

Pronoun Comprehension in Agrammatic Aphasia

The Structure and Use of Linguistic
Knowledge

Publication of this thesis was financially supported by the Dutch Aphasia Foundation (Stichting Afasie Nederland - SAN).

Published by
LOT
Janskerkhof 13
3512 BL Utrecht
The Netherlands

phone: +31 30 253 6006
fax: +31 30 253 6000
e-mail: lot@let.uu.nl
<http://www.lot.let.uu.nl/>

Cover illustrator by Mitar Vasić.

ISBN-10: 90-78328-11-8
ISBN-13: 978-90-78328-11-7

NUR 632

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Pronoun Comprehension in
Agrammatic Aphasia
The Structure and Use of Linguistic Knowledge

Begrip van voornaamwoorden in
agrammatische afasie

Structuur en gebruik van linguïstische kennis
(met een samenvatting in het Nederlands)

PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Universiteit Utrecht
op gezag van de Rector Magnificus, Prof. Dr. W.H. Gispen
ingevolge het besluit van het College voor Promoties
in het openbaar te verdedigen
op dinsdag 3 oktober 2006
des middags te 12:45 uur

door

Nada Vasić

geboren op 16 juli 1974 te Doboj, Bosnië Herzegovina

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Acknowledgements

There are many people who helped me during this long and intense endeavour, and I do not only refer to the process of writing a dissertation, but the 5 years that took to get here. There is no space to thank everyone, so if I have not mentioned you please don't think I forgot you.

I would like to start with Sergey Avrutin, without whom the Comparative Psycholinguistics Project would not have existed. If somebody had asked me 5 years ago, what kind of a supervisor would you like to have, I would have said the following: 'I would like her/him to be an inspiring person, not just linguistically, but in general; someone who is passionate about art and the finer things in life. I would like this person to be good natured and kind, with a funny edge. I would also like it to be someone who understands my background and culture.' After reading this, you all and me included, would think it is impossible to find someone who has all these characteristics. Well, I found him or he found me.

Esther Ruigendijk has been my aphasia supervisor from day one but also a good friend and fun to work with. She helped me enormously with all the testing and was a great partner in writing abstracts for conferences, papers, presentations etc., not to forget that she helped me learn how to '*desyntactify* my papers and presentations so that normals could follow'. I sincerely hope our cooperation continues.

Peter Coopmans has played an important role in a few of my academic achievements including this final one. I am ever so grateful for his comments, patience, time, reading and rereading, and rereading, and yet again rereading...

The rest of my colleagues from the Comparative Psycholinguistics Project Shalom Zuckerman, Sergio Baauw and Joke de Lange - it has been a pleasure and honour to work with you.

I must not forget my other linguistic colleagues who also helped me along the way by discussing important issues with me, or by having fun with me on different conferences or just taking time to listen to me (and I talk a lot!): Petra Burkhardt, Naama Friedmann, Nino Grillo, Yosef Grodzinsky, Edith Kaan, Jacqueline van Kampen, Arnout Koornneef, Shakuntala Mahanta, Mariana Marelj, Ineke van der Meulen, Iris Mulders, Sieb Noteboom, Aleksandra Perović, Bill Philip, Maria Piñango, Elisa Rosado Villegas, Eric Reuland, Kakhi Sakhltkhutsishvili, Lew Shapiro, Anca Sevcenco, Krista Szendrői, Evy Vlachou, Willemijn Vermaat, Femke Wester, Frank Wijnen, Sharon Unsworth and many many others.

I would like to thank UiL OTS for having me and supporting me in many different ways and not losing faith in me. Thanks to the institute's financial support I was able to attend many important conferences all around the world including the exotic islands of Hawai'i. UiL OTS and its people have

provided an inspiring and stimulating environment for my research and the interaction between theoretical and experimental research is hopefully reflected in this dissertation. I especially thank Martin Everaert and Maaïke Schoorlemmer for their understanding and willingness to help me in all the difficult moments of my 'AiOschap'.

Many thanks to Maud Fontein, Miso Lazović, Mitar Vasić, and Marga van der Zee for helping me with the experiments.

I am grateful to Roelien Bastiaanse for referring me to the Stichting Afasie Rotterdam (SAR) and the SAR for the few months spent under their wing. I especially thank Mieke van de Sandt for helping me understand the clinical aspects of aphasia research. I would also like to thank Herman Kolk and Maria Varela-Put for referring one of their patients to us, Márel Krabbe for helping out with the patients too, and the rehabilitation centers 'De Hoogstraat' in Utrecht, 'Het Roessingh' in Enschede and 'De Trappenberg' in Huizen. I thank the 'Stichting Afasie Nederland' (SAN) for providing me with financial support for the publication of this dissertation. Finally and most importantly, I thank all the aphasic patients that took part in my experiments and made this research possible.

I thank Dawn Danish for proofreading the manuscript, my roomies at ADD: Ellen Gerrits, Jan de Jong, Petra van Alphen and my adopted family the 'dislexie' project for caring for me. Petra for reading my dissertation and all the other little things that helped me relax when I was high-strung. My dear friends Babbete, Danijela, Elisa, Frank, Hugo, Iris, Inez, Judith, Lisa, Marieleen, Nanna...

All Pathuisjes thank you for welcoming me into the big family.

And last but definitely not the least, Hedzermiko thank you for making it all dynamic and exciting; it has been never a dull moment with you. And of course you are my co-author, what an impressive first publication! You know that this is just 'a beginning of a wonderful friendship' (Black Cat White Cat/Casablanca).

Драге моје мике, Тања, Дејане и Марија хвала вам на свему и да у здрављу и весељу положимо и онај други пуно битнији докторат живота (ријечи нашег милог о. Војислава Билбије).

Драги моји мама, тата, Сузана и Мићо иако далеко осјећам да кроз све прошазимо заједно у срцу и души.

Chapter 1

General introduction

1.1 Introduction

In this study I examine the establishment of dependencies between pronominal elements and their antecedents.¹ I focus on the interpretation of pronouns in agrammatic Broca's aphasic speakers.² The primary aim of this study is to use the data gathered from agrammatic Broca's aphasics as a tool for the inquiry into the organization of linguistic knowledge in general. I believe that the pattern of errors in agrammatism can reveal how the system of various constraints on pronominal reference assignment is functionally organised. I argue that the architecture of this system is reflected in distinct processes at a neural level, following Reuland's (2003:3) *correspondence thesis*:

"Differences between major modules of the grammatical system correspond with differences in processes at the neural level and vice versa."

The theoretical model that I argue for focuses on the division of labour between the different linguistic levels of representation (modules) through which pronominal reference assignment is regulated, resulting in different types of pronominal dependencies. Pronouns are a good test case in this matter because they allow for an examination of different levels of representation (modules) and their interactions. This study should thus offer insight in how the fields of aphasiology and linguistics can meet and can help broaden one's knowledge base on this particular linguistic phenomenon and its breakdown in Broca's aphasia.

In addition to data from language impairment, I also provide data on the comprehension of pronouns in preschool-children. All experiments I carried out with Broca's patients were also conducted with children in order to compare their behaviours. There are a few reasons why the acquisition data are added. It is well-known that the processing capacity

¹ I use the term pronominal to denote pronouns, reflexives and reciprocals.

² From this point on the term Broca's aphasia will be used interchangeably with the term agrammatism and will refer to the same type of aphasia, namely, agrammatic Broca's aphasia. The characteristics of this type of aphasia will be discussed in section 1.2.

of agrammatic aphasic patients is compromised (Linebarger, Schwartz & Saffran, 1983; Haarmann & Kolk, 1991a; Friederici & Frazier, 1992; Zurif, Swinney, Prather, Solomon & Bushell, 1993; Kolk, 1995). If their errors are analysed as a consequence of such a limitation, it is reasonable to look for independent support in the form of data from a population with similar problems in relation to language processing. This other population is children. I propose that the two language systems, the impaired system in agrammatism and the developing system in children, share the same insufficient ability to implement grammatical knowledge as a consequence of a lack of processing resources. As such, children's and Broca's patients' performance patterns in establishing pronominal dependencies can be compared and on the basis of the patterns both of these populations display, more can be learned about the ways our knowledge of reference assignment is structured in general. Second, the two systems differ in that the developing language system in children is a dynamic, constantly changing system while the impaired system in agrammatism is relatively static. This offers a nice contrast and, as will become apparent from the studies reported here, the differences between the patterns these two populations exhibit offer insight into the specific nature of language use in the impaired and developing brains.

The structure of this study is as follows. In the first part of this chapter the notions *dependency* and *agrammatic Broca's aphasia* are described and further defined. An overview of general comprehension problems in agrammatism is presented from the perspective of two different claims about the nature of impairment in agrammatic comprehension, the structural versus processing deficit. Finally, a concise overview is given of the processing of pronominal elements in agrammatism. In the second part of this chapter the theoretical framework of this study is outlined. Three theoretical models of pronominal reference assignment are discussed in the chronological order of their formulation, each of which sparked the formulation of the next one: the Binding theory (Chomsky, 1981), the Reflexivity model (Reinhart & Reuland, 1993) and the Primitives of Binding model (Reuland, 2001). In this study I will argue that the Primitives of Binding approach, in combination with the assumption that in Broca's aphasia syntactic processing is weakened and therefore slower than in healthy adults, provides the best toolkit for explaining the data gathered in the experiments discussed in this study. Chapters 2, 3 and 4 present data from experimental studies conducted with agrammatic aphasic patients. In Chapter 2, two experimental studies are discussed. One study examined the interpretation of

antecedent-pronoun dependencies in structures where the two elements are in a coargument configuration (simple transitive sentences) and in non-coargument configuration (Exceptional Case Marking structures - ECM). The other experiment reported in this chapter examined Broca's aphasic patients' ability to make use of morphosyntactic information on pronouns when assigning reference to these elements. In Chapter 3 coreference in coordinated structures is studied as well as the effect of contrastive stress on reference shift in these structures. Chapter 4 provides data on the interpretation of possessive pronouns in VP-ellipsis constructions. In Chapter 5 the data from the experiments conducted with agrammatic patients are compared to the data from pre-school children gathered by means of the same experimental method and materials. Finally, in Chapter 6 a summary of the findings is offered and an attempt is made at connecting the Broca's aphasic patients' comprehension data to the production data found in the literature. The comparison will be extended to phenomena other than pronominal reference assignment in an attempt to reach a unified account of the language impairment in agrammatism.

