment on language faculty in either the comprehension or the production. On the other hand, *agrammatism* is a more restrictive impairment that seems to accompany some cases of aphasia, mainly Broca's aphasia. Agrammatism is a syndrome, that is, a collection of symptoms both in speech and in language comprehension, rather than a diagnostical category like Broca's or Wernicke's aphasias.

Finally, a brief introduction will be given on basic concepts and theories that form the Government & Binding framework (Haegeman 1994, Shapiro 2000) within Generative Linguistics. This introduction is necessary because it constitutes the framework on which this whole paper relies.

1.1 Aphasia

Language is the system that allows people to communicate an unlimited combination of ideas by using a highly structured stream of sounds.

Language is a core faculty different from other cognitive abilities like reasoning, with which it often interacts. Thinking is the ability both to have ideas and to infer new ideas from old ones. Language is the ability to encode those ideas into signals for communication to someone else. People do not think only in the words and sentences of

their language. Thinking can occur in the absence of language. On the other hand, language cannot express the totality of a person's knowledge.

Given that language is one of the most accessible parts of human cognition, it has attracted much attention in the last decades of scientific research. More specifically, language acquisition and language breakdown have been used to study the working of "normal" (in the sense of unimpaired) adult language.

Within language breakdown, aphasia is an excellent source of information because it is a disorder that only affects language faculty: there is virtually no effect in other cognitive systems. The DSM-IV (American Psychiatric Association 1994) defines aphasia as in (1):

(1) *Aphasia:*
Impairment in the understanding or transmission of ideas by language in any of its forms – reading, writing, or speaking – that is due to injury or disease of the brain centers involved in language.

Why is the study of aphasia important? Aphasia, as said before, is a disorder that exclusively affects language faculty without any influence whatsoever on other cognitive modules. Considering this point, aphasiology can help to clarify the relationship between brain and language, namely, which neurological mechanisms are implied in the language function.

For example, it is known that injury or traumatism on the left hemisphere leads to a loss in the language ability whereas injury on the right hemisphere leaves the main linguistic functions more or less intact. These data, among other findings, have led researchers to the formulation of the Wernicke-Geschwind model (Dronkers et al. 2000), represented in Figure 1, which tries to account for language processing and its neurological implementation.

The earliest version of this model consists of three components:

1. **Wernicke's and Broca's areas** were assumed to have the burden of processing the acoustic images of words and the articulation of speech, respectively.

2. **The arcuate fasciculus** was thought to be an unidirectional pathway that brought information from Wernicke's area to Broca's area.
3. Both Wernicke's and Broca's areas were presumed to interact with the polymodal association areas.

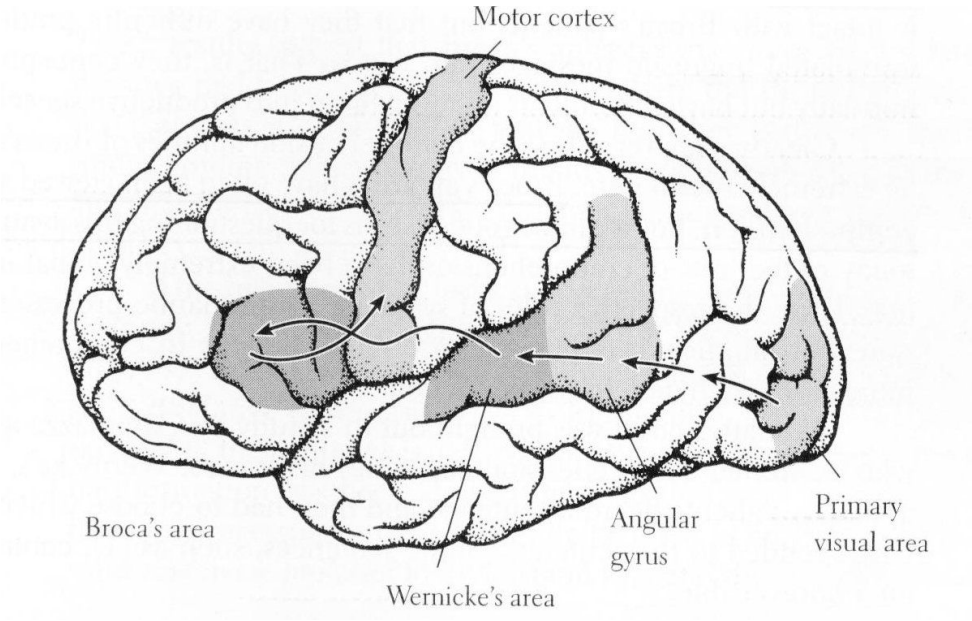

Figure 1 Wernicke-Geschwind model (picture taken from Carroll 1999)

According to this model, after a spoken word is processed in the auditory pathways and the auditory signals reach Wernicke's area, the word's meaning is evoked when brain structures beyond Wernicke's area are activated. Similarly, nonverbal meanings are converted into acoustic images in Wernicke's area and turned into vocalizations after such images are transferred by the arcuate fasciculus into Broca's area.

This model has been very useful in order to make a classification of aphasic syndromes (Dronkers et al. 2000):

1. **Broca's aphasia:** results from a large frontal lobe lesion, mostly in Broca's area. Although this type of aphasia is not a single entity, it can be characterized by non-fluent, effortful and *agrammatic* speech (this characteristic is discussed in the next section); a largely (but not completely) preserved comprehension for single words and grammatically simple sentences (this characteristic shall be largely discussed throughout this paper); and incapacity for repetition.

2. **Wernicke's aphasia:** results from damage to left temporal lobe structures, mainly to Wernicke's area. The speech of these patients is fluent, abundant, well articulated and melodic but it lacks linguistic message. This means that they speak a lot but meaning is lost. They usually create new words ("neologisms"). Their linguistic comprehension is impaired as well as their capacity for repetition.
3. **Conduction aphasia:** results from damage to structures that interact with major language areas of the brain such as the left superior temporal region and the supramarginal gyri. Speech is usually fluent with some articulatory defects. Comprehension ability is intact or largely preserved. However, the capacity for repetition is impaired.
4. **Global aphasia:** is thought to be a combination of Broca's, Wernicke's and Conduction aphasias. These patients have completely lost the ability to comprehend language, formulate speech, and repeat sentences, thus combining the features of the three previous aphasias. So much damage can only be caused by a large infarct in the region supplied by the middle cerebral artery.

New data provided by more advanced techniques like the positron emission tomography (PET), functional magnetic resonance imaging (fMRI) or event-related electrical potentials (ERP), have shown that this model has severe limitations. It is now clear that the roles of Wernicke's and Broca's areas are not as clear as they first appeared. The idea that Wernicke's aphasia is no more than a comprehension disorder and Broca's just affects to the production must be abandoned under the light of new data (Camarazza & Zurif 1976, Grodzinsky 1984, 1995a, Avrutin 2001, among many others). Similarly, the arcuate fasciculus is now appreciated to be a bidirectional system.

The modern framework (Dronkers et al. 2000) that has emerged from these latter works, suggests that three large systems interact closely in language perception and production:

1. The language areas of Broca and Wernicke, selected areas of insular cortex, and the basal ganglia form one system. Together, these structures constitute a **language implementation system**. It analyzes incoming auditory signals so as

to activate conceptual knowledge and also ensures phonemic and grammatical construction as well as articulatory control.

2. The implementation system is surrounded by a second system, the **mediational system**, made up of numerous separate regions in the temporal, parietal, and frontal association cortices. The mediational regions act as third-party brokers between the implementation system and the conceptual system.
3. The **conceptual system** is a collection of regions distributed throughout the remainder of higher-order association cortices, which support conceptual knowledge.

1.2 Agrammatism

Agrammatism is a syndrome that usually appears in a more general aphasic impairment, mostly (but not exclusively, see section 2.5 below and Berndt et al. 1996) in Broca's aphasia. It is manifested by the presence of ungrammatical utterances in the speech. That is to say that functional heads, such as inflections, bounds morphemes like tense, case and agreement are lacking (or unspecified) in the agrammatic speech (see the Agrammatic Condition in section 2.4.1 below in this paper, Grodzinsky, 1984).

Until the late 70's, it was commonly thought that Broca's aphasics suffered only from impaired language production, on the basis of their agrammatic speech. However, Camarazza & Zurif (1976) showed that their comprehension was impaired as well. After the work of those authors, many others (Grodzinsky 1995a, 1995b, 2000; Bastiaanse et al. 2001; Burchert et al. 2003, among many others) have shown that agrammatism also affects language comprehension capacity.

One of the most influential theories on agrammatic comprehension is the Trace Deletion Hypothesis, more recently redefined as the Trace Based Account (TBA henceforth, Grodzinsky 1995a). It characterizes agrammatic patients as good comprehender of active sentences but as bad comprehenders of semantic reversible passive sentences. This theory, among others, will be discussed below in chapter 2.

Nonetheless, agrammatism does not imply an unitary comprehension pattern. Other patterns of comprehension, different from the one described by the TBA, have

been observed and documented by Druks & Marshall (1995) and Berndt et al. (1996) among many others (see references cited therein).

On the one hand, there exist Broca's patients that do not show agrammatism either in production or in comprehension and, on the other hand, patients other than Broca's may show agrammatism too. Therefore it is not entirely clear to what extent agrammatism can be considered as a differential diagnostical category.

1.3 Government and Binding Theory

Modern theories on agrammatic language production and comprehension claim to be based on Linguistic Theory. In particular, the hypotheses on agrammatism surveyed in chapter 2, strongly rely on the framework of G&B (Shapiro 2000; Haegeman 1994), which is a particular view of the grammar of human languages. Within this framework, language is thought of as an independent faculty of the human being. This independency is reflected in the *double modularity view of the language*. That is to say, on the one hand, that the language itself is an independent module, different from other cognitive processes, such as reasoning or memory. On the other hand, language is modular because it is, in turn, composed of several modules that are, to a certain extent, independent from each other. All human languages are thought to share certain basic rules, i.e. the *Universal Grammar* (UG henceforth), which accounts for, among other things, the *learnability problem of language*. In other words, UG accounts for the question as to how children can learn a language in such a short time considering the poverty of the linguistic stimuli they receive. The grammar in G&B is composed of several theories (modules of the grammar) that interact with each other (see Figure 2).

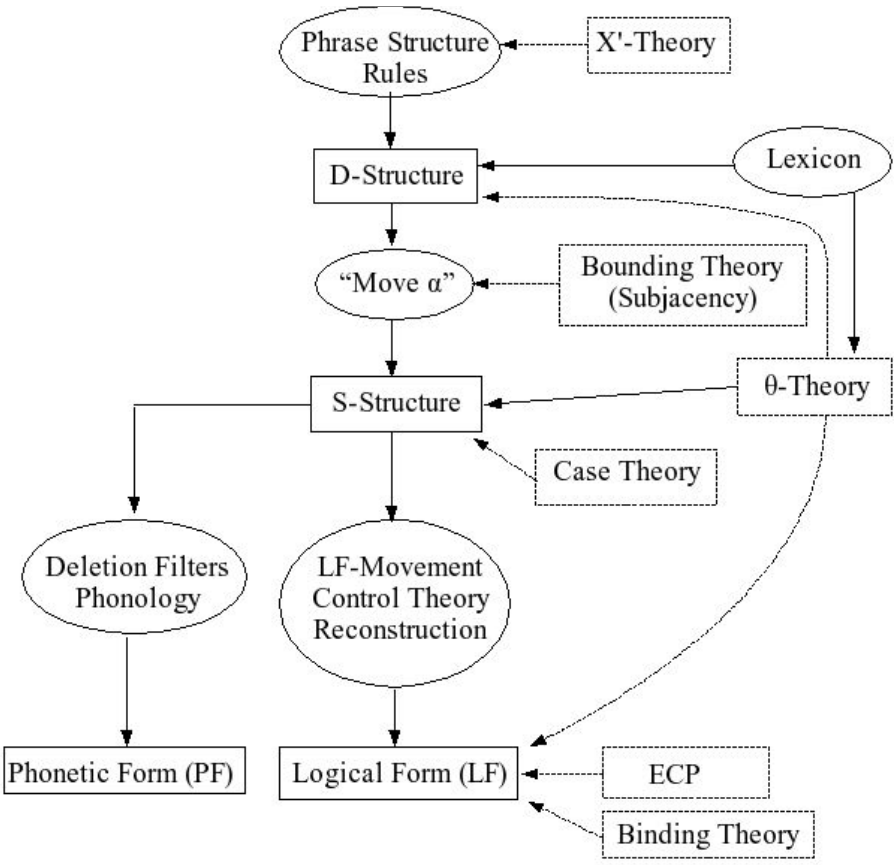

Figure 2 The organization of the modules of Government & Binding Theory

1. **X-Bar Theory:** this module tells us about the internal structure of syntactic constituents. It was originally intended to place constraints on the power of phrase structure rules. X-bar Theory captures the insight that all phrases share some essential structural properties and elements. That is to say, all phrases have the same structure, represented in Figure 3.

   According to X-Bar Theory, all lexical and functional elements project X-bar levels, thus nouns, adjectives, prepositions and verbs (lexical elements) head and project onto NPs, APs, PPs and VPs, respectively; whereas the finite inflection of the verb and the complementizers (functional elements) respectively head and project onto IPs and CPs. A sentence is an IP, which most of the times further projects onto a CP, whether or not the complementizer is phonetically realized.

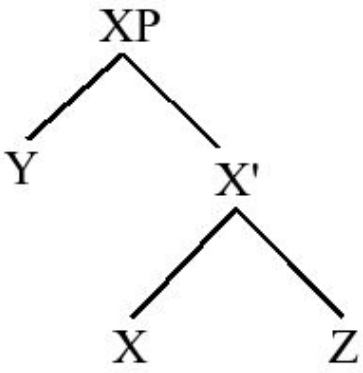

Figure 3 Structure of a phrase, according to X-Bar Theory

2. **Dependency Theory:** deals with *syntactic movement*, which is an essential process in order to derive the Logical Form (LF) of a sentence from its S(urface)-Structure and this, in turn, from its D(eep)-Structure. Movement consists of reordering a constituent of the sentence. G&B acknowledges four levels of representation, which form the T-Model of the Grammar (represented in Figure 4):

   a) D-Structure: a level of representation determined by lexical information.

   b) S-Structure: a level of representation derived from D-structure by transformational rules (movement), and input to the rules deriving PF and LF.

   c) Phonological Form (PF): a level of representation where only information relevant to the phonetic realization of the utterance is present. At this level, which is derived from S-structure, only phonological processes may apply.

   d) Logical Form (LF): a structural level of representation, which contains all (and only) the syntactic information that is relevant for semantic interpretation. LF is thus taken to be the interface between an expression (language) and its logical form (in the semantic sense).

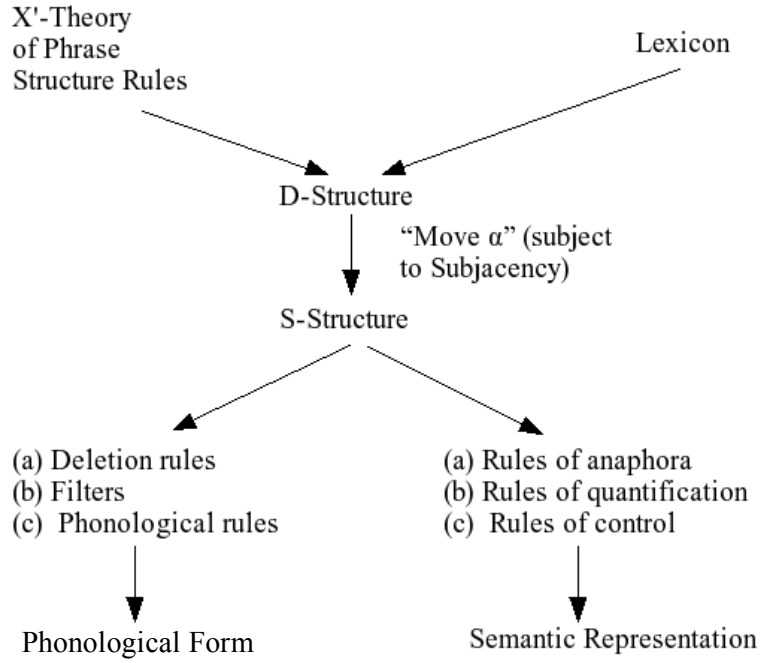

Figure 4 T-Model of Grammar

We say that an element at S-structure has been moved if there is a certain relationship between the element and an empty position elsewhere in the structure. This relation is represented by means of a chain formed between the moved element and the trace that it lefts behind.