1.1.1 Dependencies

All human languages encode information in the form of overt and covert elements that are dependent on other elements found in the same sentence or in the broader linguistic context for their appropriate interpretation. In sentences (1) and (2), two types of referential dependency, covert and overt, are exemplified respectively.

- (1) **The dog** that the man hit [**e**] ran away.
- (2) **The boy** said that the man hit **him** and ran away.

Both of these sentences contain an element that is dependent for its interpretation on a Determiner Phrase (DP) found elsewhere in the clause.³ In the case of the object relative sentence in (1) this element is covert, also known as a gap or a trace. The object DP *the dog* originates in the object position of the verb (V) *hit* where it receives its case and is subsequently moved to the sentence-initial position where it is assigned a thematic role (for details, see Haegeman, 1994). In (2) the dependent element, the pronoun *him* is overt, spelled out phonologically. In the

³ In generative theory, the notion DP has replaced the notion NP because it is argued that the head of the phrase is the determiner selecting an NP as its complement (Abney, 1987).

example in (2) the pronoun is interpreted as referring to the DP *the boy*, therefore, it is dependent on this particular DP for its interpretation.

From the perspective of syntactic theory, these two types of dependency are distinct. Specifically, the gap in (1) results from a movement operation and in the case of the pronoun (2) this is clearly not the case. Nevertheless, when we consider the processing of these dependencies in real time, they are essentially the same. When encountered, both the gap (trace) and the pronoun need to be connected to something else previously mentioned in the sentence in order to be interpreted. Therefore, the null hypothesis is that dependency operations that have to do with reference and dependency relations that result from movement operations are syntactically different, but are in principle the same in terms of processing.

The majority of the research examining comprehension in agrammatism has focused on the type of dependencies that involve movement (for an overview, see Grodzinsky, 2000), since these appear to cause problems in comprehension. The focus of this study will be on the comprehension of pronominal dependencies in Dutch agrammatic Broca's aphasia. This type of dependencies does not involve movement, and their processing has been somewhat neglected in the research on agrammatic comprehension. The limited number of studies that have looked at these particular dependencies (Blumstein, Goodglass, Statlender & Biber, 1983; Grodzinsky, Wexler, Chien, Marakovitz & Solomon, 1993; Love, Swinney & Zurif, 2001; Avrutin, Lubarsky & Green, 1999; Piñango & Burkhardt, 2001; among others) have indicated that pronominal elements are not completely spared in this population; Broca's aphasic patients have more problems with the comprehension of pronouns than of reflexives. The exact pattern of what is impaired and what is spared in agrammatism with regard to pronominal elements will be discussed in detail in section 1.6.

In the following section I explain what is understood by agrammatic Broca's aphasia. Then I discuss the psycholinguistic background of the impairment in this type of aphasia in language comprehension, which is the focus of this study. The issues related to language production in Broca's aphasia are addressed in the final chapter of this study where an attempt is made at relating the findings from comprehension of pronouns and other phenomena to the findings from production. In the final chapter I will argue for the existence of a single deficit in agrammatism that is reflected through different phenomena in production versus comprehension.

1.1.2 Agrammatic Broca's aphasia

This section provides a brief overview of the disorder known as aphasia, with the emphasis on a particular type of aphasia, agrammatic Broca's aphasia. First I will give a concise overview of the field of aphasiology in order for the reader to get an impression of the magnitude of the field so often neglected because most linguistic research focuses on either Broca's or Wernicke's aphasia. Then I will discuss in more detail the main characteristics of Broca's aphasia.

Aphasia is a language disorder that arises as a consequence of a focal damage to the brain tissue. Its most frequent cause is a cerebral vascular accident (CVA), more commonly known as a stroke. Aphasia can also develop as a consequence of an existence or a removal of a brain tumor or as the result of a traumatic brain injury. In aphasia, spoken and written language as well as reading can potentially be impaired, as can auditory comprehension. The impairment can manifest itself on all linguistic levels - phonology, morphology, semantics and syntax. As will become clear, there are numerous different types of aphasia. Each type represents a syndrome with a number of related symptoms.

I will focus on the type of aphasia that is known as *Broca's aphasia* or *Agrammatic Broca's aphasia*. Broca's aphasia received its name from Paul Broca, a French neurologist, who was the first to associate a particular region of the brain, the third frontal gyrus, with articulation. Broca published in 1861 a study describing the speech of a 57-year-old patient, Leborgne, who for 21 years had been capable of producing only one recurring utterance - *tan*, but whose comprehension seemed to be intact. The patient's right leg was paralysed and after his death an autopsy revealed a lesion caused by a cyst in the third frontal convolution of the left hemisphere. Broca proposed that this circumscribed area of the left frontal lobe was the centre for the 'faculty of articulate language'; patients with this type of aphasia have an impaired production and relatively spared comprehension. In 1865 Broca published another paper in which he reported eight other cases of aphasia following left hemisphere damage. These events represent the birth of modern aphasiology and neuropsychology. Nowadays, with the help of imaging devices such as magnetic resonance imaging (MRI) the area that is affected in this population can be defined much more precisely. In the present literature, Broca's aphasia is generally associated with a lesion in the left frontal lobe of the brain, more specifically, the third frontal convolution, which is the portion of the cortex in front of the primary motor zone for the muscles serving speech (Goodglass & Kaplan, 1972). However, some researchers have suggested that the brain area

associated with this type of aphasia should be extended to the adjacent and deeper area of the third frontal convolution (Naeser, Palumbo, Helm-Estabrooks, Stiasny-Eder & Albert, 1989; Alexander, Naeser & Palumbo, 1990; Swinney & Zurif, 1995).⁴

In 1874 Carl Wernicke, a German neurologist, presented two patients suffering from damage to the posterior two-thirds of the superior temporal lobe. The language impairment of these two patients was characterised as being related to a problem in language comprehension. Their speech was fluent, characterised by phonological errors - paraphasias and jargon (neologisms). On the basis of the two different types of aphasia that had two different lesion locations and showed selective impairment, Wernicke proposed a model of language production and comprehension. Broca's aphasia was described as a non-fluent expressive aphasic syndrome with intact comprehension and impaired production and Wernicke's aphasia as a fluent type of a syndrome with a relatively preserved production and impaired comprehension. Wernicke also predicted that other types of syndromes must also exist and would be discovered as the research unfolded. This was indeed the case when new cases emerged new forms of aphasia were defined and described.

Broca's and Wernicke's aphasia are probably the most frequently studied types of aphasia. However, there are many other types that can be distinguished, such as global aphasia, subcortical aphasia, anomic aphasia, conduction aphasia, trans-cortical sensory aphasia, trans-cortical motor aphasia, mixed trans-cortical aphasia, neologistic jargon aphasia etc. (Goodglass & Kaplan, 1972). These different varieties of aphasia will not be discussed here since they are not relevant for the work presented in this study. Nevertheless, it should be noted that the classification of patients is rather difficult since the syndromes are not 'pure' but very often represent a combination of symptoms characteristic of different syndromes. For more information on the classification of aphasic patients into different syndromes, see Goodglass & Kaplan (1972) and Prins (1987).

I will examine now some of the most important general aspects of language production and comprehension in Broca's aphasic patients. For

⁴ There is evidence from deficit-lesion correlation analyses (see Caplan, Hilebrant & Makis, 1996 and Caplan, Alpert, Waters & Olivieri, 2000) which indicates that the brain area related to this type of aphasia extends through the entire perisylvian cortex. It is also important to note that there are studies (for a review, see Dronkers, Redfern & Knight, 2000) which show that patients with a lesion restricted to Broca's area do not necessarily suffer of Broca's aphasia.

a very long time, this type of aphasia was treated as a production disorder. It was believed that the patients suffering from it have a fairly intact comprehension. This is not surprising since this disorder affects the expressive aspect of language, which sticks out most clearly. The main characteristic of agrammatic speech is its telegraphic nature, as can be seen in the spontaneous speech sample in (3) (taken from Avrutin, 2001).

- (3) *B.L.*: Wife is dry dishes. Water down! Oh boy! Okay. Awright. Okay... Cookie is down ... fall, and girl, okay, girl ... boy ... um...
Examiner: What is the boy doing?
B.L.: Cookie is ... um ... catch
Examiner: Who is getting the cookies?
B.L.: Girl, girl!
Examiner: Who is about to fall down?
B.L.: Boy ... fall down!

Broca's patients take a long time to express their thoughts through language, which results in halting speech, indicated by the dots in the sample (3). Broca's patients also often have problems with activation of lexical items in production. They produce significantly fewer embedded sentences than non-brain-damaged speakers (Menn & Obler, 1990). When they produce a complementiser such as *that*, which indicates subordination, they often fail to complete the rest of the sentence (Friedmann, 1999). Their utterances are reduced to mainly content words (open class constituents), and functional categories/grammatical morphemes (closed class constituents) such as determiners, auxiliaries, complementisers, prepositions and tense are frequently omitted.⁵ The omission of grammatical morphemes was used by Kean (1977) and Saffran, Berndt & Schwartz (1989) as a characteristic that distinguished a subgroup of Broca's aphasia, which they called agrammatic aphasia.⁶

⁵ However, recent studies conducted by Friedmann (2001) and Ruigendijk (2002), among others, have indicated that not all function words are equally affected.

⁶ The term agrammatism was first used by Pick (1913) who claimed that agrammatism is a consequence of an impairment in the grammar. He also introduced the term *Notsprache* (emergency speech) for agrammatic speech. He treated it as a strategy that is governed by *economy* where the redundant elements, which do not bear semantic content, are omitted. His ideas have been used in defining so-called economy-based approaches to agrammatism. The notion of economy will be discussed in detail in the theoretical introduction because it is a crucial notion in the Primitives of Binding model, a theoretical model of pronominal reference assignment I will use to account for agrammatic speakers' errors with pronouns.

They categorised Broca's aphasic patients that did not omit these morphemes as non-agrammatic. In this study, I have tested aphasic speakers that were categorised as having Broca's aphasia and whose production was typically agrammatic, as described by Menn & Obler (1990). These patients omitted functional categories; they produced mainly non-finite verbs; they produced simple sentences without subordination.

1.1.3 Comprehension in agrammatism

At first sight, comprehension in agrammatism seems to be unimpaired. The study conducted by Caramazza & Zurif (1976), however, provided data that changed the picture. They found that individuals with agrammatism had more trouble interpreting *semantically reversible* object relatives, such as (4), than *semantically irreversible* object relatives, as in (5).

- (4) The *cat*_{*t*} that the dog is chasing *t*_{*i*} is black.
- (5) The *house*_{*t*} that the man is painting *t*_{*i*} is blue.

Both of these sentences contain a moved element, the italicized DP that originates in the object position after the verb indicated by *t_i*. This means that in order to correctly interpret who is performing the action on whom, at the point after the verb the italicized DP has to be reactivated. In semantically reversible relatives, such as in (4) semantically both *the cat* can chase *the dog* and *the dog* can chase *the cat*. The only way to get the correct interpretation is to use the relevant syntactic information about these particular types of structures. In the semantically irreversible relatives, such as in (5), only *the man* can paint *the house* and the reverse is impossible: *the house* can never paint *the man*. Agrammatic patients had problems with the reversible sentences where they had to rely on syntactic information. Their performance was above chance on the irreversible relatives because for these they could use semantic cues to get around their comprehension problem. Caramazza & Zurif's findings opened a new direction of psycholinguistic research into agrammatism, showing that the impairment is related to linguistic knowledge in general and that the production/comprehension divide was an unnatural one. Their study was followed by a series of studies that examined agrammatic comprehension in greater detail. The pattern that emerged reflected problems with comprehension of non-canonical word order. However, Broca's aphasic speakers could understand these sentences when plausibility considerations supported "educated

guesses" (Swinney & Zurif, 1995). These results pointed towards a syntactic problem and that is what most of the psycholinguistic models of breakdown in agrammatism reflect. I will discuss now some of the most prominent models of comprehension problems in agrammatism.

In the last few decades many attempts have been made to characterise the nature of the language comprehension deficit in Broca's aphasia. The first question to consider is whether the language comprehension deficit is a matter of language loss or a consequence of a lack of processing resources resulting in patients' inability to use linguistic knowledge. An additional fact to be explained is that this particular type of aphasia manifests itself even more prominently in production than in comprehension. Therefore, the second question that should be posited is whether the deficits in both the comprehension and production of agrammatic patients should be viewed as separate deficits with different sources. Or whether these deficits should be unified and treated as having the same underlying source that manifests itself in different problems in production and comprehension. The second question will be addressed in more detail in Chapter 6.

The following sections present brief overviews of the two most prominent psycholinguistic approaches that account for the characteristics of the language impairment in agrammatism in the light of the first question posed in the previous paragraph. First the account that supports a lack of a particular aspect of linguistic knowledge will be reviewed, followed by a discussion of the so-called lack-of-processing resources model. It should be noted that the *structural deficit approaches* treat agrammatic comprehension and production as two separate deficits. The lack-of-resources approaches, on the other hand, generally attempt to provide a unified explanation for both production and comprehension.

1.1.4 Agrammatism as a structural deficit

One of the most influential models of the agrammatic comprehension deficit centres on Trace Deletion Hypothesis (TDH) put forward by Grodzinsky (1995). The TDH restricts the problem in agrammatic comprehension to a very specific syntactic deficit, namely, problems with structures that involve syntactic movement. Grodzinsky's model is anchored in the Government and Binding theory (Chomsky, 1981) wherein movement of a constituent leaves a trace in the position it occupied; trace is an abstract phonetically empty marker. Grodzinsky hypothesises that Broca's aphasics cannot represent traces, which are left behind by moved elements. Traces play an important intermediary role

in the assignment of thematic roles to the moved DPs. These roles are assigned hierarchically and if a thematic position is occupied by a trace then the trace is assigned the thematic role and the antecedent (moved DP) will receive the thematic role indirectly through some process of coindexation. According to Grodzinsky, agrammatic patients (a) fail to comprehend movement-derived structures, (b) they are also unable to detect grammatical violations when movement rules are involved (Grodzinsky & Finkel, 1998), and (c) they cannot properly process movement-derived structures on-line (Swinney & Zurif, 1995).⁷

The first claim is that individuals with agrammatism have problems comprehending movement-derived structures. In numerous off-line experimental studies across languages it has been established that, as a group, agrammatic aphasic patients perform above chance in the comprehension of canonical (i.e. standard word order) constructions. In these constructions the *agent/experiencer* thematic role is carried by a DP that appears in a sentence in the position before the DP that carries the *theme/patient* role, such as in actives and subject relatives. The same patients perform at chance level when interpreting non-canonical sentences, such as passives, object relatives or object clefts (see Caramazza & Zurif, 1976; Schwartz, Saffran & Marin, 1980; Linebarger, Schwartz & Saffran, 1983; Caplan & Futter, 1986; Grodzinsky, 1989, 1995, 2000; Hagiwara, 1993; Hickok, Zurif & Canseco-Gonzales, 1993; Grodzinsky, Piñango, Zurif & Draai, 1999; among others). I will illustrate the TDH using the passive versus active contrast as an example:

- (6) Peter (*agent*) kicked Mary (*patient*).
- (7) Mary_i (*patient*) was kicked t_i by Peter (*agent*).

In the passive structure (7) the DP *Mary* leaves a trace in the object position after the verb. Agrammatic patients fail to interpret the DP *Mary* as the *patient* of the action because they cannot represent a trace; they fail to transmit those thematic properties of the object trace to the DP *Mary*. According to Grodzinsky, they then apply a non-syntactic strategy by which they assign the *agent* role to the first DP they encounter. The second DP *Peter* is assigned the *agent* thematic role by the preposition *by*. Agrammatic patients are thus confronted with a representation in which two DPs have the role of *agent* giving rise to a conflict. This results in them guessing and consequently leads to a chance performance with these and many other similar movement-derived structures. In the active

⁷ Wilson & Saygin (2004) failed to replicate Grodzinsky & Finkel's (1998) findings.

structure (6), applying the non-syntactic strategy of “first DP is *agent*” does not result in erroneous comprehension: the first DP *Peter* is the *agent* and the second DP *Mary* is the *patient*.

The second claim that the TDH makes with regard to agrammatic comprehension is that Broca’s patients fail to detect grammatical violations in structures that require syntactic movement. However, studies on Italian, German and Serbo-Croatian have demonstrated that agrammatic patients can detect violations of inflectional morphology (Bates, Friederici & Wulfeck, 1987; Haarman & Kolk, 1994; Friederici, Wessels, Emmorey & Bellugi, 1992; Lukatela, Shankweiler & Crain, 1995). More studies have contradicted this claim and have shown that Broca’s aphasic patients, even the more severe ones, can detect grammatical violations in these structures (Linebarger, Schwartz & Saffran, 1983; Lukatela, Crain & Shankweiler, 1988; among others).

Finally, according to Grodzinsky (1995) and in accordance with the TDH, agrammatic patients fail to correctly process movement-derived structures on-line (Swinney & Zurif, 1995). It appears that structures that Broca’s patients perform on above chance in off-line tasks are not processed on-line in the same way as in unimpaired adults. Subject relative clauses like in (8) are not overtly affected by movement and in off-line tasks pose no problem for agrammatic patients.

- (8) The linguist liked *the professor* from the other department who *1 hated lunch breaks.

In a priming study Zurif, Swinney, Prather, Solomon & Bushell (1993) found that, in subject relative clauses, healthy adults exhibited a priming effect for a word semantically related (e.g. *teacher*) to the antecedent of the relative pronoun (*professor* in (8)) immediately after the relative pronoun was presented (indicated by *1). Broca’s aphasic speakers did not show any priming effect for the same word presented after the relative pronoun. According to the authors, Broca’s patients understand subject relatives, which is supported by the above chance scores in off-line tasks. However, as indicated by the on-line data, they process these sentences in an abnormal way in real time; they fail to make the fast connection between the trace and its antecedent.⁸

⁸ There are studies that have provided evidence against the TDH (Tait, Thompson & Ballard, 1995; Hickok & Avrutin, 1995; Beretta & Munn, 1998; Piñango, 1999, among others). However, it is beyond the scope of this study to discuss them in greater detail (for an overview, see Avrutin, 2001).

These results lead to the conclusion that it is not the representation of traces itself, which seems to pose the problem for these patients but rather the process of connecting traces to their appropriate antecedents. In the following section, an alternative explanation is given for the impairment in agrammatic Broca's aphasic speakers, which is expressed through a particular error pattern in their comprehension in general.

1.1.5 Agrammatism as a lack of processing resources

The second approach to the deficit in agrammatic aphasia assumes that the impairment in comprehension is a reflection of a decreased processing capacity in this population, which mainly affects the syntactic subcomponent of the language-processing device. It has been argued by many that brain damage in agrammatic Broca's aphasic patients results in a reduction of resources available for language processing (see Linebarger *et al.*, 1983; Haarmann & Kolk, 1991a, 1994; Grodzinsky, Wexler, Chien, Marakovitz & Solomon, 1993; Friederici & Frazier, 1992; Zurif, Swinney, Prather, Solomon & Bushell, 1993; Kolk, 1995 and many others). These patients possess the grammatical knowledge of language but fail to implement this knowledge in real-time language comprehension and production. Several researchers have argued that the brain damage in agrammatism results in a reduction of brain activation required for the execution of syntactic operations (see, for example, Avrutin, 2006). The syntactic module is 'weakened' and the operations that take place within this module and that are normally the most automatic operations become delayed. The decreased speed in building syntactic structure adversely affects language processing in these patients, as for instance formulated by the Slow-Syntax model (Piñango, 1999). In an online priming study, Swinney, Love, Nagel & Zurif (in preparation) (for more details see Zurif, 2003) found that agrammatic speakers show a priming effect when reactivating the antecedent linked to the trace of the moved constituent in object relative clauses (9), not at the point of the trace but at a later point in the sentence; they prime at about 500 ms later than non-brain-damaged adults do.

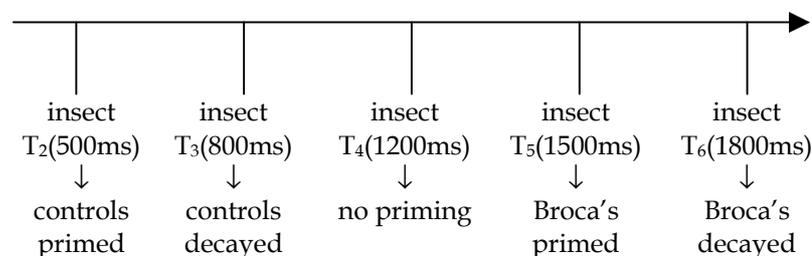
- (9) The priest enjoyed **the drink**_i that the caterer was serving **t_i** to the guests.