3. **Theta Theory:** concerns thematic (theta) roles. The theta roles encode the relation of a participant with the verb that describes the event or action. The most typical roles are *agent*, *theme*, *patient*, *experiencer* and *instrument*. The *Theta Criterion* is a condition that states that, at D-structure, each verb argument is in a theta-position, and that each theta-position contains an argument.

4. **Case Theory:** case is a grammatical feature that distinguishes, among other functions, *subject* and *(direct) object*. In many languages, such as Latin and German, case is morphologically visible. In English and Dutch, morphological case is only visible in the pronominal system (*he* vs. *him* etc.). Even in languages without overt *morphological case*, there is *abstract case*, which is a condition necessary in order to license overt noun phrases in the sentence. The distinction between *structural case* and *inherent case* is that the former is assigned under Government, which is the basic relationship between two constituents in the

sentence whereas inherent case is tied to a specific thematic interpretation and is closely related to theta assignment. The *Case Filter* requires an (overtly realized) NP argument either to be case marked or to be associated with a case position.

5) **Binding Theory:** accounts for how different kinds of nominal expressions (NPs and pronouns) have anaphoric relations between one another.

6) **Bounding Theory:** is a theory about the locality of movement. The main principle of Bounding Theory is the *Subjacency condition*, which forbids movement across more than one bounding. In more recent stages of G&B, bounding nodes have been redefined as barriers, defined as categories that serve as a blockage for Government and/or movement.

7) **Control Theory:** theory that accounts for the referential properties of PRO, which is a pronoun without phonetic properties. PRO is the subject of infinitival clauses such as "*I want [PRO to go home]"*.

Chapter 2
Literature Review: Agrammatism and Linguistic Theory

In this chapter, I will review the main theories proposed so far to account for the effects of agrammatism in both language production and comprehension. These theories have been classified depending on which module of the language faculty they mainly rely. In section 2.1 three hypotheses which rely on the notion of syntactic movement are discussed. In the next section I present other three hypotheses that resort to Theta Theory (which is the module that concerns the assignment of thematic roles to the participants of the event conveyed by the verb, and the relationship between those roles with their syntactic functions such as *subject* or *direct object*). Some accounts relying on Case Theory are presented in section 2.3. Other theories are eventually commented in section 2.4, and the final section presents the general conclusions that I have reached by the analysis of the literature reviewed in the present chapter.

2.1 Agrammatism and Syntactic Movement

When one looks at dependency relations, it can be seen that an impaired comprehension arises.

The formal aspects of binding relations are intact in agrammatism. The fact that certain relations among pronouns, reflexives, and their antecedents are impaired is actually related to discourse aspects of pronominal reference and not to binding theory as such (Grodzinsky & Reinhart 1993 and Avrutin, S. 1994; both cited in Grodzinsky 1995a).

However, syntactic movement seems to be seriously damaged (Grodzinsky, 1995a). Three kinds of syntactic movement can be distinguished:

1. **X^0-movement:** is commonly known as *head-to-head* movement and it is instantiated in verb movement, Subject-Aux(iliary) inversion, *do-support* and the movement of matrix verbs to the second position (V2) in Germanic languages.
2. **A-movement:** results in chains headed by an element in an A-position. This includes passive, unaccusatives, and raising constructions.
3. **A'-movement:** results in chains headed by an element in an A'-position. An instance of this kind of movement is *Wh*-movement in the formation of questions.

X^0-movement seems not to be impaired in agrammatism (Grodzinsky 1995, but see section 2.1.3 below and Bastiaanse 2001) whereas A- and A'-movement are clearly hampered.

2.1.1 The Trace Based Account

In order to account for Broca's aphasics' impaired performance on semantically reversible passive sentences and unimpaired performance on semantically reversible active sentences, Grodzinsky (1995a, 1995b, 1998) formulated the *Trace Deletion Hypothesis* in (2).

(2) *Trace Deletion Hypothesis (TDH):*

In agrammatism, all traces[1] of movement are deleted from S-Structure representation.

The TDH could not explain, however, why agrammatics' performance on structures that involved syntactic movement, was sometimes unimpaired, as in the case of subject

[1] In G&B, it is assumed that if an element X has been moved in the course of a derivation, it has left a trace in its original position, as in (i). It is possible to determine the thematic role of the moved NP via its trace since they both form a syntactic chain. See Shapiro (2000) and Haegeman (1994) for an extended discussion on syntactic movement and traces.

(i) $John_i$ seems [$\mathbf{t}_i$ to have left]

relative sentences. An extra element, of non linguistic nature, had to be included in the theory so as to gain explanatory force. This element was the *Default Strategy*, defined in (3).

(3) *The Default Strategy:*

This is a non linguistic general cognitive strategy that assigns to the NPs lacking a theta-role, a default role by their linear position in the sentences. This role, for cases tested so far (at that time), was always *agent* (but see Grodzinsky 1995b for *psych-verbs*).

The original TDH claimed thus, that all traces were deleted from S-structure representations in agrammatism. As a consequence, theta-role transmission to moved constituents, normally mediated by the chain that the trace and its antecedent formed (and potentially, intermediate traces as well), could not take place. Any moved NP thus, would lack its thematic role. Therefore, structures that contained traces[2] were not normally understood whereas the rest, i.e. structures without traces, were preserved.

However, several factors made the TDH inappropriate under the light shed by new empirical data. First of all, the TDH was too weak because all traces were predicted to be deleted. However, it was shown that some instances of movement were well preserved, such as verb movement in *yes/no questions* in English. Moreover, the VP-Internal Hypothesis[3] gained more strength in the late period of the G&B framework. This means that even active sentences were thought to contain traces since the subject was base-generated in [Spec, VP] and thence, it should further move to [Spec, IP] so as to receive its Case. Finally, Avrutin (2000) showed that referentiality of DPs influenced agrammatics' comprehension, which was impaired on Which-questions (that are D (iscourse)-liked-Wh-questions) whereas it was surprisingly normal-like on Who-

[2] At the time this version of the TDH was formulated, the VP-Internal Hypothesis (see footnote 3) was not taken under consideration. Hence, actives sentences were thought not to contain any trace in their S-structure.

[3] The VP-Internal Hypothesis (VPIH) claims that the verb is not base generated in [Spec, IP], as in (ii), but in [Spec, VP] and thence it further moves to [Spec ,IP] in order to get nominative case, as in (iii):

(ii) $[_{IP}$ subject $[_{VP}$ V]]

(iii) $[_{IP}$ subject$_i$ $[_{VP}$ t_i $[_{V'}$ V]]]

questions (Non-D(iscourse)-linked questions). This is to say, in sentences like "*Which girl is kissed by the man*" the performance was like the TDH predicted, but in sentences like "*Who is kissed by the man*", the performance was normal-like, this is, above chance. This showed that the predictions of the TDH were contradicted by fact.

Therefore, the TDH was reformulated as the Trace-Based Account (TBA) (Grodzinsky 1995a), given in (4), in order to include these latter experimental findings.

(4) *The Trace-Based Account (TBA):*

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

(5) *R(eferential)-Strategy:*

Assign a referential DP a theta role by its linear position if and only if it has no theta-role.

The strength of the deletion of traces was restricted so that it had effect just on theta-positions, that is, positions that contain DPs that must be theta-marked by a theta-assigner. Other positions, such as head (X^0) positions, were not affected by the deletion of traces or, in other words, the effect of the trace deletion was not noticeable.

In a similar way, the Default Strategy was constrained and R(eferential Strategy) was formulated as in (5). DPs lacking a theta role were assigned a theta-role by their linear position if and only if they were referential. If not, as in non-D-linked-Wh-questions or quantified NPs, the system was forced to infer the thematic role from the verb, and a normal-like performance resulted.

R-Strategy gives either competition or compesation of thematic roles. If competition results, the patient is forced to guess and hence the chance performance. This explains normal performance on active, subject relative and subject cleft sentences (there is compensation of thematic roles) and chance performance on passives, object relative and cleft sentences (there is competition of thematic roles).

Following the TBA, active sentences are well understood because, though deletion of the trace of the DP in subject position takes place and hence, it cannot "*grammatically*" receive its agent theta role, as in (6c), the application of R-Strategy

compensates the trace deletion and the DP in [Spec, IP] receives its agent role, as in (6d).

(6) a) The boy $_{agent}$ kisses the girl $_{patient}$ *(active sentence)*

b) [$_{IP}$ The boy $_{i,agent}$ [$_{VP}$ t$_{i,agent}$ [$_{V'}$ kisses the girl $_{patient}$]]] *(normal representation)*

c) [$_{IP}$ The boy $_{no\ theta\ role}$ [$_{VP}$ [$_{V'}$ kisses the girl $_{patient}$]]] (*Trace Deletion*)

d) [$_{IP}$ The boy $_{agent}$ [$_{VP}$ [$_{V'}$ kisses the girl $_{patient}$]]] (*R-Strategy applies*)

In subject relative and cleft sentences, the rationale is the same. Even when the moved DP cannot receive its theta role by means of the chain that it should form with its trace, R-Strategy compensates this and it receives an agent role.

However, passive sentences are not well understood since the moved DP in [Spec, IP] cannot receive its theta role by means of the chain as in (7c). Then, R-Strategy applies but the DP is assigned an agent role whereas its original role is patient, as can be seen in (7d). The problem is that the DP in the *by*-phrase is assigned an agent role by means of the preposition "*by*". Thus there are two competing agent roles and the patient is therefore forced to guess which one is the correct one. Hence, the performance is at chance in passive sentences.

(7) a) The girl $_{patient}$ is kissed by the boy $_{agent}$ (*passive sentence*)

b) [$_{IP}$ The girl $_{i,patient}$ [$_{VP}$ is kissed t $_{i,\ patient}$] [by the boy$_{agent}$]] (*normal representation*)

c) [$_{IP}$ The girl $_{no\ theta\text{-}role}$ [$_{VP}$ is kissed] [by the boy$_{agent}$]] (*Trace Deletion*)

d) [$_{IP}$ The girl $_{agent}$ [$_{VP}$ is kissed] [by the boy$_{agent}$]] (*R-Strategy applies*)

This explanation holds for object relative and cleft sentences. The moved DP receives agent role by its linear position. However, there is already another agent role and a competition between them both takes place, forcing the patient to guess which DP is the "real" agent, and hence, the chance performance.

Non referential NPs are exempt from this strategy. In particular, quantified NPs and non-referential *Wh*-expressions are outside the scope of R-Strategy. This accounts for the experimental findings of Avrutin (2000): semantically reversible passive

sentences where the moved DP was quantified (like "*every girl is kissed by the boy*") or non-D-Linked-*Wh*-element (like "*who is kissed by the man*") were normally understood by agrammatics. The TBA predicts now that passive sentences with quantified antecedents will be well understood since R-Strategy does not apply (given that a quantified antecedent is not referential). The system is thus forced to infer the theta role of the quantified DP from the theta-grid of the verb as in (8).

(8) a) Every girl $_{patient}$ is kissed by the boy $_{agent}$ (*passive sentence*)

b) [$_{IP}$ Every girl $_{patient}$ [$_{VP}$ [$_{V'}$ is kissed t $_{patient}$ by(..) $_{agent}$]]] (*normal representation*)

c) [$_{IP}$ Every girl $_{no\ theta\ role}$ [$_{VP}$ [$_{V'}$ is kissed by(…) $_{agent}$]]] (*Trace Deletion*)

d) [$_{IP}$ Every girl $_{patient}$ [$_{VP}$ [$_{V'}$ is kissed by(…) $_{agent}$]]] (*R-Strategy cannot apply*)

Sometimes, the *by*-phrase is not present, as in (9).

(9) The girl is kissed (*short passive sentence*)

However, the argument in the *by*-phrase is syntactically active, as can be shown by several tests (see Grodzinsky & Balogh 2000). The implicitness/explicitness of the *by*-phrase is a phonological process: even when the *by*-phrase is not pronounced it is always present both in syntax and semantics. Grodzinsky & Balogh (2000) argue – supported by evidence - that agrammatics have that knowledge of implicitness/explicitness of the *by*-phrase unimpaired and thus, even in short passives (i.e. without overtly pronounced *by*-phrase), their performance is at chance. This can only be accounted for if it is assumed that agrammatics' syntactic representation of short passives sentences include the implicit *by*-phrase with the agent role, so that competition of agent roles takes place.

2.1.2 The Double Dependency Hypothesis

The Double Dependency Hypothesis (DDH henceforth, Mauner et al. 1993 cited in Beretta et al. 2001) tries to deal with agrammatics' above-chance performance on actives vs. chance performance on passives. It claims that in syntactic chains where only one

theta role is assigned, the dependency between a referential DP and the foot of the chain is disrupted. In sentences where there are two such dependencies, it is unclear which DP is coindexed with which trace. Since the coindexation is ambiguous and since thematic role assignment is thereby also ambiguous, agrammatics must guess who is doing what to whom. However, when there is only one such dependency, i.e. just one chain, no ambiguity is possible, and therefore comprehension should be normal.

(10) *The Double Dependency Hypothesis (DDH):*

a) The deficit underlying asyntactic comprehension affects the processing of syntactic referential dependencies.

b) When there is only one such dependency, the resulting syntactic representation, though abnormal, is not ambiguous, but when there are two such dependencies, the resulting representation is ambiguous.

Beretta et al. (2001) carried out an experiment in order to come up with evidence to contrast the DDH versus the TBA, the Mapping Hypothesis (MH), and the Argument Linking Hypothesis[4] (ALH).

They compared agrammatics' performance on scrambled actives; clitic left dislocation structures; and scrambled passives:

1. **Scrambled actives**: in Korean, the basic word order is SOV. However, scrambling the object is allowed, which yields the structure in (11). The predictions are as follows: DDH predicts chance performance due to the fact that there are two chains. The TDH predicts a below-chance performance given that both theta roles would be assigned by R-Strategy, the first one agent and the second one theme. The ALH predicts chance performance given that semantic linking is at odd with syntactic linking and MH predicts chance performance because the most controlling role is not the first one.

[4] Both the MH and the ALH will be described further below in this paper.

(11) *Scrambling active:*

Saja-lul $_i$ key-ka $_j$ t $_j$ t $_i$ mul-eyo

lion-acc dog-nom bit-comp

"The dog bite the lion"

2. **Clitic left dislocation**: in Spanish, object scrambling is not permitted unlike left dislocation. The object can be put before the subject. However, a clitic is necessary. The predictions in this structure are the same as for scrambling actives in Korean.

(12) *Clitic left dislocation:*

a) A la girafa la mujer la está empujando

To the giraffe the woman it is pushing

"The woman is pushing the giraffe"

b) [A la girafa] $_i$ [la mujer] $_j$ t $_j$ t $_i$ la está empujando

3. **Scrambled passives**: in this structure, DDH predicts chance performance. On the contrary, all other hypothesis predict unimpaired performance. The TDH predicts that, given that both DPs are moved, the first one will receive agent role by R-Strategy and the second one the theme role. As for the ALH, above chance performance is predicted since the semantic linking (agent-first DP, theme-second DP) coincides with syntactic linking (agent-by phrase, theme-NP). Given that the moved NPs are reordered canonically, the MH expects agrammatic comprehension to be normal.