Many other experimental studies (Burkhardt, Avrutin, Piñango & Ruigendijk, submitted; Piñango, 1999, 2001; Piñango & Burkhardt, 2001; Love, Swinney & Zurif, 2001; Swinney, Zurif, Prather & Love, 1996 and Zurif *et al.*, 1993) also found that the processing of syntactic information

in aphasic patients is slower than in non-brain-damaged speakers by examining various phenomena that involve grammatical dependencies (wh-questions, relative clauses, pronouns). Agrammatic aphasic speakers seem to be unable to carry out the construction of syntactic structure on time. There is a point at which syntactic structure is fully formed but this point is delayed in comparison to that in non-brain-damaged adults.

An important question to ask is why syntax would be delayed. The answer might lie in slow lexical access in these patients, as argued by Swinney, Zurif & Nicol, (1989) and Zurif (2003). In two online priming studies, Prather, Zurif & Love (1992) and Prather, Zurif, Love, & Brownell (1997) examined the process of lexical access in agrammatism crucial for online sentence comprehension. The building of syntactic structure is constrained by temporal factors and if these are affected by slow lexical access, syntactic processing will suffer. In their study Prather *et al.* (1997) tested the speed of lexical activation using the list-priming paradigm (LPP), where subjects were presented words as letter strings sequentially and continuously. As each letter string was presented, the subject had to decide as quickly as possible whether the string represents an existing word in English. After the subject reacted, the presentation of the following word varied in latency; it was presented 500ms, 800ms, 1200 ms, 1500ms 1800ms or 2100ms after the subject had reacted. Embedded in this list were experimental pairs such as *BUG-INSECT* and *BUG-SPYING DEVICE* and the semantically related first word in the pair was expected to prime the second word reducing the reaction time for the second word. Unimpaired controls exhibited automatic priming of the most frequent (easiest to access) meaning, *INSECT* for *BUG*, at around 500ms after the presented stimuli; the priming effect decayed 300ms later, see (10). The agrammatic speakers' automatic priming effect was delayed until approximately 1500ms and it decayed within 300ms.

(10) bug
T₁(0ms)



Prather *et al.*'s (1997) conclusion was that the primary problem in agrammatic lexical activation has to do with the *speed* of activation. Such patients have the ability to access lexical information in comprehension automatically but only if they are allowed enough time to do so. These results indicate that agrammatic patients show priming when there is enough time for the activation of lexical items to spread among associates in a network.⁹ The slower activation, as argued previously, has an adverse effect on online sentence processing. Therefore, it is reasonable to assume that as a consequence of a slower lexical access, the building of the syntactic tree structure will also be delayed. Avrutin (2001) uses this model to account for the most basic comprehension patterns observed in aphasia, such as in object relative clauses, subject gaps, and passive constructions.

Haarmann & Kolk (1991b) conducted a computer simulation study that tested the temporal course of agrammatic sentence understanding. In this study, the building of syntactic structure was assumed to proceed as a series of activations of lexical items and syntactic phrases. In their model they dealt not only with a slow down of activation of lexical items and syntactic phrases but also with a too fast decay of these elements. According to the authors, an element can be processed only if its activity is above a critical threshold. The activation rate of an element determines how long it takes for the element to surpass the critical threshold. The decay rate of an element determines how long it takes for the element to drop below the critical threshold. Their argument is that if the activation rate of an element is decreased it will rise above critical value later and will decay sooner. In this view, there is no difference between delay in access and too fast decay of elements. The slower the activation of an element, the more chance there is for its premature decay. The results of this study indicated that slow activation and fast decay of only lexical items was insufficient to simulate the results of agrammatic patients; phrasal nodes had to be included (for details, see Haarman & Kolk, 1991). They pointed out a number of limitations of their model and emphasised that this study represents a first attempt at simulating particular aspects of agrammatic comprehension. As it will become clear from the following chapters, pronoun resolution is dependent on structural information, which can be affected by both delayed access and too fast decay. Therefore, the discussion about whether too slow delay or

⁹ Hagoort (1997) does find lexical priming in Broca's patients within a temporal window assumed to reflect automatic activation.

too fast decay of lexical items and syntactic phrases adversely affects agrammatic comprehension will be left aside.

As already pointed out, I follow the second approach and ascribe the comprehension (and production) problems in agrammatic patients to a general slow down in the building of syntactic structure in time, as a consequence of a general reduction in their processing capacity. The main reason for adopting this view rather than the TDH is that it allows for a unified account of errors agrammatic patients make with regard to moved elements and elements that do not involve movement. The primary problem for the TDH is pronominal reference assignment, which is the focus of this study and which does not involve overt movement. The TDH cannot account for the problems with these elements because it is too restrictive as a model and deals with only one specific aspect of the syntactic structure - traces. Besides pronominals, there are many other phenomena (for details, see Avrutin, 2001; see also footnote 7) that the TDH fails to account for. In the final chapter of this study, I will return to this issue and discuss the final reason why the TDH should be abandoned. It is a model that deals with agrammatic comprehension and not with production. According to TDH, the impairment in production is supposed to have a different source. I will argue in Chapter 6 that the processing account makes it possible to unify comprehension and production as having the same underlying source.

1.1.6 Pronoun comprehension in agrammatism

This section provides an overview of studies that have examined the ability of agrammatic patients to correctly establish antecedent-pronominal dependencies. As already mentioned, referential dependencies have been somewhat neglected in comparison to other types of structural dependencies. Nevertheless, the few studies that have focused on these dependencies have provided evidence that the comprehension problems in agrammatism are not restricted to moved elements only. Reference assignment is selectively impaired in Broca's aphasia. The results of off-line studies indicate that the interpretation of reflexives in this population is less problematic than the interpretation of pronouns. Nevertheless, on-line studies show that even the elements on which Broca's patients score above chance in off-line tasks, such as reflexives, are processed on-line by these patients in an abnormal fashion. In this section I will discuss the most prominent off- and on-line studies and review their findings.

Grodzinsky, Wexler, Chien, Marakovitz, & Solomon (1993) conducted one of the first studies examining pronominal reference. Their aim was

to shed more light on what exactly is impaired with regard to pronominal elements and whether it is selectively impaired in patients suffering from Broca's aphasia. They also aimed at providing new data that would aid in formulating the rules governing reference assignment in linguistic theory. They found that Broca's patients have problems interpreting the following type of sentence:

- (11) **Mama Bear* is touching *her*.¹⁰

Broca's patients' performance was at chance level, which means that half of the time they incorrectly allowed the pronoun *her* to refer to the subject DP *Mama Bear*. Their performance on sentences containing reflexive pronouns (12) and sentences where the only potential antecedent is quantified (13) was significantly above chance.

- (12) *Mama Bear* is touching *herself*.
 (13) *Every bear* is touching **her/herself*.

I will return to their findings and conclusions in Chapter 2, where some issues raised by their study will be discussed in detail.

Avrutin, Lubarsky & Green (1999) examined structures where contrastive stress causes a shift in reference.¹¹

- (14) First John hit *Bill* and then Mary hit *him*.
 (15) First *John* hit Bill and then Mary hit *HIM*.

In order to correctly establish reference in these sentences, one first needs to establish reference in the non-stressed cases (14). Subsequently, stress is applied to the pronoun in (14) as a second step operation and reference then shifts from *Bill* to *John* in (15). Avrutin *et al.*, (1999) pointed out that prosodic cues generally seem to be preserved in aphasic patients. It is when these interact with other types of rules, such as syntactic binding principles, that problems appear to arise. Their results indicated that Broca's aphasic patients have trouble interpreting pronouns in sentences where stress shifts reference.

The two previously discussed studies employed off-line techniques to study the comprehension of pronominal elements in Broca's aphasia. There are also a few online studies that examined these dependencies in

¹⁰ The *italics* indicate that the two phrases are treated as semantically related. A star (*) indicates that the binding interpretation is ruled out.

¹¹ The capital letters indicate the application of contrastive stress to a DP.

agrammatic patients. Love, Nicol, Swinney, Hickok & Zurif (1998) examined the comprehension of pronouns and reflexives in Broca's and Wernicke's aphasic patients. The paradigm they used was a cross-modal semantic priming task, which has been successfully used in sentence processing studies of impaired and unimpaired subjects to demonstrate reactivation of antecedents for different types of traces/referential elements (Nicol, 1988; Love & Swinney, 1996; Swinney *et al.*, 1996; Zurif, Swinney, Prather & Love, 1994). Love *et al.* (1998) tested sentences of the following type:

- (16) The **boxer**_i said that the **skier**_j in the hospital had blamed him_i/himself_j^{*1} for the recent injury.

The subjects heard a sentence over headphones and at the point immediately after the pronoun or the reflexive (*1) a target word was flashed on a computer screen. This word was either semantically related to the antecedent, semantically unrelated word or a non-word in filler items. The subjects had to make a lexical decision - indicate whether the target was a word of English by pressing a button. Their reaction time was measured and a difference in reaction time (a lower reaction time for the related word) was interpreted as an indication that the pronoun/reflexive was identified with its antecedent.

In this experiment, Love *et al.* (1998) exclusively examined the time course of linking the correct antecedent for the reflexive (**skier** in (16)) in sentences containing either a reflexive or a pronoun. They tested 3 Broca's and 3 Wernicke's aphasic patients and matching controls. Their results reveal a re-activation of the structurally correct antecedent (**skier**) to the reflexive and no such re-activation for the pronoun for the controls and for Wernicke's patients. In contrast, Broca's patients exhibit no priming for the reflexive and atypical priming for the pronoun. Specifically, after processing the pronoun they show a priming effect for the wrong antecedent (**skier**), which is the correct antecedent in the case of a reflexive interpretation. These findings are similar to the results obtained by Zurif *et al.* (1993), discussed in section 1.4. Recall that in Zurif *et al.*'s (1993) study subject relative constructions, which agrammatic patients can correctly interpret in an off-line task, show an abnormal on-line processing pattern. The study by Love *et al.* (1998) provides additional evidence that the dependencies that agrammatic patients comprehend well in off-line tasks, such as reflexives, are processed on-line by these patients in a manner that deviates from neurologically intact adults. Love *et al.* (1998) conclude that Broca's area

seems to be critical in the automatic linking during structural co-reference processing.

Piñango & Burkhardt (2001) conducted an on-line experimental study testing Broca's patients' comprehension of two types of reflexives, namely non-logophoric and logophoric reflexives.¹² The two types of reflexives differ in their relation to the main verb of the sentence that they are a part of. In the case of a non-logophoric reflexive, both the antecedent NP and the reflexive are coarguments of the same predicate. Therefore, the reflexive is interpreted within its syntactic context. A logophoric reflexive, on the other hand, does not belong to the same predicate as its antecedent. It is interpreted outside syntax, invoking the rules of discourse representation (Reinhart & Reuland, 1993).¹³

(17) Non - logophoric reflexive:

[The lawyer who was young]_i defended himself_i when....

(18) Logophoric reflexive:

[The daughter]_i hid a present behind herself_i when....

In an on-line study with non-brain-damaged adults, Piñango, Burkhardt, Brun & Avrutin (2001) observed a difference in the processing of logophoric versus non-logophoric reflexives. Their findings indicate that the former impose a higher processing load on the parser. Piñango & Burkhardt (2001) set out to check the same process in Broca's aphasic patients. A cross-modal lexical decision paradigm was used to examine the processing load during comprehension of the two types of reflexives. The subjects heard sentences through headphones and at the point immediately after the reflexive, a letter string semantically unrelated to the sentence was flashed on the computer screen. They had to make a lexical decision, i.e. whether the word was an existing word of English. The idea is that the two tasks that have to be performed draw computational resources from the same pool. If the primary task, in this case comprehending the sentence, requires more resources because more work needs to be performed, then this will be detected in the secondary task. The reaction time will increase if more resources are required.

Piñango & Burkhardt (2001) found that the control subjects exhibited a difference in reaction time when processing the two different reflexives.

¹² Another term for non-logophoric reflexives is anaphoric reflexive. However, I retain the term non-logophoric because that is the term used by Piñango & Burkhardt (2001).

¹³ The distinction between coarguments and non-coarguments is taken up further in Chapter 2.

Their reaction time increased when they had to process logophoric reflexives in comparison with the non-logophoric ones. Unlike the controls, Broca's aphasic patients' reaction times did not differ between the two different reflexives. This was not surprising since it had been already shown that agrammatic patients showed no semantic priming for true reflexives (Love *et al.*, 1998). The authors assumed that there is a general slow-down in the process of building the syntactic structure in agrammatic aphasic speakers, following the spirit of the Slow Syntax hypothesis mentioned in the previous section. They expected that the effect they found in the control group would be delayed in aphasics. They moved the measuring point further down in the sentence after the reflexive was encountered. As expected, they found the same increase in reaction time for logophoric reflexives as in the control group in agrammatic patients; only this effect came 200ms after the reflexive in the latter group.

They conclude that their results support the model of language comprehension in agrammatic aphasia, which predicts that the formation of syntactic structure is slower than in healthy adults. This is detectable in online studies because the process of comprehension is examined as it unfolds incrementally. In off-line studies Broca's individuals perform better with reflexives because, even though delayed, they do manage to construct the full syntactic structure at a certain point and interpret the reflexive.

Having reviewed the psycholinguistic background, in the following sections I will discuss different theoretical approaches to pronominal reference assignment.

1.2 Theoretical background

All natural languages rely on anaphora to avoid repeating information that can be inferred from the given context, be it a sentence or a larger unit (discourse), or even general knowledge. Pronouns (*he/she*) and anaphors (*herself/himself*) are such elements, which on their own do not carry enough information for their appropriate interpretation, besides their specification for *person* [first/second/third], *number* [singular/plural] and *gender* [male/female/neuter]. The interpretation of anaphoric elements depends on various syntactic and discourse factors and the interaction of these different levels of grammatical representation. In this study I examine the interaction between different domains/levels of grammar, namely, syntax, logical-syntax (semantics) and discourse in the interpretation of pronouns, particularly by agrammatic Broca's aphasic speakers.

The following section provides the theoretical background to reference assignment beginning with Chomsky's (1981) Standard Binding theory, which set the course for later theoretical models, among which the Reflexivity model (Reinhart & Reuland, 1993) and the Primitives of Binding model (Reuland, 2001). The results of the experimental studies reported in this study will be used to assess the predictions the Reflexivity model and the Primitives of Binding model make with regard to pronoun resolution in the structures tested. In this study I will argue that Primitives of Binding is the most advanced model of how pronominal dependencies are encoded in the grammar. To my knowledge, it is the first theoretical model that addresses both the representation as well as the processing of these dependencies. On the basis of the results gathered in experiments with agrammatic patients and children, I will argue in the subsequent chapters that the Primitives of Binding model provides the most comprehensive account of the data from the two populations.

1.2.1 Binding Theory (Chomsky, 1981)

In Chomsky's (1981) Binding Theory (henceforth BT), Principles A and B structurally regulate the relations between anaphoric elements and their antecedents within the same sentence. These principles constrain the interpretation of two different types of DPs: reflexives, pronouns, whose antecedents are in A-position (an argument position that can potentially be assigned a thematic role by its predicate, i.e. a position in which arguments can be base-generated). Principle A determines the interpretation of reflexive elements; Principle B deals with the interpretation of pronouns.

(19) *Principle A*: An anaphor is bound in its governing category.

Principle B: A pronoun is free in its governing category.

In this framework, an antecedent DP *binds* an anaphoric element if it c-commands it and is coindexed with it; *free* simply means not-bound.¹⁴ In order for an anaphoric element to receive its referential content from an antecedent, the two elements need to share the same index, they need to be coindexed.¹⁵ The structural domain in which coindexation is allowed

¹⁴ Node A c(onstituent)-commands node B iff the branching node α_1 immediately dominating A either dominates B or is immediately dominated by a node α_2 which dominates B, and α_2 is of the same category type as α_1 . (Reinhart, 1983:23)

¹⁵ In order to properly capture the notion of coindexation, in the sections where the Binding Theory (1.2.1) and the Reflexivity (1.2.2) model are explained, the binding

in the case of Principle A or disallowed in the case of Principle B is defined as the *governing category* of an anaphoric element. It is the domain which is the smallest maximal projection (IP or NP) containing the anaphor, the governor for the anaphor and an accessible subject.

(20) Sue_i claimed that [_{IP} Ann_j gave herself_{*i/j}/her_{i/*j} in].

According to Principle A, the reflexive *herself* in (20) must be bound in its governing category, which in this case is the complement IP containing it. There are two candidate DPs *Ann* and *Sue* in (20) that could potentially bind the reflexive. The DP *Ann* c-commands the reflexive and binds it, since it is found in the governing category of the reflexive. The DP *Sue* fails to bind the reflexive locally because it is outside the governing category of *herself*. The interpretation of pronouns, on the other hand, is governed by Principle B, according to which a pronoun must be free in its governing category. The DP *Ann* can therefore, not bind the pronoun because but it can be bound by the DP *Sue*, which is outside its governing category.

According to this model, pronouns and reflexives are supposed to be in complementary distribution. There are, however, a number of environments, two of which are exemplified in (21), where the two elements are not in complementary distribution and, therefore, cannot be accounted for by BT (for an overview, see Burkhardt, 2004, and the references therein).

- (21) a. Sue_i put the book near herself_i/her_i.
 b. Mary_i found that the picture of herself_i/her_i was appalling.

Furthermore, sentences such as (22) are grammatical but in each one of them Principle A is violated.

- (22) a. All the guests, apart from myself, seemed to like the food served at the party.
 b. Max_i boasted that [_{IP} the queen invited Lucie and himself_i for a drink].
 c. [_{DP} Peter_i's jokes] worked against himself_i.

and coreference relations between the pronominal element and an antecedent are indicated by subscripts only. As already mentioned, throughout the rest of this study I indicate such a relation using italics.

In sentence (22a) the first person reflexive has no obvious antecedent and appears to be left unbound (for details, see Zribi-Hertz, 1989; among others). In (22b), the embedded IP is the governing category within which the reflexive *himself* must be bound. However, the antecedent DP *Max* binding the reflexive is outside the governing domain. In sentence (22c), the whole DP *Peter's jokes* c-commands the reflexive, yet the reflexive is linked with *Peter*, a constituent that does not c-command it.

There are also examples of Principle B violations and one such example is the use of third person pronouns in some dialects of American English (23) (see Horn, 2002, and the references therein). The pronoun *him* in (23) is bound by an antecedent in its governing domain, which violates Principle B.

(23) John_i won him_i a prize.

BT also fails to capture a distinction between SELF-anaphors (*zichzelf*) and SE-anaphors (*zich*) that exists in languages like Dutch, but not in English (Everaert, 1986). There are environments where the two can co-occur, such as in (23), where in English *himself* is used.

- (24) a. Jan_i hoorde zich_i/zichzelf_i fluisteren.
 Jan heard SE/SELF whisper.
 b. John_i heard himself_i whisper.

The above listed phenomena represent problems for BT and many attempts have been made to reformulate or extend the theory in order to accommodate for these facts, as well as others. The majority of these attempts remained syntactic in nature. For example, Hestvik (1991, 1992) made an attempt at redefining the government categories by introducing subjectless domains in order to account for the non-complementary distribution of reflexives and pronouns in PPs such as in (21). Another example is a parameterised BT introduced by Wexler & Manzini (1987) in order to account for cross-linguistic differences in the nature of binding domains, which the authors treat as language-specific. Besides the above-mentioned reformulations, there are many other similar attempts (for an overview, see Burkhardt, 2004).

As opposed to purely syntactic BT, a proposal based on Reinhart's (1976, 1983) ideas has emerged, which has pointed out that there are a number of pronominal dependencies that cannot and should not be explained on the basis of structural relations only. This proposal can for example be found in the formulation of the Reflexivity model (Reinhart

& Reuland, 1993), which acknowledges the need for a discourse level of representation in order to account for all instances of pronominal reference. It relies on the notion of c-command as the main tool in separating syntactic dependencies from the ones that occur at the level of discourse, and dependencies are defined in terms of relations of the pronominal element and its antecedent with their predicates. The Reflexivity model will be discussed in the following section.

1.2.2 Reflexivity (Reinhart & Reuland, 1993)

In the Reflexivity model two modules govern the distribution of pronominal elements. One is related to the function of reflexivization and is relevant for the reformulated binding conditions in (25), which are defined in terms of conditions on predicates that are accompanied by the set of definitions given in (26) (Reinhart & Reuland, 1993: 678). The other module is related to the referential property [R] of the pronominal element and is referred to as the A-chain condition, which I will return to after I discuss the first module related to the reflexivizing function.

(25) *Binding Conditions*

A: A reflexive-marked predicate must be interpreted reflexively.

B: A reflexively interpreted predicate must be reflexive-marked.