(13) *Scrambled passive:*

Por la mujer la girafa está siendo empujada

By the woman the giraffe is being pushed

"The giraffe is being pushed by the woman"

Table 1 summarizes the predictions of the four theories with respect to the experimental conditions.

Structure	TDH	MH	ALH	DDH
Scramble active	Below-chance	chance	chance	chance
Left dislocation	Below-chance	chance	chance	chance
Scramble passive	Above-chance	Above-chance	Above-chance	chance

Table 1: Predictions of the TDH, MH, ALH, and DDH for the three experimental conditions (Beretta et al. 2001)

The evidence from the experiment supports the DDH. The performance of the agrammatics was at chance in all three conditions. This rules out TDH, MH and ALH since their predictions are incompatible with these experimental results.

Beretta et al. (2001) argue that the other theories cannot capture these results because they rely on *linearity*, which is something epiphenomenal in linguistic theory. However, the DDH is purely structural and does not apply to linearity. This makes it more appropriate in order to explain impaired and unimpaired agrammatics' comprehension.

2.1.3 Verb movement

Verb movement is an instance of X^0-movement. A lexical head moves from a head-position to another head-position. Grodzinsky (1995a) claims that this kind of movement is unimpaired in agrammatism. However, Bastiaanse et al (2001) and Bastiaanse & Thompson (2003) have recently shown that verb movement is indeed impaired in English and Dutch languages.

In Dutch, there is an asymmetry between matrix and embedded clauses regarding the position of the verb, shown in (14a) and (14b).

(14) a) Ik lees een boek *(Dutch matrix clause)*

I read a book

"I read a book"

b) Ik dacht dat je een boek las *(Dutch embedded sentence)*

I thought that you a book read

"I thought you were reading a book"

c) Ik wil een boek lezen *(Dutch sentence with auxiliar verb)*

I want a book read

"I want to read a book"

Whereas in embedded clauses (as in (14b)) the verb (either tensed or tenseless) remain in its base-generated position, in matrix clauses (as in (14a)) it undergoes V2 movement, typical of Germanic languages, by which the verb overtly[5] moves from V^0 to I^0 (that is why the verb is always in second position, as can be seen in (14a)). When there are auxiliaries or modal verbs, V2 is prevented because these are generated in I^0, and thus the verb remains in situ (i.e. in V^0), as can be seen in (14c).

In English, verb movement is not necessary since the inflectional features of the verb can be covertly checked, so that the verb may remain in V^0, as in (15a) below. Nevertheless, auxiliaries, the copula verb "to be", and modal verbs are claimed to be generated in I^0, as seen in (15b).

(15) a) $[_{IP}$ I $[_{VP}$ read a book]]

b) $[_{IP}$ I $[_{I'}$ will $[_{VP}$ read a book]]]

Bastiaanse et al. (2001) used a sentence completion experiment with Dutch agrammatic speakers and Dutch speaking children, in order to see if either population had problems with verb movement of inflected verbs in Dutch.

The subjects could make four types of errors:

a) **V_{fin} final**: finite verbs in a final position, instead of moving them to I^0 so as to check their tense feature.

[5] In early stages of the Minimalist Program (Chomsky 1995; Hornstein et al. in progress), it is claimed that the inflected verb is inserted in the derivation from the lexicon and then, in the course of the syntactic derivation, it must check its inflectional (e.g. tense) features against a proper head (in this case I (nflection)). This feature-checking is done by means of movement (either overt or covert) of the verb from V^0 to I^0.

b) **Auxiliary insertion:** insertion of an inflected auxiliary and leaving the non-finite verb in final position, as in (16b).

c) **Verb omission**: omit the finite verb.

d) **Other**: when the subject did not respond or made an irrelevant response.

The results obtained by the authors are summarized in table 2.

	V $_{fin}$-final	**Aux-insertion**	**V-omission**	**Other**
Aphasics	21	0	14	4
Children	1	10	10	6

Table 2: Error types in matrix clauses for aphasics and the young children (Bastiaanse et al. 2001)

As can be seen in the experimental results, children tended to insert auxiliaries as well as to omit the verb. The auxiliary insertion in Dutch is somewhat similar to the *Do-support*, and it is allowed in several dialects, as shown in (16).

(16) a) Ik snijd de tomaat *(Dutch, no auxiliary insertion)*
I cut the tomato

b) Ik doe de tomaat snijden *(Auxiliary insertion[6])*
I do the tomato cut

Agrammatics, however, did not insert auxiliaries, and their errors were mainly, verb final and verb omission.

As for the comparison between the two populations, an interesting conclusion emerges: while agrammatics and children share the same problem, namely, failing to raise the finite verb in an overt way, they choose different strategies to overcome this problem. The aphasics apply a "*non-movement*" strategy and the children a "*merge*" strategy. Both strategies are available in UG, and result in a structure that is more economical than the target structure. The question arises as to why do agrammatics and children use different strategies to overcome the same problem? A possible answer to

[6] Allowed in some Dutch dialects.

this question is that while children have a problem with verb movement alone, agrammatics' problem is a combination of difficulties with verb movement and the underspecification of the Tense node (see section 2.4.2. and Friedmann 2000). The children are able to overcome the verb movement problem by inserting an auxiliary in I (nflection) but the agrammatics are forced to leave the verb in the final position because their syntactic representation does not have an operative I(nflection) node.

Bastiaanse et al. (2003) conducted an experiment to contrast whether agrammatics had problems with verb movement alone or it really was a problem of underspecification of the syntactic tree as claimed by Friedmann (2000). The Tree Pruning Hypothesis (TPH), is discussed in the section 2.4.2.. The TPH argues for the underspecification of all the nodes in the syntactic tree from T(ense) up, though C(omplementizer) is more impaired than T. According to this theory, verb movement is impaired because the Tense node is not available and not because the movement itself is hampered. Bastiaanse et al. (2003) argued that, if as the TPH claims, verb movement is prevented because of the underspecification of the T node, then, for English this means that the production of finite lexical verbs (that remain in V^0) should be less impaired than the production of finite auxiliaries (that are base-generated in T/I^0), which should be less impaired than production of moved finite auxiliaries (that move to C^0). This hierarchy in agrammatics' production is not expected under the assumption that the crucial factor is the verb movement as such. The results of the experiment are summarized in table 3.

V-in-V	Aux-in-V	No movement	Aux-in-C
39,16	35	37,08	15,63

Table 3: Mean percentages correct for the three experimental conditions (Bastiaanse & Thompson 2003): finite verbs in base generated position (V-in-V), auxiliaries in base-generated position (Aux-in-I), total base-generated position (no movement, this is V-in-V + Aux-in-I), and moved auxiliaries (Aux-in-C)

From the experimental results, it can be concluded that both finite verbs and auxiliaries in their base generated positions, are easier to produce than moved auxiliaries. No significant differences were found between the "*V-in-V*" and the "*Aux-in-I*" conditions, whereas the difference between the "*No movement*" (i.e. *V-in-V* plus *Aux-in-I*) and "*Aux-in-C*" conditions was significant. The data support indeed the claim that it is not the

position in the syntactic tree what predicts production impairment, as the TPH claims, but rather whether or not verb (or auxiliary) movement is required.

2.2 Agrammatism and Theta Theory

It was traditionally taken for granted that Broca's aphasics only suffered from impaired speech, whereas they retained a virtually perfect comprehension. The aphasic syndromes have been classified typically in emission and reception deficits (which roughly correspond to Broca's and Wernicke's aphasias, respectively), depending on the aspect of the language (either production or comprehension, respectively) was thought to be hampered (Carroll 1999).

In the late 70's, Camarazza & Zurif (1976) showed that Broca's aphasics did not comprehend syntactically complex sentences in a normal way. More concretely, the aphasics had problems with the so-called semantically reversible sentences, which have two verbal arguments whose thematic roles can be exchanged without affecting the grammaticality of the sentence, as occurs in (17):

(17) a) The boy $_{agent}$ kisses the girl $_{patient}$

b) The girl $_{agent}$ kisses the boy $_{patient}$

Camarazza & Zurif (1976) claimed that Broca's aphasics had a complete syntactic loss. However, this claim turned on to be too strong, since they seemed to properly comprehend some structures and to judge their grammaticality. Several theories have therefore been proposed since then in order to explain the abnormal comprehension of agrammatic aphasics, who seem to sometimes make inappropriate theta assignments, i.e. some verbal argument is assigned a thematic role that does not correspond to.

2.2.1 The Mapping Hypothesis

Both the TBA and the DDH claim that the source of abnormal comprehension in agrammatics is due to impaired syntactic representations. Contrary to this, the Mapping Hypothesis (MH hereinafter; Schwartz et al.1987; Linebarger 1995) claims that

syntactic representations are not damaged since the syntactic parser per se is unimpaired, but it is the exploitation of the information given by the parser, that fails in agrammatic comprehension.

Linebarger (1995) shows some evidence of a preserved parsing ability in agrammatics. This is to say that there is a spared parser in agrammatism, at least in grammatical judgment tasks. However, it is surprising why agrammatics perform so poorly on comprehension tasks involving passives and *Wh*-gaps, while they are able to parse such structures.

The MH, given in (18), tries to answer this question by postulating that the syntactic parser cannot be used by agrammatics in order to reach a normal-like comprehension in spite of the fact that the parser itself is not damaged.

(18) *The Mapping Hypothesis (MH):*

Agrammatics are able to recover phrase structure but are impaired in exploiting their syntactically structure representation of the input sentence for interpretive processes.

To put it in other words, the problem of agrammatics is not to *parse* the sentence, but to *match* its syntactic structure with the thematic structure of the verb. The theta-assignment is claimed to be a locus of vulnerability in agrammatics, since it involves linking elements in two structures, the S-structure and the verb theta grid. Even theta assignment for unmoved arguments is predicted to be impaired in agrammatism.

The fragility of the mapping process renders it more dependent on - and more vulnerable to - a host of extra-grammatical processes that are operative in normal as well as aphasic speakers. These processes may either enhance or disrupt, but do not replace subjects' attempts to carry out the algorithmic mapping. Three such processes are:

a) **Canonical word order effects:** an uncontroversial generalization for English and many other languages is that the most active and controlling argument tends to occur first, the directly affected argument tends to occur next, and other arguments tend to occur thereafter. Agrammatics are facilitated thus by this

pseudo-heuristic in canonical structures whereas they are garden-pathed in non-canonical structures.

b) Nearest NP effects

c) **Selectionaly based role filling:** during the parse, initial thematic role assignments are also made on the basis of verb-specific selectional information. If these assignments are correct, they facilitate the syntax-based mapping (it would be something like recognition rather than recall). When they are incorrect, however, they may lead to "*thematic garden paths*", i.e. the subject accepts the initial thematic assignment and ignores the thematic relations yield by the syntax-based mapping.

Why does the mapping procedure fail? Explanations in order to account for this point include (Linebarger 1995) the following:

a) **Loss of verb-specific thematic information:** specific impairment involving the retrieval of thematic role information associated with verbs.

b) **Specific mapping deficit:** specific impairment in the operations that link grammatical functions, such as *subject* or *direct object*, with thematic roles, such as *agent* or *patient*. This is precisely what the theory that I propose in chapter 3, namely the LMI-Hypothesis, argues for.

c) Processing or memory impairments.

d) Closed-class deficit.

The most important piece of evidence given by Linebarger (1995) in order to support the MH is the *grammaticality judgment-comprehension disparity*, i.e. the fact that some agrammatics can judge the grammaticality of structures that they cannot comprehend.

2.2.2 The Argument Linking Hypothesis

According to the number of arguments that a verb may select, there can be distinguished two main types of verbs:

1. **Transitive verbs:** select two or more arguments, like "*to buy*" or "*to eat*", and one of them is external (i.e. generated in [Spec, TP] like in (19b) or, following the VP-Internal Hypothesis (VPIH henceforth), in [Spec, VP] like in (19c); with other words, the external argument is that one generated not as complement of the verb).
2. **Intransitive verbs:** select only one argument, like the verb "*to run*" and the verb "*to grieve*". Within intransitive verbs, we can further make more distinctions, depending on whether the argument is external or internal (generated as complement of the verb):
    a) **Unaccusative verbs** select one internal argument, i.e. they are base-generated within the VP, and subsequently move out of the verbal shell to [Spec, IP], leaving a trace inside the verbal phrase, as can be seen in (19a).
    b) **Unergative verbs** select one external argument. Unlike unaccusative verbs, there is no trace within the VP, either we assume VPIH (see footnote 15) or not, because the argument is always external.

(19) a) $[_{IP}$ Internal argument $_i$ $[_{VP}$ verb t $_i$]] (*unaccusative verb*)

b) $[_{IP}$ External argument $[_{VP}$ verb]] *(unergative verb (not assuming VPIH))*

c) $[_{IP}$ External argument $_i$ $[_{VP}$ t $_i[_{V'}$ verb]] *(unergative verb (assuming VPIH))*

One difficulty the TBA has to face is why agrammatics' performance with unaccusative verbs is virtually normal. Let us take as example sentence (20b), which contains an unaccusative verb ("*to fall*") and one argument whose thematic label would be *patient*. If we follow the rationale of the TBA, the trace located within the VP is unavailable for theta assignment due to trace deletion, as in (20c). The moved DP cannot receive its theta role and R-Strategy applies. The DP should be assigned an *agent* theta role as in (20d).

(20) a) The girl fell

b) [$_{IP}$ The girl $_{i,\ patient}$ [$_{VP}$ fell t $_{i}$]] *(Unaccusative sentence)*

c) [$_{IP}$ The girl $_{no\ theta\ role}$ [$_{VP}$ fell]] *(Aphasic trace deletion)*

d) [$_{IP}$ The girl $_{agent}$ [$_{VP}$ fell]] *(Application of R-Strategy)*

The predictions of the TBA are contrary to fact, however (Piñango 2000; Thompson & Lee 2004). Agrammatics perform like normal subjects in task requiring unaccusative verbs. This is to say, they do not interpret the argument of the unaccusative verb as *agent* but as a *theme*, in sentences like (20).

Piñango (2000) proposes the Argument Linking Hypothesis (ALH henceforth) in order to account for the agrammatics' normal-like performance with unaccusative verbs. The point is that in these structures, there is syntactic movement but yet no reversal of thematic roles. Broca's aphasics have no problem dealing with unaccusative verbs due to the lack of thematic roles reversal.

It is claimed that there are two ways of linking thematic roles to the different DPs in the S-structure of the sentence:

1. **Semantic linking**, which is purely semantically based and establishes a correspondence between arguments (*agent*, *theme*...) and linear positions in the sentence (*first DP*, *second DP*, etc...)
2. **Syntactic linking** establishes a correspondence between arguments and syntactic functions (*subject*, *direct object*) based on syntactic principles.

Semantic linking can emerge as the dominant system of correspondence whenever syntactic principles of linking fail to be properly implemented or fail to be implemented *on time*. Evidence for such a claim comes from pidgin languages, which arise as a mixture of two or more languages. Independently of the syntactic order of the arguments of each language of origin, the pidgin language seems to remain the order established by the semantic linking. This is due to the competing syntactic rules of the languages of origin. In this case, the "*universal*" order, given by the semantic linking, is chosen to form part of the new pidgin language.

A similar argumentation can be applied to agrammatism. Once syntactic principles of correspondence are made unavailable to the system, due to a processing impairment such as Broca's aphasia (or availability of multiple systems like in pidginization), semantic principles, and, in particular, semantically based correspondence principles, are allowed to surface.

In the intact brain, the system of correspondence is constrained in such a way that syntactic linking always prevails over semantic linking. This is the **linking constraint**. In the agrammatics' system, the linking constraint is impaired, with the consequence that though both syntactic representation and argument structure are intact, the system now has, instead of one, two active linking mechanisms that, as a result, must compete against each other. The ALH states that whenever the two linking mechanisms agree, absence of the linking constraint is not noticeable. However, whenever the two linking mechanisms yield conflicting correspondences (i.e. whenever semantic roles are reversed in syntactic representation), impaired comprehension in the form of chance performance will arise.

(21) *The Argument Linking Hypothesis (ALH):*

The linking constraint, which keeps semantic linking from interfering with the syntactic linking, is not present in agrammatic comprehension associated with Broca's aphasia.

The ALH predicts above-chance performance in actives, subject relatives and clefts because in these constructions, both linking mechanisms (syntactic and semantic) coincide. Conversely, chance performance is predicted in passives, object relatives and clefts because in these constructions, the semantic and syntactic systems give conflicting correspondences.

These predictions are in accordance with the TBA concerning actives, passives, relatives and clefts sentences. However, unaccusatives derivations suppose a critical test that provides evidence for the ALH and against the TBA. Piñango (2000) shows the performance of two Broca's patients with unaccusative derivations. There were three experimental conditions: "*unergative verbs*", "*non-alternating unaccusative verbs*" and "*alternating unaccusative verbs*". A second argument was introduced in an adverbial

phrase (the *because-of*-phrase). This argument is out of the VP, i.e. it is an external argument and does not form part of the theta-grid of the verb. It was included in order to make the sentences more similar to the passive sentences used in other studies. The predictions of both TBD and ALH are summarized in table 4.

Constructions	**TDH**		**ALH**
	Assuming competition between *agent* and *causer*	Not assuming competition between *agent* and *causer*	
Unergative	Above-chance	Above-chance	Above-chance
Unaccusative (alt)	chance	Below-chance	Above-chance
Unaccusative (non-alt)	chance	Below-chance	Above-chance

Table 4: Summary of Predictions - ALH vs TDH/TBA

The experimental results of Piñango (2000) support the ALH. Both Broca's patients performed like the control subjects (i.e. neurologically intact subjects), i.e. above-chance, in the three experimental conditions. These results cannot be accounted for by the TBA and instead, act as a piece of contraevidence against it.

2.2.3 The Argument Structure Complexity Hypothesis

Thompson & Lee (2004) showed that, despite the fact that agrammatics' comprehension of unaccusative verbs is near normal (as seen in section 3.2.3), there are differences between the production of unaccusative verbs versus unergative verbs. With other words, verb impairment is selective. A significant difference between agrammatics' performance with unaccusative verbs and unergative verbs was discovered. The latter seemed to be easier to produce than the former, although the production of both was above-chance. No significant difference in the comprehension of both verbs was found, however, as argued in section 2.2.2 above.

The difficulty that agrammatic subjects encountered with unaccusative sentences was observed only in production, as said before. This suggests that the argument structure representation of unaccusative verbs is unimpaired in agrammatism and normally accessed in comprehension, but something fails in production. This

dissociation between production and comprehension raises the question as to what underlies agrammatics' impoverished production of unaccusative sentences.

It is argued that verb production difficulty increases as the number of arguments associated with the verb does, among other possible factors. Evidence supporting this claim comes from the different performance of aphasics with unaccusatives and *frighten*-type verbs. Neither kind of verb selects an external argument so the only difference between them is that the unaccusative type selects only one internal argument whereas the *frighten*-type selects two, as can be seen in (22).

(22) *Frighten-type of psych verbs* (in Thompson & Lee 2004)

verb <y,x> = [$_{VP}$ V DP^{1} DP^{2}]

In order to account for the different performance concerning these two kinds of verbs, the number of arguments of the verb turns a crucial factor.

The Argument Structure Complexity Hypothesis (ASCH), in (23), summarizes the findings of Thompson & Lee (2004):

(23) *The Argument Structure Complexity Hypothesis (ASCH):*

(a) Verbs whose argument structures entails greater syntactic complexity are more difficult for agrammatic aphasics to produce.

(b) Complexity encompasses both the number and type of arguments associated with a verb and information contained within the verb's lexical entry.

It was proposed that the number of lexical entries corresponding to each verb is crucial as well. Unaccusative verbs have two lexical entries, namely, one corresponding to the unaccusative derivation and the other one corresponding to a causative derivation which does select an external argument, as shown in (24) below.

(24) *"to open"*

a) **unaccusative entry**: open <y> → [$_{VP}$V DP] → *"The door opened"*

b) **unergative entry**: open <x,y> → [$_{VP}$ DP [$_{V'}$ V DP]] → *"John opened the door"*

Unaccusative verbs that have a causative alternation, are thought to be more difficult to process than unergative verbs because, although both types of verb have only one argument, unergative verbs do not have any alternation, which makes them easier to process and thus, to produce.

Nonetheless, the "*Lexicon Uniformity Principle*" (Reinhart 2000), given in (25), claims that each verb has only one entry in the lexicon. The different alternations are to be explained by means of operations that can be carried out either in the lexicon or in the syntax. Hence, it cannot be argued that alternating unaccusative verbs are harder to produce due to the existence of multiple entries in the lexicon. Nonetheless, the data points out to a possible difficulty in the processing after the lemma access, as Thompson & Lee (2004) claim, but before the syntactic processing of the sentence. This means that the problem could be located in the operations that apply to the verb lexical entries. The LMI Hypothesis that I will introduce below in chapter 3, relies on such a failure.

(25) *The Lexicon Uniformity Principle:*

Each verb-concept corresponds to one lexical entry with one thematic structure. The various thematic forms of a given verb are derived by lexicon-operations from one thematic structure.

2.3 Agrammatism and Case Theory

This section deals with theoretical approaches that aim to account for agrammatics' performance on linguistics tasks by means of explanations based on Case Theory. The erroneous thematic assignments will be explained not in terms of a inappropriate working of the Theta module but in terms of an impaired Case module. This is to say

that the wrong thematic assignment is the consequence of a Case module that does not work properly.

2.3.1 Abstract Case Assignment

Druks and Marshall (1995) present two case studies. They describe the performance of two aphasic patients. One has a performance in accordance with the predictions of the TBA, i.e. at chance in passive (semantically reversible) sentences and above chance in active (semantically reversible) sentences, whereas the other one presented a reversed performance pattern, i.e. at chance in active (semantically reversible) sentences and above chance in passive (semantically reversible) sentences. The latter case implies empirical contraevidence against the TBA, which cannot account for this pattern of performance.

It is suggested that the Case module of these two patients is impaired. As a result of this, verbal arguments that are not case marked cannot become visible at the level of Logical Form and thus cannot be interpreted by the Semantic System. The problem is not that the thematic role is not assigned but that the argument (that bears that thematic role) is invisible for the Semantic System.

There are two kinds of case, namely inherent and structural. *Structural case* is assigned under *government*, which is a purely structural relationship between two constituents in the sentence. Nominative and accusative cases are typically thought to be instances of structural case. *Inherent case* assignment depends on thematic assignment, this is to say, an element assigns an inherent case to another element at the same time that it theta-marks it. The thematic role and the inherent case are tightly related and the typical instances of inherent case are dative and oblique cases.

Druks and Marshall claim that the patient who performed above chance on actives and at chance level on passives, are able to assign structural Case in a normal way, whereas their inherent Case assignment, which is necessary to understand the DP within the *by*-phrase, is impaired and hence the chance performance on passives. It is postulated that only patients who have access to neither structural nor inherent Case will adopt a linear strategy such as R-Strategy of the TBA (Grodzinsky, 1995). Since this patient had

normal access to structural case, he did not apply to any linear strategy that could improve his performance in passive sentences comprehension.

The patient that performed above chance on passives and at chance on actives, is thought to have impaired structural Case assignment, while he retains an spared inherent Case assignment. As the patient is able to interpret correctly the NP in the *by*-phrase when dealing with passive sentences, he knows who the agent of the action is and hence interprets the whole sentence correctly, despite the fact that nominative case (which is a structural case) was not assigned. However, actives sentences cannot be correctly comprehended because neither nominative nor accusative cases (recall that both are structural cases) cannot be assigned.

The complete or partial unavailability of the Case module in some cases of aphasia predicts different patterns of deficit in the comprehension of reversible sentences, without the postulation of a linear strategy like R-Strategy: this is a purely linguistic account for hampered comprehension in agrammatism. The predictions are summarized below:

1. **Structural Case unimpaired, inherent Case impaired**: normal performance in actives, relatives and cleft sentences: chance in passives, datives and active sentences containing other prepositional phrases
2. **Structural Case impaired, inherent Case unimpaired**: chance performance in actives, relatives and cleft sentences: normal performance in passives, datives and active sentences containing other prepositional phrases.
3. **Structural Case impaired, inherent Case impaired**: chance performance in all sentences types in the absence of a linear cognitive strategy: above chance performance on actives and below chance performance on passives when the strategy is adopted.

However, as Druks and Marshall themselves acknowledge, an impairment of the Case module cannot explain all the comprehension deficits with reversible sentences. It is unlikely that the Case module is responsible for *'less than perfect'* but above chance performance, or for non-systematic response patterns.

One criticism to this approach is the treatment of the Case Filter. It is said that if inherent Case is not impaired, the passives are interpreted due to the fact that the *by*-phrase is correctly interpreted in spite of the fact that nominative case has not been assigned. If this were to be the case, then the verbal argument lacking the nominative case could not be interpreted at LF whatsoever, since it would not be visible (this is precisely what the Case Filter states). Case is not something optional that the arguments may bear so as to be more easily interpreted. If an argument bears no case, then it cannot be interpreted at all since it would not be visible at LF. Moreover, the derivation of a sentence that violated the Case Filter should crash at the level of LF and the performance would be predicted to be at chance. This problem is similar to the problem of the TBA and the violations of the Theta Criterion (see chapter 3, section 3.2).

2.3.2 Morphological Case

The goal of the study carried out by Burchert et. al. (2004) was to establish whether the theoretical predictions made by the TDH also could extend to languages with overt morphology, such as German, where both case morphemes and number inflections could serve as a device for the agrammatic to identify the agent and the theme of the sentence in question. Were this to be the case, German patients should not show the canonicity effect (i.e. above chance performance in canonical sentences and chance performance in non-canonical sentences, such as English passive sentences) for sentences with either overt case or overt number (agreement between the subject and the verb in number) morphology. In other words, there should be a significant difference in the performance of the agrammatics between case or number marked sentences and case or number ambiguous sentences.

Given that passive sentences involve an inverse correspondence between morphological case and the thematic role, as in (28), they do not constitute a good candidate for syntactic pair of the canonical sentences like (26). German provides, nonetheless, non-canonical structures besides the passive constructions, namely the topicalized constructions, like (27), where the object is preposed to the verb and thus the constituent order is OVS.

(26) Der junge sucht den Vater *(canonical active[7])*

the $_{nominative}$ boy is seeking the $_{accusative}$ father

"The boy is seeking the father"

(27) Den Vater sucht der Junge *(Topicalized active*

the $_{accusative}$ father is seeking the $_{nominative}$ boy *i.e. non-canonical)*

"It is the father that the boy is seeking"

(28) Der Vater wird von dem Jungen gesucht *(Passive*

the $_{nominative}$ father is being by the $_{dative}$ son $_{dative}$ sought *i.e. non-canonical)*

"The father is being sought by the son"

If agrammatic patients are sensitive to morphology as a cue to syntactic structure, as normal speakers are, the sentence comprehension disorders that have been observed in several English patients in conformity with the TDH should not be observable in unambiguously case or number-inflected sentences. In fact, German patients would then be expected to show no impairments at all in such cases. However, the results of the experiment show the contrary.

Control subjects did not have any problem in interpreting reversible as well as irreversible sentences in which agent and patient were unambiguously marked morphologically either by case or by number inflection. In contrast, in morphologically ambiguous sentences, in which either of two nouns can be the agent depending on whether a canonical or a non canonical interpretation is assigned to the sentence, unimpaired German controls did not derive the non-canonical interpretation as easily as the canonical one. As a group, control subjects performed above chance on the canonical sentence-picture match and at chance on the non-canonical match in such sentences. For German speakers, overt case and number morphology play a determining role in non-canonical sentence interpretation.

Unlike controls, the agrammatic subjects as a group had problems in interpreting morphologically marked sentences:

[7] All the examples of this section have been taken from Burchert et. al. (2004).

1. **Case marked sentences:** the (canonical) subject and (non-canonical) object relatives were compared which were used in the case-ambiguous condition with those in the case-marked condition. Whereas there was a significant difference between ambiguous and unambiguous non-canonical sentences for the groups of controls, no difference for the groups of patients was found. Agrammatic performance was above chance for canonical and non-canonical case-ambiguous and case-marked relative clauses. Furthermore, the differences were not significant.
2. **Number marked sentences:** the morphologically ambiguous relative sentences were compared with unambiguous ones. The group of controls showed significantly better performance on the unambiguous non-canonical sentences compared to the ambiguous ones. For the group of agrammatics, mean performance on all structures was significantly distinguishable from chance in all cases. Furthermore, pairwise comparisons did not reveal any significant difference, so that there is no evidence for a beneficial influence of number inflection in sentence interpretation, in contrast to the normal German population.

To summarize, unimpaired German speakers generally benefit from morphology and expectedly have no problems in correctly understanding non-canonical morphologically marked sentences. German agrammatic subjects, unlike normal controls, do not generally benefit from the information given either by case or number morphology on the distribution of agent and patient in the sentence.

2.3.3 Case and Determiners

Ruigendijk & Bastiaanse (2002) claim that verbs, as case assigners, are of special importance in agrammatic speech to the extent that if the lemma of the verb is not correctly invoked, the case assignment of the corresponding arguments will be impaired, and this will have effect in the production of full NP, i.e. the production of DPs (NPs with any determiner).

One property of the verbs is to assign Case. The verb itself assigns objective Case to its internal arguments, whether accusative or dative. The finiteness of the verb, that is, the inflection I, assigns nominative Case to the NP in subject position, i.e. [Spec, IP]. Verbs are, nonetheless, well known to be vulnerable in agrammatism. The access to the lemma does not take place correctly.

The hypothesis of Ruigendijk & Bastiaanse (2002) is that the production of complete NPs in German agrammatic speech, or in other words, the production of DPs, is related to the realization of a Case assigning verb. In order to contrast this hypothesis, two studies were carried out: one speech analysis of semi-structured interviews and an experimental task consisting of a noun phrase insertion task. The patient was presented with a picture and an SVO-sentence in which a noun phrase had to be inserted. Either the subject or the object NP was missing. The participant was asked to read the sentence aloud and to insert the missing NP.

The results of the speech analysis were as follows. The total number of verbs, auxiliaries and copulas was counted. The *finiteness index* (obtained by dividing the number of finite verbs, including copulas and auxiliaries, by the number of clauses that contained a verb) was calculated as well. So was the number of nouns and the *determiner/noun ratio* (the number of nouns requiring a determiner - NRD - that had a determiner, was divided by the total number of NRD). The analysis of the speech showed that the agrammatic speakers had problems with the production of verbs and with verb finiteness. They produced significantly fewer copula and auxiliaries than the non-brain-damaged controls. The same holds for he number of verbs. The finiteness index of the agrammatic speakers was lower than the index of the control group. Agrammatics produced significantly more nouns than the control participants. However, the determiner/noun ratios showed that they had problems with the production of determiners. It was significantly lower than that of the controls, thus the conclusion is that agrammatic speakers omitted the determiner more often than the controls. However, when a case assigner was realized, significantly more NPs were produced with a determiner than without a determiner.

The results of the experimental task show that, even if the verb is retrieved, the agrammatic speaker still has some difficulty assigning the correct Case to the object NPs. Subject NPs are Case marked correctly most of the times but NPs in object position are more problematic. They made many case-substitution errors, some of the patients overused the dative case and the others the accusative case. Few NPs in object position were erroneously marked with nominative case. Ruigendijk & Bastiaanse said that this could mean that the agrammatic knew the difference between subject and object but still had problems in differentiating the different objects (indirect vs. direct).