(26) Relevant definitions:

1. The *syntactic predicate* formed of (a head) P[predicate] is P, all its syntactic arguments, and an external argument of P (subject). The *syntactic arguments* of P are the projections assigned θ -role or Case by P.
2. The *semantic predicate* formed of P is P and all its arguments at the relevant semantic level.
3. A predicate is *reflexive* iff two its arguments are coindexed.
4. A predicate (formed of P) is *reflexive-marked* iff either P is lexically reflexive or one of P's arguments is a SELF-anaphor.

I will explain now how this model accounts for the differences in grammaticality between the examples in (27).

(27) a. *Peter_i hit him_i.

b. Peter_i hit himself_i.

According to this model, a predicate is interpreted reflexively only if the two arguments are coindexed. In both (27a) and (27b) the two arguments

are coindexed and therefore both predicates are reflexive. According to condition B, however, a predicate can only be interpreted reflexively if it is reflexive-marked. In the case of (27a), the verb *hit* is not inherently reflexive and the pronoun *him* is not a reflexive-marker. Only SELF-anaphors can function as reflexive-markers. The predicate is not reflexive-marked and the reflexive interpretation of this predicate violates condition B of the Reflexivity model. In (27b) the SELF-anaphor *himself* “saves” the predicate by reflexive-marking it and the sentence is grammatical on the interpretation given (him=Peter).

I will explain now how this model accounts for some of the examples that were problematic for BT, repeated in (28).¹⁶

- (28) a. Sue_i put the book near herself_i/her_i.
 b. Mary_i found that the picture of herself_i/her_i was appalling.

The examples (28a) and (28b) are similar in that the reflexive *herself* in both instances is a logophor, not a true reflexive anaphor. A logophor and a reflexive anaphor differ in terms of coargumenthood with their potential antecedents. A reflexive that is an argument inside a complement or an adjunct of a main predicate is referred to as a logophor; reflexive anaphor is a reflexive that is an argument of the same predicate as its antecedent. In the Reflexivity model it is suggested that the distribution of logophors is governed by discourse factors. The reflexive in (28a) fails to reflexive mark the predicate *put* because it is not an argument of this predicate; the whole PP *near herself* is the argument. Condition A, given in (25), requires only that reflexive-marked predicates be reflexive and simply does not apply when a predicate is not reflexive-marked. Therefore the sentence with a reflexive is not ruled out. In the picture-NP in (28b) the reflexive is again embedded in the argument *a picture of herself* and, like the example in (28a) it is not subject to condition A.

The Reflexivity theory, however, does not explain how the interpretation of pronouns is regulated in sentences such as (27a). In the literature, pronouns have been divided into two different types, bound variable pronouns and coreferential pronouns (Postal, 1971; Partee, 1978; Reinhart, 1976, 1983; Heim, 1982). Pronouns that are bound variables are subject to binding conditions, where c-command is the crucial notion, and coreferential pronouns are assigned an antecedent at the discourse

¹⁶ For the other examples given in the previous section a similar reasoning applies which is the reason why they have been left out at this point.

level of representation. In sentences such as (29), the two interpretations are indistinguishable.

- (29) Peter thinks he is a good football player.
 Peter (λx (x thinks x is a good football player)) - *bound variable interpretation*
 Peter (λx (x thinks he is a good football player) (he=Peter) - *coreference interpretation*

The bound variable interpretation ascribes Peter the property of *thinking of oneself as a good football player*, and the coreference interpretation ascribes Peter the property of *thinking of Peter as a good football player*. In order to account for the ultimate indeterminacy between the two interpretations, Grodzinsky & Reinhart (1993) formulated Rule-I (30) operating at the level of discourse.

- (30) *Rule-I: Intrasentential coreference*
 (Grodzinsky & Reinhart, 1993)
 NP A cannot corefer with NP B if replacing A with C, C A-bound by B yields an indistinguishable interpretation.¹⁷

Rule-I essentially states that establishing a dependency through variable binding is more economical than establishing a dependency through coreference, a discourse operation, unless coreference yields an interpretation that is distinguishable from the interpretation derived through variable binding. In (29) the two interpretations are indistinguishable; therefore, the coreferential interpretation is ruled out and the variable binding interpretation is chosen. I will return to Rule-I in Chapter 2, where it will be discussed in detail in relation to the agrammatical data.

I will now briefly discuss the second module of the Reflexivity theory related to the referential property [+R] or [-R] of the pronominal element. In examples (31a) and (31b) the ungrammaticality of the pronoun *hem* does not follow from condition B.

¹⁷ Reinhart (2000) revises Rule-I but the general observation remains that the bound variable interpretation is the preferred more economical option than the coreference interpretation.

- (31) a. Jan_i schaamt zich_i/**hem*_i.
 John shamed SE/him.
 b. Jan_i hoorde [zich_i/**hem*_i zingen].
 John heard SE/him sing.

In (31a) the verb *schamen* is inherently reflexive, which means that condition B is obeyed, yet the sentence with the pronoun *hem* is ungrammatical.¹⁸ Condition B is defined as a condition on reflexive predicates. In (31b) it does not apply since the subject of the matrix clause *Jan* and the pronominal element are not coarguments, so no reflexive predicate is created, yet the sentence with the pronoun *hem* is ungrammatical on the interpretation indicated (*hem*=*Jan*).

According to Reinhart & Reuland, two elements, like the subject of the matrix clause and the subject of the embedded small clause in (31b), that are in a binding configuration form an A-chain. They postulate the A-chain condition given in (32), according to which the foot of the chain can only be occupied by a referentially deficient element, i.e. an element that is not fully specified for morphosyntactic Φ -features (person, number and gender).

(32) *Condition on A-chains*

A maximal A-chain ($\alpha_1 \dots \alpha_n$) has exactly one link: α_1 , which is both [+R] and marked for structural case.

Where an element is [+R] when it is referentially independent and specified for all Φ -features.

Referentially deficient elements are also referred to as [-R] elements and these include SELF- and SE-anaphors. Referentially fully specified [+R] elements are standard pronouns and R-expressions. The A-chain condition solves the ungrammaticality of pronouns in structures such as (31a) and (31b). In both instances a chain is created where the foot is occupied by a regular pronoun, which is a [+R] element, violating the A-chain condition. Like Rule-I, the A-chain condition and the referential properties of pronouns will be discussed in detail in Chapter 2. I will argue that the agrammatic data obtained in various experiments testing the comprehension of pronoun in this population cannot be properly explained using the Reflexivity model. In the following section I briefly present the economy-based model proposed by Reuland (2001), which will be the theoretical framework I will adopt in this study.

¹⁸ Inherently reflexive verbs are reflexive-marked in the lexicon and can therefore reflexive-mark the predicate.

1.2.3 Primitives of Binding (Reuland, 2001)

In the Primitives of Binding model the notion of *economy* plays a crucial role in pronominal reference assignment. This notion has been exploited in syntactic theory (Chomsky, 1995) in terms of minimizing constraints that operate on linguistic symbols. According to Chomsky, derivations and representations are subject to a ‘least effort’ condition, barring unnecessary steps in derivations and unnecessary symbols in representation. Economy also plays an important role in language processing (for an overview, see Gibson, 1998) and is expressed in terms of processing cost, which can be measured in online language processing. Reuland’s model deals with structural properties of the pronominal system but also allows for predictions about on-line processing of pronominal dependencies. He dispenses with postulated constraints, such as specific binding principles and the A-chain condition, by deriving them from more general properties of grammar.

There are two dimensions that can be observed in Reuland’s model. The first dimension concerns intra-modular operations that belong to distinct modules, C_{HL} (narrow syntax), C-I interface (semantic operations) and discourse storage.¹⁹ The operations applied at these levels of representation result in different pronominal dependencies and serve to distinguish between different types of pronominal elements. The second dimension of Reuland’s model is related to its cross-modular nature. By allowing an interaction between different modules of grammar through interfaces, Reuland proposes a hierarchy of dependencies generated by these modules, which is determined by economy considerations. I will refer to this hierarchy as the *economy hierarchy*. In the following section I will discuss this hierarchy in detail.

1.2.3.1 Economy hierarchy

Reuland (2001) puts forth a number of rules, which together capture the idea that one way of interpreting an anaphoric element is preferred over another. The three rules are given in (33) - (35).

¹⁹ Throughout this study I will use slightly different labels for the listed modules than the ones Reuland uses in his (2001) article. The modified labels are given in brackets and stand for exactly the same modules as in “Primitives of Binding”. The reason for this modification is to make the operations taking place at particular level traceable in the label assigned to that level, so the C-I interface at which, according to Reuland, semantic operations applying to variables take place will be labelled as the “semantic level” in this study.

- (33) *Rule BV: Bound Variable interpretation*
 NP A cannot be A-bound by NP B if replacing A with C, C an NP such that B heads an A-CHAIN tailed by C, yields an indistinguishable interface representation.²⁰
- (34) *Rule L: Logophoric interpretation*
 Rule L: Logophoric interpretation
 NP A cannot be used logophorically if there is a B such that an A-CHAIN <B,A> can be formed.
- (35) *Rule-I: intrasentential coreference* (from Grodzinsky & Reinhart, 1993)
 NP A cannot corefer with NP B if replacing A with C, C A-bound by B, yields an indistinguishable interpretation.

Taken together, these rules imply a ranking where operations that take place within narrow syntax are more economical than operations that occur at the semantic level, and the latter are more economical than the processes that require accessing discourse. According to Reuland, it seems to be uncontroversial that operations that take place at the level of narrow syntax are subliminal. They are automatic and, therefore, the least costly in terms of real time processing. The operations that take place within the interpretive component are more costly and will be blocked if a cheaper syntactic option is available.

I will now examine the rules that are relevant for the phenomena discussed in this study leaving the logophoric interpretation aside. The three different operations in (37), taking place at different levels: syntactic, semantic and discourse, will be explained on the basis of the sentences in (36), taken from Reuland (2001: 473).

- (36) a. *Oscar* voelde [*zich* wegglijden].
 Oscar felt [SE slide away].
 b. **Oscar* voelde [*hem* wegglijden].
 Oscar felt [him (self) slide away].

²⁰ *A-binding* (logical-syntax definition, Reinhart 2000): α A-binds β iff α is a sister of a λ -predicate whose operator binds β .