However, this could be accounted for by the hypothesis of Druks & Marshal (1995) (see section 2.3.1 above), which claims that some patients have problems assigning structural Case and others assigning inherent Case. It would have been interesting to have seen whether the patients of the study of Ruigendijk & Bastiaanse (2002) that assigned erroneously dative case, would also have failed to assign accusative case, which is traditionally thought to be a pure structural case, and thus problems in comprehending passives. In a parallel way, it would have been interesting to have seen whether the patients that overused the accusative, would have tended to have problems with actives in contrast with passives, that is, assigning inherent case.

2.4 Other Theories

In this section, two theories are presented that do not center specifically on one module of the language but rather on the working of the system as such. The Agrammatic Condition was formulated by Grodzinsky in 1984 and it can be considered as the precursor of both Grodzinsky´s TDH/TBA and the Prunning Tree Hypothesis of Friedman & Grodzinsky. The Prunning Tree Hypothesis focuses not on language production but tries to understand rather the language production capacity of agrammatics.

2.4.1 The Agrammatic Condition

At the time the Agrammatic Condition was formulated, agrammatism was considered to be an omission of closed-class words (function words and inflectional morphology) in

speech (Geschwind, 1970; Foldstein, 1948; both cited in Grodzinsky 1984). However, this characterization of agrammatism held only for English and not for other languages like Hebrew, Italian and Russian, where the agrammatics made mis-selections of both function words and inflectional morphology, but never (except in very exceptional circumstances) omission of closed-class words. Grodzinsky (1984) observed that:

- Patients omit free grammatical morphemes, i.e., prepositions, determiner, auxiliaries, etc.
- Whenever the well-formedness of a lexical item does not depend on its being inflected (i.e. it has a zero-inflected, unmarked form), the form chosen tends to be the unmarked one.
- In every other case (i.e. where the lexical item depends morphologically or phonologically on the inflection vis-à-vis its well-formedness), any form may be selected from the set of permissible inflectional configurations, regardless of syntactic constraints.

Based on the data, the following conclusions were reached:

- There is some "default" procedure, by which patients select the zero-marked form when possible, namely, that there is a set of option such that the zero-marked form is always last.
- When the previous conclusion cannot be applied for structural reasons (as in Hebrew bound morphemes), some form of unconscious guessing takes place and this results, in many instances, in mis-selection.

Grodzinsky considered agrammatism as an universal phenomenon whose configurational characteristics depend on the structural characteristics of the language in question. So, while agrammatism involves function word omission in English but function word mis-selection in Italian, the underlying cause should be the same but expressed in different ways in those two languages.

First of all, a deep description of bound morphology must be done. There are two types of closed-class words:

1. **Free morphemes**: prepositions, pronouns, determiners, etc.

2. **Bound morphemes**: for example, the inflectional morphology in English. There are in turn, three types of relations between the inflectional morphology and the lexical item to which it attaches:
    a) *The lexical items may have existence independent from the inflection*: this can be seen in English where the lexical items may be zero marked (*played → play*)
    b) *The lexical items are morphologically, but not phonologically dependent on the inflection:* the lexical item in isolation (i.e. without the bound morphology) may be pronounced but it constitutes a non-word. This is typical of languages like Italian, Russian, and Spanish (*correr → cor* can be pronounced but it is a non-word in Spanish)
    c) *Lexical items depend both morphologically and phonologically on the inflectional morphology*: this is to say that the lexical item neither constitutes a word nor can be pronounced unless it has bound morphology. This happens in Hebrew.

In English, agrammatism is expressed by closed class word omission because the lexical items may exist without the bound morphology. In Italian and Hebrew, conversely, omission of closed class words would lead either to the presence of non words in the sentences (in the case of Italian) or not to being able to pronounce the lexical items as in the case of Hebrew. This last case shows most extremely, that agrammatism is not an omission of closed-class words because Hebrew agrammatics would then be mute. However, what can be seen in Hebrew and Italian agrammatics is closed-class words mis-selection.

To summarize, inflections are retained insofar as they are an obligatory part of the word (this is always the case in Hebrew) but in many instances, they are inflected erroneously, so that the result is often a syntactically aberrant sentence, where all lexical items are well formed. Something must thus be going on regarding these kind of words, since they happen to be impaired (either missing or mis-selected) in agrammatic speech.

In order to account for this, the Agrammatic Condition (AC hereinafter) is proposed. It is a condition on the S-Structure so that the grammar of the agrammatics allows the sentences they utter, i.e. with omission or mis-selection of closed-class words.

(29) *The Agrammatic Condition:*

(a) If a terminal element at S-Structure is not lexically specified, then it will be unspecified at this level.

(b) Every preposition at S-Structure will be deleted, unless it is a head of a prepositional phrase attached to S.

The S-Structure is a level where the open-class words are lexically specified whereas the closed-class words are specified only by features, as in (30b). However, the AC states that agrammatic S-Structure has underspecified nodes unless they are lexically defined, as in (30c). This means that inflections, for instance, are unspecified given that they are not lexically inserted. In languages like English, agrammatics tend not to produce the function word given that they are underspecified. However, in Hebrew and Italian, this is not possible due to their morphological characteristics, and a mis-selection of function words takes place.

(30) a) The boy kissed the girl *(example from Grodzinsky 1984)*

b) *Normal S-Structure representation:*

[S [NP [DET +def] [N boy]] [VP [V kiss] [INFL +tense]] [NP [DET +def] [N girl]]]

c) *Agrammatic S-Structure representation*[8]*:*

[S [NP [DET (*)] [N boy]] [VP [V kiss] [INFL (*)]] [NP [DET (*)] [N girl]]]

According to the AC in (29), both traces and PRO/pro, are missing from agrammatic sentence representation as well. The traces are not lexically defined so they are missing in the S-Structure and the chain between the moved element and its trace cannot be formed. This brings consequences for theta assignment, as Grodzinsky (1995a, 1995b, 1998, 2000) would further develop in the TDH and TBA.

However, other more recent studies claim that some functional categories may lack from the agrammatic speech for independent reasons other than the AC. Ruigendijk & Bastiaanse (2002), discussed in section 2.3.3 above, claim that the lack of determiners is a consequence of a defect retrieval of the lemma of the verb, which produces problems with Case assignment, and, as a result of this, the determiner layer is not created and the determiner is not generated.

[8] (*) stands for unspecified.

2.4.2 The Tree Pruning Hypothesis

Contrary to what is claimed by the AC (Grodzinsky 1984), not all function words seem to be equally hampered. Friedmann (2000) presents a study with 13 Hebrew and Palestinian agrammatics that shows that subject-verb agreement is virtually unaffected in the speech of these patients, whereas tense was totally impaired.

Four kinds of verb inflection errors are mainly found in agrammatism:

1. The use of bare verbs in English instead of tensed forms
2. The use of gerunds in English or infinitives in German instead of tensed forms
3. The use of participles in Italian instead of tensed forms
4. Finite verb omission in spontaneous speech

The key to understanding these types of errors is by saying that the incorrect verb forms are non-finite-forms replacing the finite and fully inflected ones. This is to say that the forms used by agrammatics contain the feature [-finite] but never the feature [+finite] of the fully inflected forms that are replaced. In other words, inflected and finite verb forms do not happen to appear in agrammatic speech but are replaced by non-finite forms, which are infinitive, gerund and participle, depending on the language we look at.

The Tree Pruning Hypothesis, given in (31) and schematically represented in Figure 5, tries to give an answer to this by claiming that the syntactic tree of the agrammatics at language production is damaged from the T(ense) node on (i.e. T', TP, C' and CP whereas lower nodes such as NegP, AgrP and VP are unimpaired). This entails that elements which must be generated in those underspecified nodes, such as complementizers or the tense feature of the verb, cannot be generated. Furthermore, if an element must move to such nodes, this will be impossible, explaining why *Wh*-movement is damaged in agrammatic production.

(31) *The Tree Pruning Hypothesis (TPH):*

a) T is underspecified in agrammatic production

b) An underspecified node cannot project any higher

The verb is inserted from the lexicon in V^0 and thence it moves to AgrP in order to check its agreement features, and thence it moves to TP in order to check its tense features. The TPH claims that the syntactic tree is pruned from the Tense node on so that problems with verb tense and *Wh*-elements are predicted to appear, i.e. problems related to the positions T and C, whereas subject-verb agreement is not (since that is related to the AgrP node, lower than T).

Movement of the verb to TP is prevented so that verb forms with a [+finite] feature are not licensed in speech because they cannot check their [+finite] feature against the Tense mode. Therefore, only verb forms with a [-finite] feature can occur in agrammatic speech: they do not require displacement to TP since they have no [+finite] feature that needs to be checked against the Tense node. These non-finite forms of the verb can thus remain lower in the tree. Nevertheless, they are predicted to be able to move to AgrP since verb-subject agreement is unimpaired.

Averbia, verb omission in agrammatic speech, is now accounted for by means of problems related with verb movement: finite verb forms cannot move to the nodes where they are licensed. However, movement itself is not a problem in agrammatic speech, this is to say, X^0-movement is not impaired in agrammatism since the verb is able to move to AgrP , as can be seen in the virtually unaffected subject-verb agreement in agrammatic language production.

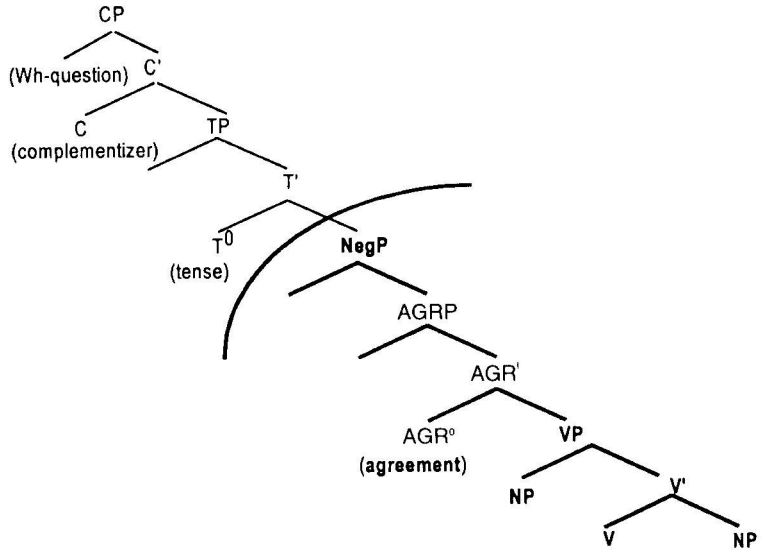

Figure 5: The Tree Pruning Hypothesis (Friedmann 2000)

Nonetheless, Bastiaanse et al. (2003) and Bastiaanse & Thompson (2003), previously discussed in section 2.1.3 above, presented evidence supporting the hypothesis that verb movement is damaged in agrammatism and this is the reason why finite forms of the verb seem not to be produced in agrammatic speech.

Another criticism to the TPH is that, in more recent versions of Minimalist Program (see for example Chomsky 1995), the verb-subject agreement is thought to be checked against AgrS, which is higher in the syntactic tree than Tense. The structure of a simple sentence would be represented in (32):

(32) $[_{AgrSP}$ subject $_i$ $[_{AgrS'}$ AgrS $[_{TP}$ verb $_h$ $[_{T'}$ T $[_{AgrOP}$ .....$[_{VP}$ t $_i$ $[_{V'}$ t $_h$]]]]]]]

Were this to be the case, subject-verb agreement should be impaired as well, which is contradictory to the fact according to the data presented by Friedman (2000). Nevertheless, Burchert et al. (2004) have noted that subject-verb agreement in number is impaired.

2.5 Conclusions

Agrammatism involves symptoms both in language production and in language comprehension. It has been tried to find an unitary account for both variants (Grodzinsky 1984, among others). However, it is very often found that patients that show agrammatic speech do not have an impaired comprehension. Moreover, there are patients that have unimpaired speech production even though they present agrammatic comprehension (Berndt et al. 1996). Agrammatism has been shown not to belong to just a group of aphasics, i.e. Broca's aphasics, but it is rather a syndrome spread throughout all distinct variations of aphasia.

Even if we focus on agrammatic comprehension, it is very difficult to find a unitary explanation able to account for all the empirical data. Most of the research works presented in this chapter assume that the basic pattern of agrammatic comprehension is at chance in passives and above chance in actives. However, this happens not to be true. Berndt et al. (1996) carried out a meta-analysis where they showed that such pattern was presented just by one third of all the subjects that participated in the studies analyzed. The results are presented in Figure 6.

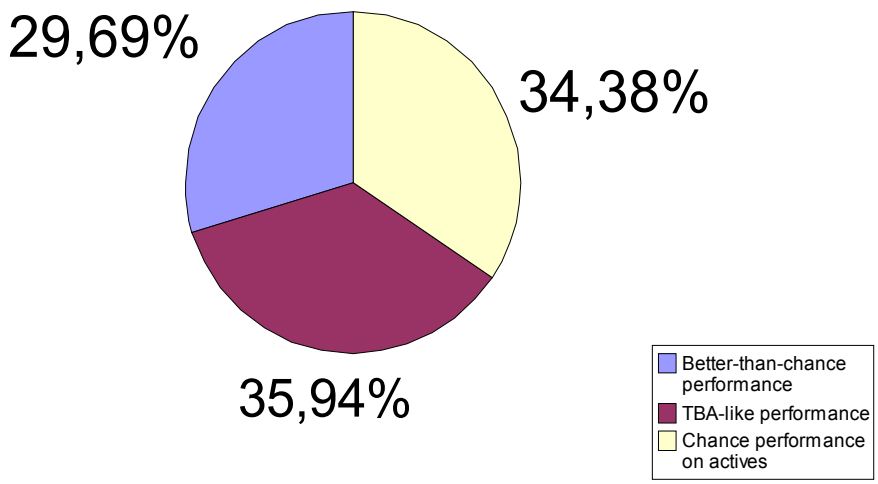

Figure 6: Results of the meta-analysis of Berndt et al. (1996)

The review of the existing literature presented here, though not complete for reasons of space, points out that not only one module of the language is impaired, but there may be more that do not work properly. The Case, Theta and Dependency (syntactic movement) modules seem not to work in an appropriate way in agrammatism. However, as said before, to find an unitary hypothesis in order to cover and account for the whole body of the existing experimental data is utopic. All mistakes of the different modules of the grammar should be included and modulated by a more general theory consisting of more than one hypothesis of the kind we have seen in this chapter, which could indeed account for all the empirical data. Further research in this direction is necessary, I believe. An assimilation of all (or at least the main) theoretical proposals in a more general hypothesis that is able to say in which circumstances one determined failures applies, is necessary. I think the most plausible theorization of the language impairments, and of agrammatism in particular, requires a modular approach of several failures in different modules of the language, that involves more than just one grammar module, since not only one system is implicated in the problem, and actually, we are probably not speaking of just one failure but rather of a more or less unitary and homogeneous conjunct of symptoms produced by different and interrelated causes.

Chapter 3
An Alternative Account for Agrammatics' Comprehension of Semantic Reversible Sentences

This chapter aims, first of all, to provide the theoretical background needed to understand the alternative approach to agrammatic comprehension of passive sentences, as well as the motivation for its formulation. Therefore, the Trace Based Account (Grodzinsky 1995a) will be more deeply explored given that this constitutes the starting point of the proposal that I will sketch here. The problems and shortcomings of the TBA will be discussed. Subsequently, Reinhart's (2003) Theta System shall be described since this is the framework on which my hypothesis directly relies. Eventually, the Lack of Merging Indexes (LMI) hypothesis itself shall be introduced. Chapter 4 presents an experiment aimed to empirically contrast the predictions of the LMI against the TBA.

3.1 A Closer Look at the Trace Based Account

The Trace Based Account (TBA henceforth, Grodzinsky 1995a) has already been introduced in section 2.1.1. Here, it will be further analyzed since it is very important that the reader completely understands it, as well as the predictions made by it. As said before, it was traditionally thought until the late 70's, that Broca's aphasics could understand as non-aphasic people. By the work of Camarazza & Zurif (1976), it was shown, however, that their comprehension ability was indeed hampered. Since then, several hypotheses have emerged in order to account for this pattern of impaired comprehension, known as "*agrammatic comprehension*". The Trace Deletion

Hypothesis (cf. Grodzinsky 1995a) was probably the one that drew the most attention, and motivated more empirical work. Later on (Grodzinsky 1995a), the TDH underwent some changes and was reformulated into the Trace Based Account (TBA) in order to incorporate some new empirical data as well as advances in linguistic theory.

3.1.1 Description

The TBA consists of two independent claims:

1. **Trace Deletion Hypothesis (TDH)** states that all traces that are in theta positions are deleted at S-Structure in agrammatic linguistic representation.
2. **R-Strategy (R-Strategy)** assigns a theta role to the referential DPs by their linear order. This theta-assignment is carried out in accordance with Jackendoff's (1972) (cited in Grodzinsky 1995b) Thematic Hierarchy[9].

In normal comprehension of passive sentences, whenever a DP moves from the position where it is theta-marked (its position at D-Structure), its theta role is transmitted by means of the trace that the DP leaves behind, as can be seen in (33a). However, in agrammatic representation that trace is no operative, and the theta role cannot be transmitted to the moved DP, as in (33b).

(33) a) The girl $_{[theme],i}$ is kissed t_i by the boy $_{[agent]}$ *(normal sentence representation)*

b) The girl $_{[no\ theta\ role]}$ is kissed by the boy $_{[agent]}$ *(agrammatic representation)*

In (34a) [$_{DP}$ *the girl*] receives the highest theta role that it can receive, namely agent. However, in (34b) [$_{DP}$ *the car*] cannot receive an agent role since it is not animate: this knowledge is thought to be well preserved by agrammatics (Grodzinsky 1995a). It receives then the highest available theta role, namely instrument.

(34) a) The girl$_{[no\ \theta\text{-role}]}$ is kissed by...→*R-Strategy*→ The girl$_{[agent]}$ is kissed by...

b) The car$_{[no\ \theta\text{-role}]}$ is blocked by...→*R-Strategy*→ The car$_{[instr]}$ is blocked by...

[9] Jackendoff's (1972) Thematic Hierarchy: (1) agent; (2) instrument; (3) experiencer; (4) theme.

The TBA can explain the chance performance of agrammatics on passives sentences and object relatives and clefts, as well as the above-chance performance on active sentences and subject relatives and clefts (see section 2.1.1).

3.1.2 Animate Agentive Passives

Animate agentive passive sentences are those whose matrix verb selects as external argument an agent, thus it must be animate. Examples of agentive verbs are "*to kiss*", "*to eat*", and "*to drink*". Let us see in more detail how the TBA accounts for the performance at chance of agrammatics in this kind of sentences:

(35) a) The boy $_{[agent]}$ kisses the girl$_{[theme]}$ *(active sentence)*

b) The girl $_{[theme],i}$ is kissed t_i by the boy $_{[agent]}$ *(normal representation)*

c) The girl $_{[no\ \theta\text{-role}]}$ is kissed by the boy $_{[agent]}$ *(trace deletion)*

d) The girl $_{[agent]}$ is kissed by the boy $_{[agent]}$ *(R-Strategy applies)*

The active sentence (35a) has two arguments, namely an agent [$_{DP}$ *the boy*] and a theme [$_{DP}$ *the girl*]. When the passive sentence is formed, [$_{DP}$ *the boy*] merges within the VP by means of the prepositional phrase headed by the preposition "*by*". The subject position of the sentence is empty and therefore [$_{DP}$ *the girl*] moves and fills it due to the EPP[10]. The verb assigns the theta role to [$_{DP}$ *the girl*] by means of the trace, i.e. the trace forms a chain with [$_{DP}$ *the girl*] and the theta role is thus assigned to the chain itself. Hence, the DP can be interpreted even being out of the VP, which is the domain wherein it is theta-marked by the verb. However, in agrammatism, the trace is deleted (or it is not visible to theta-assignment), and [$_{DP}$ *the girl*], which is out of the VP and thus out of the domain where it can be theta-marked by the verb, cannot receive its theta-role, as represented in (35c). Therefore, R-Strategy applies and assigns to it the highest available role, namely agent, as in (35d). The agrammatic representation has two agents, which is not possible in natural languages. Therefore, the agrammatic has to decide which DP is the real agent and the only way in which he can do this, is by guessing. Hence, the chance

[10] The Extended Projection Principle (EPP) states that all sentences in any natural language must have a subject, this is to say that the position Spec, IP/TP must always be occupied. See Haegeman 1994 for a more detailed argumentation.

performance, this is to say, sometimes the DP in subject position is interpreted as agent, and sometimes is the DP in the *by*-phrase.

3.1.3 Inanimate Agentive Passives

These sentences differ from the animate agentive passives in that the verb selects as external argument a DP that may or may not be animate, thus the role assigned is instrument instead of agent. Examples of these verbs are "*to open*", "*to close*", and "*to block*". Lets us see how the TBA handles the chance performance of agrammatics in these kinds of constructions:

(36) a) The stone$_{[instrument]}$ blocks the car$_{[theme]}$ *(active sentence)*

b) The car $_{[theme],i}$ is blocked t_i by the stone $_{[instrument]}$ *(normal representation)*

c) The car $_{[no\ \theta\text{-role}]}$ is blocked by the stone $_{[instrument]}$ *(trace deletion)*

d) The car $_{[instrument]}$ is blocked by the stone $_{[instrument]}$ *(R-Strategy applies)*

The active sentence has two arguments, namely an instrument [$_{DP}$ *the stone*] and a theme [$_{DP}$ *the car*]. When the passive is formed, the instrument merges within the *by*-phrase, and this, in turn, within the VP, where it is assigned the instrument role. The subject position is empty and, due to the EPP, [$_{DP}$ *the car*] moves so as to fill [Spec, TP] and there it receives its theta role by means of the chain formed between itself and its trace remaining within the VP. In agrammatism, this trace is deleted (or not visible to theta assignment) and the moved DP does not receive any theta role. R-Strategy applies and assigns a theta role to the DP. However, the agent role cannot be assigned since [$_{DP}$ *the car*] is not animate, and animacy is a requisite to be agent. R-Strategy assigns thus the highest available theta role (see footnote 50), namely instrument in this case, to [$_{DP}$ *the car*]. Since both [$_{DP}$ *the car*] and [$_{DP}$ *the stone*] are instruments, the agrammatic is forced to guess which one is the correct one and hence, the chance performance.

3.1.4 Psych-passives

Psych-verbs are those that describe psychological states. They select a theme as internal argument and an experiencer as external argument. Examples of this type of verbs are "*to admire*", "*to love*", and "*to hate*". An experiencer differs from an agent in that it does not cause the action described by the verb, but it rather experiences the action. There is no causal relation, therefore, elements like "*on purpose*" cannot modify *psych*-verbs, as represented in (37):

(37) a) The boy kisses the girl **on purpose** *(agentive active sentence)*

b) *The boy admires the girl **on purpose** *(psych-active sentence)*

c) The girl is admired by the boy *(psych-passive sentence)*

Agrammatics' performance on passive *psych*-verbs is below chance. This is to say, in sentences like (37c), [$_{DP}$ *the girl*], which is the theme, is consistently interpreted as experiencer. Let us see how the TBA can account for this pattern of comprehension.

(38) a) The boy $_{[experiencer]}$ admires the girl $_{[theme]}$ *(active sentence)*

b) The girl $_{[theme],i}$ is admired t_i by the boy $_{[experiencer]}$ *(normal representation)*

c) The girl $_{[no\ \theta\text{ -role}]}$ is admired by the boy $_{[experiencer]}$ *(trace deletion)*

d) The girl $_{[agent]}$ is admired by the boy $_{[experiencer]}$ *(R-Strategy applies)*

e) The girl $_{[experiencer]}$ is admired by the boy $_{[agent]}$ *(θ -role inversion due to THC)*

The active sentence has two arguments, namely an experiencer [$_{DP}$ *the boy*], and a theme [$_{DP}$ *the girl*]. As the passive sentence is formed, [$_{DP}$ *the boy*] merges within the *by*-phrase and thus, within the VP where it can receive its theta-role. The subject position gets empty and [$_{DP}$ *the girl*] must move and fill [Spec, TP] due to EPP. In principle, it receives its theta-role by means of the chain that gets formed between the DP and the trace remaining within the VP. In agrammatism, this trace is deleted (or it is invisible to theta assignment) and [$_{DP}$ *the girl*] cannot receive its theta role. R-Strategy applies as in (38d) and [$_{DP}$ *the girl*] receives agent role. However, this violates Jackendoff's (1972,

cited in Grodzinsky 1995b) *Theta Constraint* which states that the DP within the *by*-phrase cannot be assigned a theta role occupying a position in the Thematic Hierarchy inferior to the DP in [Spec, TP]. Therefore, the theta roles are reversed, as in (38e) and eventually [$_{DP}$ *the girl*] is interpreted as experiencer.

3.2 Shortcomings of the Trace Based Account and Motivation for the Current Proposal

Beretta & Munn (1998) have shown that the linguistic representations of agrammatic passive do not contain double agents. This contradicts the existence of R-Strategy, one of the central points of the TBA.

Following the reasoning of the TBA, the performance of agrammatics in sentences with unaccusative verbs should be disturbed. This kind of verb selects one argument that merges internally, this is, within the VP, as in (39a). Thereafter, it moves to [Spec, TP] due to EPP, as can be seen in (39b).

(39) a) [$_{TP}$ [$_{VP}$ Close the door$_{[theme]}$]]

b) [$_{TP}$ The door$_{[theme],i}$ [$_{VP}$ closes t_i]] *(normal representation)*

c) [$_{TP}$ The door$_{[no\ theta\ role]}$ [$_{VP}$ closes]] *(trace deletion)*

d) [$_{TP}$ The door$_{[instrument]}$ [$_{VP}$ closes]] *(R-Strategy applies)*

In agrammatism, the traces are thought to be deleted or invisible to theta assignment so that [$_{DP}$ *The door*] should not be able to receive its theta role, as in (39c). R-Strategy is predicted to apply and assign an instrument role to the moved DP (it could not receive an agent role because it is not animate), as in (39d). The sentence would be interpreted as the door being an instrument instead of the theme.

However, Piñango (2000) has shown that agrammatics' performance in such sentences is normal-like. An extended description on this point and on the Argument Linking Hypothesis, the alternative to the TBA that Piñango proposes, has been presented above in this paper (section 2.2.2).

The TBA claims that all instances of passivization result on chance performance in agrammatics. Were this to be the case, passives should not be expected to show up in agrammatic speech. However, Hartsuiker & Kolk (1998) have shown that Broca's aphasics can indeed produce passive sentences after semantic priming.

The TBA's account for the below-chance performance of agrammatics on *psych*-verbs does not work well. With non-referential DPs, the agrammatic is thought to have the ability to "see" the theta-grid of verb and so to infer the correct theta-role of the DP (see section 2.1.1.; cf. Grodzinsky 1995a). If the agrammatic cannot interpret the sentence in (38d) due to THC, there is no reason to invert the thematic roles. That would be a solution chosen without reason from lots of possibilities. It seems more reasonable to follow the line of thought of the TBA: when the agrammatic encounters any problem such as violation of the THC, he resorts to the alternative that is already available in the system (given that it is the option used for non referential DPs, i.e. to access the verb's theta-grid so as to infer the correct thematic role of the DP in question)

Moreover, the Theta Constraint is just a description, and not a real constraint. This is to say, the THC is just epiphenomenal. The DP within the *by*-phrase happens to be higher in Jackendoff's Thematic Hierarchy because, in Reinhart's (2003) terms, only [+c] arguments can be saturated. [+c] Arguments are instruments and agents, and they happen to occupy the two first positions in the Jackendoff's hierarchy. However, both the Thematic Hierarchy and the THC are just descriptions. They do not have enough explanatory strength so as to cause the inversion of thematic roles.

The TBA posits the violation of the Theta Criterion (see section 1.3) and even though, the sentence can be interpreted by the agrammatic. I doubt this is what really happens. In language production, if the Theta Criterion happens to be violated, the derivation of the sentences crashes at LF. I will assume that in language comprehension, something similar must happen. This is to say, if the sentence interpretation violates the Theta Criterion, it crashes at LF and then it cannot be interpreted. The chance performance would be the result not of a guessing but of a breakdown of the system. The agrammatic would be, in that case, completely unable to process the information of the sentence.

The pattern of comprehension that the TBA predicts represents just one third of the patterns that showed up in the meta-analysis carried out by Berndt et al. (1996). The TBA cannot account for the other two patterns of comprehension. A more extended discussion on this point has been presented above in section 2.5.

Finally, the TBA claims that the problem in agrammatism is related to both movement (deletion of traces) and theta-assignment (R-Strategy). I agree with Grodzinsky in that both phenomena are important in order to account for the agrammatic comprehension pattern. However, I do not think that movement is problematic because of the traces. The notion of traces no longer makes sense in more recent formulations of linguistic theory (e.g. the notions of *Move-F* and *Agree* see Hornstein et al. in progress). Although other problems related to minimality might be present in agrammatism, causing disturbances in syntactic movement, this is beyond the scope of this work and I will not discuss this point here. I will, however, focus myself on the thematic assignment on agrammatic comprehension of semantic reversible sentences. Given that I will not be concerned with movement itself, cases like subject and object relatives and cleft will not be included in my analysis.

3.3 Reinhart's Theta System

Within Generative Grammar, language is commonly thought of as a modular system in two ways. On the one hand, language is supposed a system (or module) different and independent from other cognitive systems such as memory or reasoning. On the other hand, language is considered to be made up of several modules that, in turn, are (relatively) independent from each other.

The communication between the different modules is possible because some information is legible to more than one system. Furthermore, one system can pass on information that it itself cannot read. It is the *Computational System* (CS, henceforth) which enables the interface (communication) between the different modules belonging both to the language itself and to other cognitive systems. In other words, it passes on information from the system of concepts to the Semantics and Phonology. Part of this

information is legible to the CS but another part is only visible to the relevant systems, namely, Semantics or Phonology.

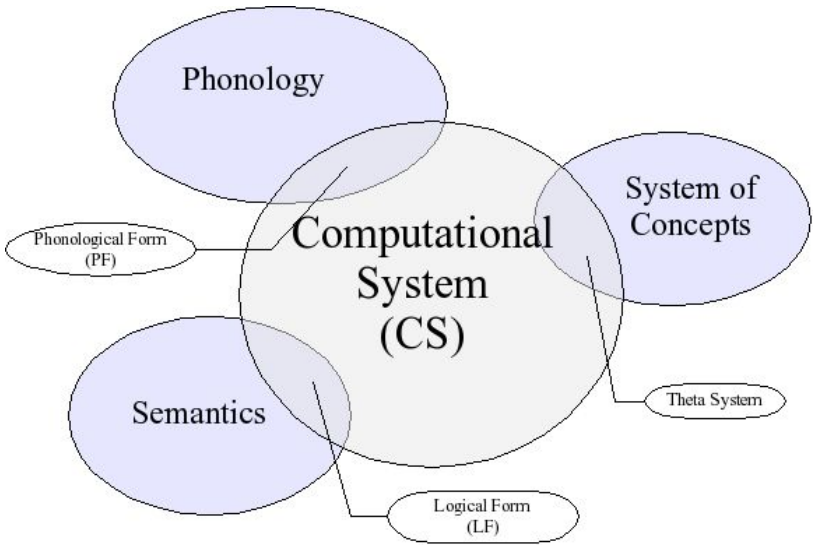

Figure 7 The modular view of the language in the Reinhart's (2003) Theta System

The *Theta System*, according to Reinhart (2002), enables the interface between the system of concepts and the CS. This is to say, the CS cannot read all the rich information that the System of Concepts can provide about the objects of the world. Only very little information passes through the CS to the semantics. In this sense, the Theta System is the system that filters the information provided by the System of Concepts, and computes it in order for the CS to be able to process it. The inputs of the Theta System are the outputs of the System of Concepts. The outputs of the Theta System, in turn, are some of them legible to the CS (merging indexes and the accusative feature), and some of them to the Semantic System (theta features). A description of the minimal elements the Theta System consists of (Reinhart 2002), is given in (40):

(40) *The Theta System consists of (at least):*

a) **Lexical entries**, which are coded concepts, with formal features defining the theta relations of verb entries.

b) **A set of arity operations** on lexical entries, which may generate new entries, or just new options of realization

c) **Marking procedures**, which prepare a verb entry for syntactic derivations: assign an ACC(usative) feature to the verb in the relevant cases, and determine merging properties of arguments (technically obtained by indices).