- (37) i. Oscar_φ voelde [zich_φ wegglijden]
(feature checking = narrow syntax)
 ii. Oscar λx (x voelde (x wegglijden))
(variable binding = semantics)
 iii. Oscar λx (x voelde (a wegglijden)) & a=Oscar
(coreference = discourse)

In (36a), a dependency between the SE-anaphor *zich* and *Oscar* is created in narrow syntax through a feature checking procedure (37i), and will be discussed in detail in the following section. The question is why the pronoun *hem* in (36b) cannot be dependent on *Oscar* for its interpretation. A syntactic dependency between *hem* and *Oscar* is impossible because of the feature specification of *hem*, which will also be discussed in the following section. The following question is why a semantic dependency between these two elements is also impossible. A semantic dependency between *Oscar* and *hem* would result in a representation like (37ii). Effectively, this representation means that *Oscar* and *hem* are reduced to one argument. Rule BV prohibits such an interpretation because the semantic interpretation would be indistinguishable from the interpretation that would be obtained by establishing a syntactic dependency. A syntactic dependency with *zich* in (36a/37i) is possible and it blocks a bound variable interpretation. The final question is why a discourse dependency between *Oscar* and *hem* is also impossible. Rule-I prohibits such a dependency between the two elements, illustrated in (37iii), because it would result in an interpretation that would be indistinguishable from the bound variable interpretation.

Reuland's model thus distinguishes three types of operations through which relations between arguments are established. The different grammatical levels and types of operation that take place at these different levels are exemplified in (38).²¹

²¹ In order to make it more explicit for the readers that are not completely familiar with the terminology used in the theoretical literature on syntax, I slightly modified the labelling of different levels of representation of Reuland's original economy hierarchy as follows. The computational system of human language (C_{HL}) is referred to as narrow syntax; the conceptual-intentional (C-I) interface is labelled as the semantic level and discourse storage as the discourse level. I also added a level that is labelled as the non-linguistic source (context), which is the level through which general knowledge (context) interacts with language. This level will be discussed in more detail in Chapters 4, 5 and 6.

(38)	LEVEL Narrow syntax ↓ Semantics ↓ Discourse ↓ (Non-linguistic source)	OPERATION (feature checking) (bound variable) (coreference) (deixis)
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The increase in cost in this model is related to the number of cross-modular steps that need to be made in order to assign reference to an anaphoric element.

I will describe these cross-modular steps on the basis of a few abstract examples taken from Reuland (2001:473). Following the economy hierarchy, the cheapest way of establishing a referential dependency is through a feature checking procedure in narrow syntax, such as in (39).

(39) Basic expressions	α ↓ C_1 ↓ x ↓ a	→	β ↓ C_1
Syntactic dependencies			
Semantic dependencies			
Discourse dependencies			

2 cross-modular operations

Two elements α (antecedent) and β (pronominal element) establish a dependency through a feature checking operation that results in syntactic chain formation, such as a dependency between *Oscar* and *zich* in (36a). The formation of a syntactic dependency between two elements entails a total number of two cross-modular steps. The establishment of a syntactic dependency (syntactic chain) between the two elements (α and β), which results in one element (C_1) is an operation within the syntactic module and it does not count as a cross-modular operation. The first cross-modular operation refers to the translation of a single syntactic element (C_1) as a single variable (x) at the semantic level. The second step is the translation of the single variable (x) into a single discourse entity (a). This type of dependency is the dependency established between SE-anaphors, such as *zich* in Dutch, and their antecedent DPs.

In (40) formation of a semantic (bound variable) dependency is illustrated.

(40) Basic expressions	α		β	
	↓		↓	
Syntactic dependencies	C_1		C_2	
	↓		↓	
Semantic dependencies	x_1	→	x_1	
	↓			
Discourse dependencies	a			

3 cross-modular operations

A semantic dependency implies that two elements (α and β) will be represented by different syntactic chains ($C_1 - C_2$) at the syntactic level but will eventually be interpreted as one variable (x_1) at the semantic level. The establishment of their identity relationship entails three cross-modular steps. The first two cross-modular steps are: translation of each different syntactic object (C_1 and C_2) into two different variables (x). The establishment of a dependency between the two variables resulting in one variable (x_1) does not count since it is an intra-modular operation. The third cross-modular step is the translation of a single variable (x_1) into a discourse value (a). An example of such a dependency is the dependency created between the reflexive *himself* and the DP *John* in (41).

(41) *John* liked *himself*.

Finally, the costliest way of establishing a referential dependency between two elements α and β is through discourse and is illustrated in (42).

(42) Basic expressions	α		β	
	↓		↓	
Syntactic dependencies	C_1		C_2	
	↓		↓	
Semantic dependencies	x_1		x_2	
	↓		↓	
Discourse dependencies	a	→	a	

4 cross-modular operations

A discourse dependency between elements α and β implies that the two elements are represented by different syntactic chains (C_1-C_2) and different semantic variables (x_1-x_2), but they correspond to one discourse value (a). Four cross-modular operations must be performed in order to

establish such a dependency. First, two operations are required for the translations of each different syntactic object into a (different) variable. The other two cross-modular steps are the translations of each different variable into a discourse value. Again, the establishment of a dependency between two discourse values resulting in one discourse value (a) for the two elements does not count as a cross-modular operation because it is intra-modular in its nature. An example of such a dependency is a coreferential relationship established between the pronoun *he* and the DP *the man* in (43).

(43) *The man* sat down. *He* was tired.

This type of dependency will also be discussed in detail in the following chapters.

1.2.3.2 Derived A-chain condition

An important feature of the Primitives of Binding model is that it dispenses with the A-chain condition postulated in the Reflexivity model. Reuland derives the effect of this condition from feature checking, which is a basic operation in narrow syntax (Chomsky, 1995). The pronominal dependency that is established in syntax results in a chain formation and the only element among Dutch pronominals that can enter into such a dependency is the SE-anaphor *zich*.

According to Reuland, *zich* is a referentially deficient element specified only for the Φ -feature [*person*], not for [*gender*] or [*number*]. The feature [*person*] has characteristics which allow it to be eliminated (checked) in narrow syntax resulting in a syntactic dependency relation between the matrix verb *Jan* and the SE-anaphor *zich* in (44).

(44) *Jan zag zich dansen.*
Jan saw SE dancing.

This dependency represents a feature-based (feature-checking) type of dependency, which was treated as an A-chain dependency in the in the Reflexivity model.²²

²² The actual feature checking procedure is obviously more technical than the one described above. According to Reuland, the feature [*person*] of *zich*, represented as [Fz] in (i), undergoes movement and adjoins to the INFL because the [*case*] feature of *zich* is checked by the matrix verb *zag*, which is finite. The verb in the complement clause is non-finite and therefore cannot check the [*case*] feature of *zich*.

(i) [**Jan** [_{INFL} [Fz] [**zag**_{+fin} **zich**_{Fz} [**dansen**_{-fin}]]]]

The reason why a pronoun *hem* cannot form a syntactic dependency with the subject of the matrix clause in (45) is because of its feature specification.

- (45) **Jan zag hem dansen.*
Jan saw him dance.

Besides being specified for [*person*], pronouns are also specified for [*number*]. The feature [*number*] is interpretable, as is the feature [*person*], and its deletion during the checking procedure would leave this element uninterpretable. Moreover, the feature [*number*] of the matrix subject cannot recover the deleted feature [*number*] of the pronoun. The reason for this, according to Reuland, is the nature of the contribution each occurrence of the feature [*number*] in a numeration makes. In other words, the number feature on *Jan* is not, in a sense, the “same” number feature as on *hem*. Consider for example (47).

- (46) The times were rough. Men were betraying men (and women were betraying women). (Reuland, 2001; p. 258)

In (46), the features [*person*] and [*gender*] have identical effects on the interpretation of the two occurrences of *men*. However, as far as the [*number*] feature is concerned, the two occurrences of *men* may pick out two different sets of individuals with different pluralities, which indicates that these two different pluralities can, in principle be different. This also means that there are two or more possible interpretations for a single numeration in terms of plurality. That is why the feature [*number*] of the subject cannot recover the feature [*number*] of a pronoun and why this feature must be preserved.

Therefore, the [*number*] feature of a pronoun serves as a signal to the language system that a syntactic dependency is impossible. Summarizing, in the ECM sentence in (45) a syntactic dependency between the subject DP *Jan* and pronoun *him* is impossible because the

A checking procedure implies checking and elimination of features that are checked against the same features on another element; therefore, as a result of checking, the feature [*person*] on *zich* will be eliminated. This elimination, as such, results in a loss of information needed for interpretation; however, the interpretable feature [*person*] of the subject DP *Jan* recovers the feature [*person*] of *zich* in (i). By checking it, the subject DP identifies the feature [*person*] of *zich* and recovers it, which results in the formation of an A-chain (Jan, Fz), a syntactic referential dependency between *Jan* and *zich* (for further details, see Reuland, 2001).

[*number*] feature of the pronoun would be deleted as a result of the feature checking and elimination procedure. The subject DP would fail to recover the deleted [*number*] feature of the pronoun and the interpretation would crash.

1.2.4 Summary

Agrammatic Broca's aphasia is a language disorder that affects both production and comprehension of language. For a long time, comprehension problems in agrammatism have primarily been related to structures with moved elements. However, a growing body of evidence has been gathered in the last decade indicating that not only dependencies between moved elements and their traces are problematic in these patients. Other types of dependencies, such as referential dependencies between pronominal elements and their antecedents, also appear to be problematic for these patients.

The comprehension of pronominal dependencies in Broca's aphasic patients is precisely the focus of my study. The primary aim of this study is to examine the patterns agrammatic patients exhibit with regard to pronominal dependencies in order to learn more about the organisation and use of linguistic knowledge of pronominal reference assignment in general. Agrammatic data will be used to distinguish between different theoretical models of reference assignment.

The second aim is related to the nature of the linguistic impairment in this population. I assume that brain damage in these patients results in a reduced capacity to process syntactic information in time. The syntactic machinery is weakened in agrammatism and syntactic structure building is slower than in neurologically intact individuals. In this study, the pattern agrammatic individuals exhibit in pronoun comprehension will be related to slower-than-normal syntactic processing.

Chapter 2

Interpretation of pronouns in simple transitive and Exceptional Case Marking constructions

2 Introduction

In this chapter the interpretation of pronouns by Broca's aphasic patients in two different constructions will be examined: simple transitive and Exceptional Case Marking (ECM) sentences. The crucial difference between the two types of environments lies in the structural relations between the pronoun and its c-commanding DP in these sentences. In the simple transitive cases the two elements are both arguments of the same predicate (co-arguments); the local antecedent DP is the external argument of the main verb and the pronoun is the internal argument of the same verb. In ECM sentences this is not the case; the local antecedent DP is the external argument of the main verb but the internal argument of this main verb is a small clause containing the pronoun. This pronoun is the subject of this clausal complement, often the external argument of the lower verb.