This section is organized as follows. First of all, the theta features, this is, the outputs of the Theta System that are legible to the Semantics, will be introduced. Afterwards, the merging indexes and the accusative feature, this is to say, the outputs of the Theta System that the CS can process, will be discussed. Subsequently, some classes of verbs shall be presented and eventually, several arity operations on the verb theta grid will be addressed, namely those that are responsible for the formation of passive sentences and unaccusative verbs.

3.3.1 Theta Features

The lexical entry of the verb contains, among other things, theta features. These are features that are legible to the Semantics, this is to say, they provide some semantic information about the argument they refer to. The theta features cannot be interpreted by the CS itself. However, it can pass them on so that they can be processed by the semantic system.

There are two theta features; each of which can have either a positive or a negative value:

- **The /c/ feature** is associated with a role that is perceived as sufficient condition (/+c/, if not /-c/) for the action described by the verb.
- **The /m/ feature** is associated with some sort of mental state of the participant but does not determine the causal status of the argument, this is, whether or not it is a sufficient condition. If the argument is mentally involved in the action described by the verb, it is marked /+m/. If not, it is marked /-m/.

These two features define eight clusters that roughly correspond with the traditional theta-roles:

(41) *Feature composition of the (traditional) theta-roles:*

[+c+m]	Agent	[+c]	Cause
[+c-m]	Instrument	[-c]	Goal/benefactor
[-c-m]	Theme/patient	[+m]	Sentient
[-c+m]	Experiencer	[-m]	Subject matter

The roles of agent, instrument, theme and experiencer are *fully specified clusters*, i.e. they are specified for both theta features. The other roles, namely, cause, goal, sentient and subject matter, are *undefined* for either feature. This implies that they have more interpretative freedom. For example, a cause [+c] role can be interpreted either as an agent [+c+m] or as an instrument [+c-m] depending on the context. In other words, the context will determine the value of the undefined feature, in this case, the /m/ feature.

3.3.2 Merging Instructions

In addition to the information that will be visible to the semantic system (the theta features), the Theta System also prepares the verb arguments to be processed by the CS. This is done by means of merging indexes, given in (42). Each argument is marked by the Theta System and these marks are, in turn, interpreted by the CS as orders concerning how those arguments will be merged, namely, either as internal or as external argument.

(42) *Lexicon Marking:*

Given an n-place verb entry, n>1,

a) mark a [-] cluster with index 2

b) mark a [+] cluster with index 1

c) if the entry includes both a [+c] cluster and a [/-a,/-c], mark the verb with the ACC feature.

(43) *CS Merging Instructions:*

a) when nothing rules this out, merge externally

b) an argument realizing a cluster marked 2 merges internally; an argument with a cluster marked 1 merges externally.

Let us take as example the verb "*to break*". The Theta System accesses the information relevant to the verb in the System of Concepts. Two arguments are codified for "*to break*", namely a cause [+c] (that can also be interpreted both as agent and as instrument) and a theme [-c-m]. These are the theta features that will be interpreted by the Semantics. Moreover, the theta grid of the verb will include the merging indexes and, in this case, the accusative feature as well. The lexicon marking only applies in case the verb selects more than one argument. This is the current case so that the arguments are marked as follows: the [+c] argument is a [+] argument and it thus receives an index 1. This means that this argument will be obliged to merge as external argument, in other words, as specifier of the verb (following the VP-Internal Hypothesis). The theme role is [-c-m], this is a [-] role and hence it is marked with an index 2. The CS will merge it internally, this is, as complement of the verb. Given that the verb has both a full cluster and at least one with /+c/ feature, it receives the accusative mark. This means that the verb will be able to check the structural accusative feature of its internal argument. The theta grid of the verb is summarized in (44):

(44) a) To break$_{acc}$ ([+c]$_1$,[-c-m]$_2$)

b) [$_{VP}$ Max$_{[+c+m],1}$ [$_{V'}$ breaks the door$_{[-c-m],2}$]]

c) [$_{VP}$ The wind$_{[+c],1}$ [$_{V'}$ breaks the window$_{[-c-m],2}$]]

The roles theme [-c-m], goal [-c], and subject matter [-m] are always marked with an index 2. Therefore, they merge internally whenever the marking applies. The roles agent [+c+m], cause [+c], and sentient [+m] are all marked with an index 1, thus they always merge externally. The two mixed clusters, namely instrument [+c-m] and experiencer [-c+m] do not receive any mark since they are neither [+] nor [-]. As a consequence, they will be merged externally by (43a) whenever there is no other argument marked

with index 1, which would rule out (43a). In that case, they would merge internally. This happens with subject experiencer and manner verbs, which are discussed below.

3.3.3 Operations on the Theta Grid

Some entries of the verb are listed in the lexicon as such; this is to say that they are basic entries in the lexicon. Some others are derived from the basic ones by means of a lexicon operation. The unaccusative entries are, for instance, derived from the causative entries of [+c] verbs (see section 3.3.4.1 below).

There are three types of operations that can apply to verb's theta grid: *saturation*, *reduction* and *expansion*. Saturation applies in the formation of passives. Reduction reduces the verb's arity in one. The outcomes of such operations are unaccusative and reflexive derivations. Expansion augments the verb's arity in one.

Only saturation and expletivization shall be described in this section since they are concerned with the proposal outlined in this paper (they are responsible for the formation of passives and unaccusatives, respectively). A more detailed explanation on saturation, reduction (arity), and expansion operations (causativization) can be found in Reinhart (2002).

3.3.3.1 Saturation

This operation applies in passive formation, and closes one of the arguments which will not be realized syntactically. However, the saturated argument is still present in the semantic interpretation. The accusative feature is also eliminated from the verb.

(45) a) Wash_{acc} ($[+c+m]_1$,$[-c-m]_2$) *(basic entry)*

b) $\text{Max}_{[+c+m],1}$ washed $\text{Mary}_{[-c-m],2}$

c) S(wash) ($[-c-m]_2$) *(saturated entry)*

d) $\text{Mary}_{[-c-m],2}$ was washed t

e) X $_{[+c+m]}$ washed $\text{Mary}_{[-c-m],2}$ ≡ $\text{Mary}_{[-c-m],2}$ was washed t

The basic entry of the verb "*to wash*" selects an agent [+c+m] and a theme [-c-m] as arguments. Saturation applies to the agent role so that it is not present in syntax any more. The theme argument is the only one present in the syntax. It merges internally since it is marked with an index 2, and subsequently it moves to [Spec, TP] due to EPP, as in (45d). However, the agent role is still present in Semantics, as can be seen in (45e). This is to say, although there is no agent visible in the syntax, it is supposed to exist for the sentence to be correctly interpreted. The accusative feature of the verb is deleted when saturation applies.

3.3.3.2 Expletivization

This is a reduction operation that may apply to any external [+c] role. External reduction differs from saturation in that the reduced role is no longer present either in syntax or in semantics. This operation is responsible of the formation of, among others, the unaccusative entries of [+c] verbs. The accusative feature of the verb is reduced as in the case of saturation.

(46) a) Open_{acc} $([+c]_1,[-c\text{-}m]_2)$ *(basic entry)*

b) The $\text{wind}_{[+c],1}$ opens the $\text{door}_{[-c\text{-}m],2}$

c) R(open) $([-c\text{-}m]_2)$ *(reduced entry)*

d) The $\text{door}_{[-c\text{-}m],2}$ opens t

Let us take the verb "*to open*" as example. The basic entry of the verb, represented in (46a) selects a cause [+c] argument (that is also congruent with both agent [+c+m] and instrument [+c-m] roles) and a theme [-c-m] argument. When expletivization applies, as in (46c) the external [+c] role is eliminated altogether: it is not present either in syntax or in semantics, unlike in saturation. The theme [-c-m] merges internally since it is marked with an index 2. Afterwards, it must move to [Spec, TP] due to EPP.

3.3.4 Classes of Verbs [11]

In this section, the types of verbs that are relevant for my proposal will be presented, namely, *causative*, *agentive*, *psych*-verbs, *experiencer*, and *theme unergative* verbs. A more extended discussion on the classes of verbs can be found in Reinhart (2002).

3.3.4.1 Subject [+c] Verbs

Subject [+c] verbs select a [+c] external argument and a theme [-c-m] internal argument. However, both agent [+c+m] and instrument [+c-m] can be selected as external argument given that they are congruent with the unspecified [+c] cluster.

(47) V($[+c]_1$,$[-c\text{-}m]_2$)

a) The wind $_{[+c],1}$ / Max $_{[+c+m],1}$ / The key $_{[+c\text{-}m]}$ opened the door $_{[-c\text{-}m],2}$

b) The storm $_{[+c],1}$ / Max $_{[+c+m],1}$ / the stone $_{[+c\text{-}m]}$ broke the window $_{[-c\text{-}m],2}$

These verbs have an unaccusative alternate and vice versa: all unaccusative verbs have a [+c]-verb alternate (in one or another language):

(48) a) Max $_{[+c+m],1}$ opened the door $_{[-c\text{-}m],2}$ *([+c]-verb)*

b) The door $_{[-c\text{-}m],2}$ opened t *(one place unaccusative verb)*

There is another set of [+c] verbs that select an experiencer [-c+m] role as internal argument. This kind of verbs shall be described in the section 3.3.4.4.

3.3.4.2 Subject [+c+m] Verbs

These verbs are more commonly known as *agentive verbs* and they select an agent [+c+m] as external argument and a theme [-c-m] as internal argument. However, these verbs have fixed interpretation (unlike causative verbs) given that the external role must always be interpreted as agent and not as either a cause or an instrument.

[11] All the examples of this section have been taken from Reinhart (2002).

(49) V ($[+c+m]_1$,$[-c-m]_2$)

a) The baby $_{[+c+m],1}$ / *the spoon $_{[+c-m]}$ / *the hunger $_{[+c],1}$ ate the soup $_{[-c-m],2}$

b) Lucie$_{[+c+m],1}$ / *the snow$_{[+c-m]}$ / *the desire to feel warm$_{[+c],1}$ dressed Max$_{[-c-m],2}$

3.3.4.3 Subject [+m] Verbs

These verbs select a [+m] role as external argument and a theme [-c-m] role as internal argument. They are similar to subject experiencer verbs but, unlike them, the [+m] role can never merge internally.

(50) V ($[+m]_1$,$[-c-m]_2$)

a) Max $_{[+m],1}$ loves Mary $_{[-c-m],2}$

b) Mary $_{[+m],1}$ admires Max $_{[-c-m],2}$

The *psych*-verbs that were used in Grodzinsky (1995b) correspond to this cluster composition.

3.3.4.4 Experiencer Verbs

Experiencer verbs are a subset of [+c] verbs. They select a cause [+c] role as external argument. However, the internal argument is an experiencer [-c+m] role instead of theme [-c-m].

(51) V($[+c]_1$,[-c+m]($[-m]_2$))

a) Fred $_{[+c+m],1}$ / the noise $_{[+c],1}$ / the gun $_{[+c-m]}$ scared Lucie $_{[-c+m]}$

b) Fred $_{[+c+m],1}$ / Fred's behavior $_{[+c],1}$ / the discussion$_{[+c-m]}$ surprised Lucie $_{[-c+m]}$

When the [+c] goal is reduced, either by expletivization or by saturation, the [-m] role can be realized:

(52) a) Lucie$_{[-c+m]}$ scared about Fred's illness$_{[-m],2}$ *(expletivization of the [+c] role)*

b) Lucie$_{[-c+m]}$ was scared about Fred's illness$_{[-m],2}$ *(saturation of the [+c] role)*

3.3.4.5 Theme Unergative Verbs

These kind of verbs select only one argument, which is external and still is a theme [-c-m]. Although the role is a [-] cluster, it does not receive any merging index due to (42), i.e. the number of arguments must be bigger than 1, otherwise marking does not apply.. Since the theme argument has no index, it can merge externally by (43a).

(53) V([-c-m])

a) The diamond $_{[-c-m]}$ glows.

b) The star $_{[-c-m]}$ shines.

3.4 The Lack of Merging Indexes Hypothesis

The Lack of Merging Indexes Hypothesis (LMI henceforth) aims, as previously stated, to be an alternative to the Trace Based Account without relying on either syntactic movement or the notion of trace. It is a purely structural model unlike the TBA, which is basically a linear model. The problems and inadequacy of such models have been pointed out by (Beretta et al. 2001) and previously discussed in section 2.1.2.

3.4.1 Description

The LMI, given in (53), focuses on the process of mapping thematic roles onto the syntactic representation by postulating a failure of the Theta System in the assignment of indexes. These indexes are used by the CS in order to correctly merge the different arguments of the verb.

(53) *The Lack of Merging Indexes Hypothesis (LMI):*

The Theta System of agrammatics fails (in certain conditions) in the assigning of (at least) the merging indexes to the verb arguments.

In order to comprehend a sentence (either the output of speech or written language), the lemma of the words must be activated by the listener. I will be assuming that when the lemma of the verb becomes active, the marking procedures apply so that the subject "knows" how the arguments must be merged and hence, the linear order of the arguments. Once the theta grid is active in the linguistic representation of the person, the DP out of the VP will be matched with the theta role of the argument marked with 1 in the verb's theta grid, and, in a similar way, the arguments within the VP will be matched with the arguments marked with index 2 or not marked at all (in case there is already an external argument). I will be assuming here that it is the configuration of the verb's theta grid and not the linear order of the DPs in the sentence which allows the subject to match the arguments with the thematic roles. To sum up, it is not the lemma access what is postulated to be impaired but the application of the marking procedures once the lemma has (correctly) been activated. This possibility of impairment in the processes that apply after lemma access has already been suggested by Thompson & Lee (2004).

The chance performance in active sentences is accounted for by the lack of indexes in the representation of the theta grid the person has. Without them, the subject cannot match the DPs in the sentence with the theta roles in the theta grid of the verb. Hence, he must guess which DP bears which thematic role.

The chance performance in agentive passive sentences is accounted for as follows. Once saturation has applied, the remaining argument is still marked with an index 2, hence it merges internally by (43b) and thereafter, moves to [Spec, TP] due to EPP. If there is no index, the representation of the sentence (54a) will be (54c) instead of (54b). This is to say, the agrammatic does not know that the argument has moved not because movement itself is problematic but due to the fact that the argument is not marked with an index 2, thus the agrammatic infers that the [$_{DP}$ *The door*] merges externally by (43a).

(54) a) John $_{[+c+m],1}$ opens the door $_{[-c-m],2}$ *(active sentence)*

b) The door $_{[-c-m],2}$ is opened $t_{(\text{the door})}$ (by John $_{[+c+m]}$) *(saturation)*

c) The door $_{[-c-m]}$ is opened (by John $_{[+c+m]}$) *(LMI)*

The problem is that the saturated [+c] role is still present in semantic, whether the *by*-phrase is overtly present in syntax or not. The representation of (54c) is exactly the same of the representation of the theme unergative verbs. These verbs, as seen above in section 3.3.4.5, select just one theme argument but this is no marked so that it merges externally. One characteristic of theme unergative verbs is that they are totally incompatible with a [+c] role[12], as shown in (55).

(55) * The diamond$_{[-c-m]}$ glows because of the light$_{[+c]}$

The passive sentence is thus interpreted as a sentence with a theme unergative verb. However, the saturated [+c] argument is present and this causes a breakdown in the system, which yields the chance performance.

Although unaccusative verbs are also interpreted as theme unergative verb, this does not produce a system breakdown like the saturation procedure. This is so because expletivization reduces altogether the [+c] role, this is to say, it is not present any more either in syntax or in semantics. Therefore, these verbs are not normally processed though no breakdown occurs and a normal-like performance emerges.

(56) a) John $_{[+c+m],1}$ opens the door $_{[-c-m],2}$ *(active sentence)*

b) The door $_{[-c-m],2}$ opens $t_{(\text{the door})}$ *(expletivization)*

c) The door $_{[c-m]}$ opens *(LMI)*

3.4.2 Constraints

The LMI does not always apply. As shown by Berndt et al (1996, see chapter 2, section 2.5), there are two other agrammatic comprehension patterns besides the one typically

[12] See Reinhart (2002) for a more detailed discussion on this point.

described by the TBA. This points out that the failure in the mapping process occurs neither in all cases nor in the same way for each agrammatic:

1. **Actives good / passives bad:** this is the pattern of comprehension studied by the TBA. I claim this is due to a lack of merging indexes in certain conditions, given in (57). This is to say, the LMI applies selectively.
2. **Actives good / passives good:** The marking process of the merging indexes is not hampered at all. The merging indexes are correctly represented.
3. **Actives bad / passives good:** this pattern cannot be currently accounted for by the LMI in its present form.

I will be assuming that LMI does not apply in all cases. Not all patients have equal big neurological damage and hence, not all patients are equally sensitive to the lack of resources. The second pattern described by Bernd et al (1996) are patients that do not suffer from any reduction of resources and therefore, no consequence in the mapping process is to be observed. The first pattern, this is, the one described by the TBA is produced by a selective application of the LMI. The question now is to define when it applies and when it does not. As a first approximation to this, I propose that is the interaction of several modules that results, in some patients, in a lack of resources. When this happens, there are not enough resources and the marking process is the most fragile element, hence it is the one that suffers the most. This is very similar to the reasoning of the Mapping Hypothesis (see section 2.2.1 and Linebarger 1995). The conditions where the LMI applies are given in (57).

(57) *Conditions where the LMI applies:*

a) When discourse module comes into play (for example, with D-Linked *Wh*-questions (see Avrutin 2000))

b) When operations on the theta grid of the verb apply in the syntax and not in the lexicon, such as:

- Saturation in (at least) languages like English, Dutch and Spanish
- Reflexivization in languages like Spanish (but not in languages like English and Dutch, in which case reflexivization applies in the lexicon)

When several modules come into play, the resources are used for other operations than the marking procedures because this latter is more vulnerable for whatever reason. There must still be patients that have a very great lack of resources and therefore, the LMI would apply virtually always. This predicts a pattern, not described in the metanalysis of Berndt et al (1996), in which the comprehension of both active and passive semantically reversible sentences is disturbed. The third pattern of agrammatic performance found by Berndt et al (1996) cannot be accounted for by the LMI at this moment.

Chapter 4
Experiment – Dutch Aphasics' Performance on Saturated Experiencer Derivations

This chapter presents an experiment that aims to empirically contrast the LMI, introduced in the chapter 3, versus the TBA. The first section seeks to give the rationale of the experiment. Section 3.2 presents the data concerning the subjects that participated in the experiment. In section 3.3 I present method that was followed and the materials used to carry out the experiment. The results obtained are shown in section 3.4 and eventually, section 3.5 discusses them and reaches the general conclusions of the experiment.

4.1 Introduction: Predictions of the LMI vs. TBA

The LMI predicts the same chance performance as the TBA when agrammatics encounter agentive passives verbs. However, it correctly predicts above-chance performance with unaccusative verbs, unlike the TBA. Now the question is whether there are other situations for which the predictions made by the TBA are different from the ones made by the LMI. Indeed, there is at least one: passive sentences with an experiencer role (i.e. *saturated experiencer sentences*). Table 5 summarizes the different predictions made by the two hypotheses (TBA versus LMI).

4.1.1 Saturated Experiencer Derivations

Experiencer verbs, previously described in section 3.3.4.4, are those that select a cause [+c] role and an experiencer [-c+m] role. Their basic entry is represented in (51), repeated here as (58):

(58) V ($[+c]_{1,[-c+m]}$ ($[-m]_2$)) *(basic entry of experiencer verbs)*

Saturation may apply to the cause [+c] role. Recall that the experiencer role is not marked by any index and might, by virtue of the lack of the [+c] role that is marked with index 1, merge externally by (43a). However, if saturation applies in the syntax in Dutch, these indexes cannot be erased (for this to be possible, saturation should apply in the lexicon (Siloni 2002). The index 1 of the [+c] role cannot be erased from the syntax and this prevents the experiencer role to merge externally and it eventually merges internally, i.e. within the VP, and thereafter moves to [Spec, TP] as in (59).

(59) $[_{TP}\ DP_{[-c+m],i}\ [_{VP}$ verb t_i]]

Following Grodzinsky's reasoning, this structure should produce chance performance given that the trace left by the moved DP, is not visible for theta role assignment and hence that DP can not receive any theta role grammatically. R-Strategy would apply then (in case the moved DP is not referential) and it would receive an agent role. However, the saturated [+c] role is still present in the semantics (it can even show up in a *by*-phrase). If this saturated [+c] role happened to be animated as well, it would be interpreted as an agent [+c+m] by the principle of *Full Interpretation of Thematic Roles* (Marelj 2002), which states that all thematic roles must be fully specified at the level of interpretation. As a consequence, there would be two agent roles and the agrammatic would be forced to guess which one is the real agent. Therefore, the performance is predicted to be at chance.

Contrary to this, the LMI predicts above chance performance whether it applies or not. If the LMI applied, (59) would be interpreted as (60), i.e. the agrammatic is not able to know that there is a trace in the VP because there is no index 2 in the theta grid of the verb after saturation applies. However, (60) cannot be interpreted as a theme

unergative verb because the argument present in the sentence is not a theme [-c-m] but an experiencer [-c+m]. Consequently, these sort of passive sentences are interpreted as if they would have not involved any movement at all. Nevertheless, they are predicted by the LMI to yield a normal-like performance.

(60) $[_{TP}\ DP_{[-c+m]}\ [_{VP}\ verb\ ]]$

	TBA	**LMI**
Unaccusatives	chance	above chance
(active) agentive verbs	above chance	above chance
Saturated (passive) agentive verbs	chance	chance
Saturated experiencer verbs	**chance**	**above chance**

Table 5 Predictions TBA vs. LMI

4.2 Subjects

Two groups have been selected to form part of the experiment:

a) **Experimental group**: is composed of 6 patients affected with aphasia and receiving treatment in the rehabilitation center De Hoogstraat in Utrecht (The Netherlands). Their ages vary between 26 and 62. The diagnosis has been reached with the help of the Akense Afasie Test (AAT) (Graetz et al. 1992). One subject suffered from Wernicke's aphasia, two from Broca's aphasia, two from global aphasia, and the last from mixed aphasia. The data of the patients is summarized in Table 6.

subject	**initials**	**gender**	**age**	**laesi**	**diagnosis**
1	D.L.	male	64	CVA left	global
2	M.B.	female	50	Intracerebral hematoma	Broca
3	D.H.	male	47	CVA left	mixed
4	D.F.	male	35	CVA left	Wernicke
5	D.M.	male	53	CVA left	global
6	D.A.	male	26	CVA left	Broca

Table 6 Data of the experimental subjects

b) **Control group:** consists of 6 students of the Faculty of Arts at the University of Utrecht. The age ranges between 19 and 24 years old and the gender was balanced, i.e. there were three males and three females.

4.3 Materials and Procedures

The experiment was carried out at the rehabilitation center De Hoogstraat in Utrecht (The Netherlands), during the months of October and November of the year 2004.

The task consisted of a true/false judgment of a sentence inserted in a context that was given by means of a short story and a black and white picture. The story was as short as possible (a couple of sentences) and the picture as iconic and simple. With this, I meant for the patient to be able to understand the context of the target sentence as well as possible.

Each experimental subject was presented 16 items. Each of them consisted of a picture, a short story and a sentence. In the appendices A and B, the complete set of items used in the experiment is available.

The sentences used in the experiment were divided in:

a) **8 Target sentences:** passive sentences with a Dutch experiencer verb that has undergone saturation of its [+c] role. The *by*-phrase is explicitly present. An example is given in (61).

(61) Jan$_{[-c+m]}$ wordt verblijd door Marie$_{[+c]}$ *(Saturated experiencer verb)*
Jan is rejoiced by Marie

b) **8 Control sentences:** 4 passive sentences with a Dutch agentive verb (that has undergone saturation of its [+c+m] role, as in (63)) and 4 actives sentences with a Dutch agentive verbs (this is, no saturation applies, as in (62)). These items are typically used in the experiments of Grodzinsky (1995a). The *by*-phrase is also explicitly present in the passive sentences. It is important that the verbs are

[+c+m] and not [+c] given that underspecified /m/ clusters might be more problematic that fully specified clusters, which could be a strange variable.

(62) Marie$_{[+c+m],1}$ omarmt Jan$_{[-c-m],2}$ *(Agentive verb)*

Mary embrace Jan

(63) Jan$_{[-c-m],2}$ wordt gezoend t_i door Marie$_{[+c]}$ *(Saturated agentive verb)*

Jan is kissed t_i by Marie

Both subject and object of all sentences are animate so that they are compatible with the /+m/ feature, so the subject cannot to distinguish them by means of their animity.

Three conditions were, thus, differentiated: two control conditions (active agentive sentences and passive agentive sentences) versus one experimental condition (passive experiencer sentences). The two control conditions aim to show if the subjects perform as the TBA and the LMI predicts concerning passive versus active agentive verbs. If not, the conclusion is that LMI is not applying in that subject (see section 3.4.2) and no conclusions can be reached that apply to the LMI.

4.4 Results

The individual means of the subjects are summarized in Table 7, and the means of the two groups are summarized in Table 8 and graphically represented in Figure 8.

subject	Initials	Saturated experiencer	Saturated agentive	Agentive
1	D.L.	0.88	0.50	1
2	M.B.	0.63	0.75	0.5
3	D.H.	0.88	0.75	1
4	D.F.	0.75	0.25	1
5	D.M.	0.63	0.75	0.5
6	D.A.	0.88	0.75	1

Table 7 Means of the experimental subjects

Only four experimental subjects were selected for the data analysis. The two non-selected subjects, namely M.B. and D.M., did not show a comprehension pattern like the one predicted by the TBA and the LMI (when it applies) with regard to agentive sentences. Therefore, the LMI predictions in this experiment are valid only if the subjects present a TBA-like performance in passive agentive sentences, i.e. above chance performance on active agentive verbs and chance performance on passive agentive verbs. The two subjects that were ruled out presented the opposite pattern: something other than a failure on the assignment of merging indexes is happening and the LMI cannot account for these subjects (see section 3.4.2).

	Experimental group		**Control group**	
	mean	Std. deviation	mean	Std. deviation
Saturated experiencer	0.8438	0.06250	1	0
Saturated agentive	0.5625	0.23936	1	0
Agentive	1	0	1	0

Table 8 Means of the groups

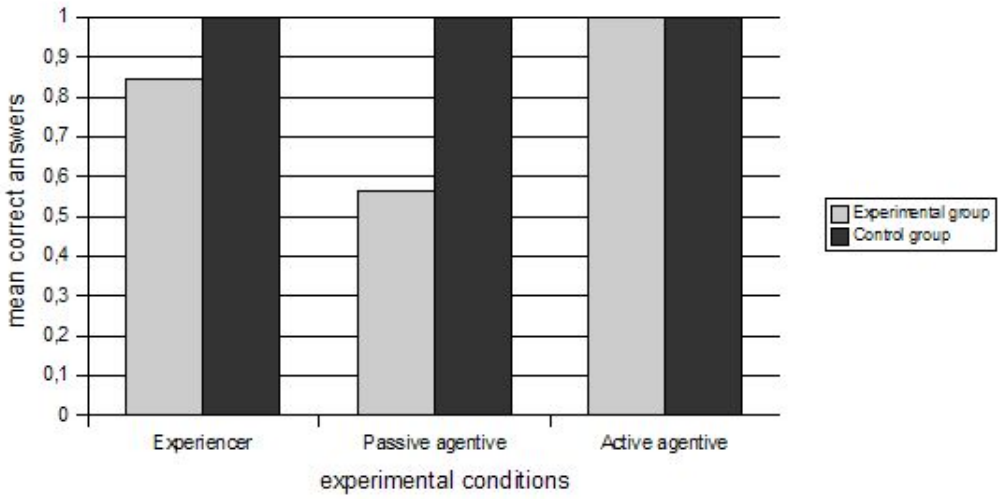

Figure 8 Results of the experiment

The answers could be either true (the target sentence matched with the picture and the short story) or false (the sentence did not match) and the subject could answer right, in which case they received one point, or wrong, in which case they received no point.

The control subjects performed perfectly in the three experimental conditions (mean = 1) and in a very uniform way (standard deviation = 0), this is to say, no control subject made any mistake whatsoever in the experiment. This is predicted by both the TBA and LMI.

The experimental subjects performed all perfectly in the active agentive sentences (mean =1; standard deviation = 0), like the TBA and the LMI predict, and at chance (mean 0.5625, df = 3, p = 0.638) in passive agentive sentences. The pattern was however less uniform (standard deviation = 0.23936) than the performance in active agentive sentences (standard deviation = 0).

As for the saturated experiencer verb condition, aphasics' performance is slightly superior (mean = 0.8438) than their performance with passive agentive sentences. An Analysis of Variance was carried out in order to check whether this difference was significant and it was indeed (d.f. = 3; p=0.024). This, however, does not entail that aphasics' performance in saturated experiencer verbs is perfect since the difference between their performance on saturated experiencer verbs and the value 1 is significant as well (d.f. = 3; p=0.015). However, the performance on saturated experiencer verbs was significantly above chance (df = 3, p = 0.002)

4.5 Discussion and Conclusions

The experimental results partially support the LMI. Agrammatics perform significantly better, and above chance, in sentences with saturated (passive) experiencer verbs than with saturated agentive verbs. This result cannot be accounted for by the TBA, which predicts chance performance in both conditions since both involve movement and trace deletion.

However, the LMI predicts that the performance in saturated experiencer verbs should be perfect, as with agentive verbs. This is contrary to fact and it may be due to two reasons:

1. The significant difference between aphasics' performance in saturated experiencer verbs and controls' experiencer verbs is a statistical artefact, since the variance of the control group in that condition is zero. A larger control sample could remediate this problem.
2. Although the performance in experiencer verbs is better than in agentive verbs (above chance), something must be acting besides the LMI, so that the performance is not perfect. Either the LMI is too weak in the sense that it allows a normal like performance and needs thus to be reformulated, or something other than the LMI is affecting the aphasics' comprehension.

Nevertheless, it is worth noting some points that should be considered to interpret the experimental results:

1. Both experimental and control samples are quite small. This can deform the significance between means.
2. The experiment has some design errors. The stories that were told while the subject was allowed to behold the picture, clearly overloaded the memory ability of the aphasics. The intention was that the subject could understand the context of the target sentence as well as possible. However, this was reached at the cost of overloading their working memory, which is something known to be generally impaired in aphasia.
3. The pictures were not easy to understand by the experimental subjects, in spite of the short stories.

It is my opinion that the results should be replicated by means of a more refined experiment that does not overload the working memory of the agrammatics. It would be recommended, furthermore, to study a larger sample population so as to get more reliable data and more robust conclusions.

Nevertheless, the experimental results cannot be accounted for by the TBA, which predicts the same impaired comprehension with agentive passive sentences than with experiencer passives sentences. This is clearly not the case, which is predicted, in turn, by the LMI.

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