These structural differences imply different sets of principles constraining the assignment of reference to the pronoun in the two constructions. As we saw in Chapter 1, there are various theoretical models to account for the ways reference is assigned to pronouns and other pronominal elements. In the first half of this chapter, I will focus on the Reflexivity model (Reinhart & Reuland, 1993) in order to account for the results obtained from the agrammatic Broca's patients. This model proposes that the interpretation of pronouns in simple transitive environments is constrained by Principle B and Rule-I. The latter principle has been regarded as problematic for agrammatic patients because of the reduced processing capacity in this population. In the ECM sentences, in addition to Rule-I, the relevant constraint is the A-chain condition. In Experiment 1 (to be discussed in section 2.1.4) I tested the Broca's patients' interpretation of pronouns in the two types of sentences and, as will become evident from the results, they exhibited more problems with pronoun comprehension in ECM environments than in transitives. Additionally, the results I obtained from these

patients on pronouns in simple transitive sentences deviate from previous results on the same constructions reported in the literature.

In the second half of the chapter I will examine a potential source of errors with pronouns in ECM constructions. From the perspective of the Reflexivity model, the failure of agrammatic patients to apply the A-chain condition could be ascribed to their inability to access and use the morphosyntactic (Φ) features that specify pronouns. In Experiment 2 (to be discussed in section 2.2.4) I tested this hypothesis and found that the agrammatic patients know and are able to use the information specified by the features [*number*] and [*gender*]. I will conclude that their problems with these constructions must lie elsewhere.

In a study, discussed in detail in the following section, Grodzinsky, Wexler, Chien, Marakovitz & Solomon (1993) used the Reflexivity model to account for their data on comprehension of anaphoric reference in agrammatic patients. On the basis of the results gathered in both experiments to be discussed here, I will argue in the final part of this chapter that Reflexivity may not be the best model to explain these data. I will propose that the Primitives of Binding model (Reuland, 2001) provides better tools for explaining the pattern of errors found in agrammatism. This model offers an analysis of a different type, assuming a hierarchy of different linguistic levels through which reference is assigned to anaphoric elements. The economy hierarchy turns out to be crucial in accounting for the error pattern in agrammatic patients. This hierarchy makes it possible to put forward a unified account of the variety of problems agrammatic patients experience when they need to interpret anaphoric elements.

2.1 Pronouns in ECM versus simple transitive sentences

2.1.1 Binding and coreference

Grodzinsky, Wexler, Chien, Marakovitz & Solomon (1993) conducted one of the first studies that examined anaphoric reference assignment in agrammatic Broca's (and Wernicke's) patients hoping to provide further insight into the way rules governing anaphoric dependencies should be formulated.¹ Their primary aim was to find evidence for the "biological feasibility of particular rule systems" (p. 397). Their experiment was inspired by a study Chien & Wexler (1990) had carried out with pre-school children. In their study Chien & Wexler focused on the contrast

¹ Piñango (2000) replicated Grodzinsky *et al.*'s (1993) results using the same method and materials with two more agrammatic patients.

between reflexives and pronouns, such as *herself* and *her* in (1). They also tested pronouns with referential expressions as antecedents (*the girl* in (1)) versus pronouns with quantified antecedents (*every girl* in (2)).

- (1) The girl touched her/herself.
- (2) The girl/every girl touched her.

Grodzinsky *et al.* (1993) observed that the performance of Broca's patients mirrors the performance of pre-school children.² Both populations experience fewer problems when they interpret reflexives than when they interpret pronouns in the same constructions.

- (3) *The girl touched herself.* (above chance performance)
- (4) **The girl touched her.* (chance performance)

Both children and agrammatic patients correctly interpret *herself* as bound by the antecedent *the girl* in (3) and incorrectly allow *her* to corefer with *the girl* in (4). These results could potentially be interpreted as indicating that Principle A of the Standard Binding theory (Chomsky, 1981) is preserved in agrammatism and that Principle B is impaired in this population. However, Grodzinsky *et al.* (1993) tested an additional set of constructions that provides evidence for a different source of difficulty with pronouns in agrammatism.

When confronted with sentences where the antecedent for the pronoun is a quantified expression, such as *every boy* in (5), both agrammatic patients and children perform above chance.³

- (5) **Every boy pointed at him.* (above chance performance)

The good performance on pronouns in sentences such as (5) shows that the dissociation in performance is not related to the type of anaphor used, *e.g.* reflexive versus pronoun. The pattern that both aphasic patients and children exhibit is related to the type of operation through which reference is assigned to an anaphoric element. Quantified

² This phenomenon, which in the acquisition literature is sometimes referred to as the "Delay of the Principle B effect", has been found in children acquiring a variety of languages such as English (Jakubowicz 1984; Chien & Wexler 1990, among others), Dutch (Koster, 1993; Philip & Coopmans, 1996; among others), Icelandic (Sigurjónsdóttir, 1992), and Russian (Avrutin & Wexler, 1992).

³ See Elbourne (2005) for criticism of experimental studies examining children's interpretation of pronouns with quantified antecedents.

elements, such as *every boy* in (5), are non-referential and can therefore only establish a (variable) binding relationship with a pronoun. In sentences such as (5) both children and agrammatic aphasic patients correctly reject the interpretation where the quantified DP *every boy* binds the pronoun *him*. Referential elements, such as DP *the girl* in (4), on the other hand, enter a coreferential relationship with a pronoun. In these cases the pronoun is interpreted as a free variable whose interpretation is determined by discourse factors, and in such instances it has a uniquely identifiable discourse referent (Reinhart, 1983, 2000). The results reported by Grodzinsky *et al.* (1993) indicate that the operations that involve variable binding are less problematic for both children and agrammatic patients in comparison with the operations that involve establishment of coreferential dependencies.

2.1.2 Rule-I

In their study, Grodzinsky *et al.* (1993) hypothesise that agrammatic patients lack processing resources needed for the computation of the so-called Rule-I, which governs intrasentential coreference. Specifically, the working memory in Broca's agrammatic patients is limited and results in a failure to apply Rule-I repeated in (6). This claim corresponds to the proposal put forth by Grodzinsky & Reinhart (1993) to account for children's data. According to Grodzinsky & Reinhart, the computation of reference in structures containing pronouns and non-quantified local antecedents also exceeds the working memory capacity in children. Therefore, they argue, the processing of Rule-I causes problems in both children and agrammatic aphasic patients.

- (6) *Rule-I: Intrasentential coreference*
 (Grodzinsky & Reinhart, 1993)
 NP A cannot corefer with NP B if replacing A with C, C A-bound by B yields an indistinguishable interpretation.

The following example shows how Rule-I works in a simple transitive sentence with a pronoun object in object position.

- (7) **John* is kicking *him*. (him = John)

In (7), variable binding is in principle possible because the antecedent DP *John* c-commands the pronoun *him*. The interpretation under binding is $(\lambda x (x \text{ is kicking } x) \ \& \ x = \text{John})$, where 'self-kicking is performed by John'. The coreference interpretation 'John is kicking x' ($x = \text{John}$) where

the pronoun receives a fixed value from discourse is indistinguishable from the binding interpretation; hence, the binding interpretation must be chosen according to Rule-I. However, Principle B rules out a local binding configuration, and therefore the pronoun must refer to some other DP outside the sentence.

In order to assign reference to the pronoun in sentences such as (7), a reference set needs to be computed. This reference set must include two possible representations during processing: one that involves a binding option (semantic operation) and another with the alternative coreference interpretation (involving discourse-level information). These two representations must be held in short-term memory and compared, relative to their context, in order to decide whether they are distinguishable, that is, whether they yield different interpretations. The coreference interpretation is allowed only in the instances where the two representations yield different interpretations. In instances where there is no difference the pronoun is interpreted as a bound variable. Regardless of the outcome of whether coreference is allowed or not, Grodzinsky *et al.* (1993) hypothesise that this kind of decision-making requires a complex computation that surpasses the processing ability of agrammatic patients. According to the authors, 'the need to hold and compare two representations surpasses the processing ability of the language-deficient hearer, whether an aphasic or a child' (Grodzinsky *et al.*, 1993, 410), and this leads to comprehension errors with sentences such as the one in (7). Crucially, the claim is that both patients with agrammatic Broca's aphasia and children have the appropriate knowledge of Rule-I but fail in the execution of all the steps that are required by the rule and resort to guessing.

2.1.3 The A-chain condition

As we have seen, Grodzinsky *et al.*'s (1993) study suggests that, as a consequence of a reduced processing capacity, agrammatic patients make errors when interpreting pronouns in simple transitive constructions because of their inability to execute Rule-I. The question arises whether all problems with anaphoric reference assignment in agrammatism can be treated as instances of a failure to execute Rule-I. In order to test this, another type of construction needs to be considered where reference assignment is not exclusively dependent on the execution of Rule-I, such as the ECM construction exemplified in (8).⁴

⁴ Furthermore, agrammatic data resemble data gathered from children examining the interpretation of pronouns in ECM constructions, for Dutch, see Philip & Coopmans

- (8) Jan zag [*hem* dansen].
Jan saw him dance.

Let us begin by looking closely at these constructions and their importance for the proper formulation of constraints on reference assignment. In the Government and Binding framework (Chomsky, 1981), the term exceptional case marking was originally used to describe sentences such as (9), where the main verb *believes* selects a non-finite complement clause as its internal argument. The subject DP *him* in the complement clause is assigned accusative case by the main verb *believe*, exceptionally, through a clausal barrier. The clausal component is transparent for a structural government relation of the embedded subject by the matrix verb, hence for case assignment.

- (9) John believes [*him* to be a liar].

In this study I will be referring to ECM constructions as all instances where the pronoun is not an argument of the main verb, i.e. the pronoun is thematically unrelated to the main verb, yet, in a case relation with it. The internal argument of the main verb in (9) is the whole infinitival clause; in (8) it is a so-called small clause. The relation between the subject DP of the main clause and the subject DP (pronoun) of the complement clause is not one of coargumenthood. They are arguments of different lexical verbs. Within the original GB framework, in both simple transitive and ECM constructions, the interpretation of pronouns is supposed to be governed by Principle B of the Binding theory.

In the Reflexivity model, Reinhart & Reuland (1993) hypothesise that the interpretation of pronouns in simple transitive sentences such as (10) and ECM sentences exemplified in (8) is constrained by different conditions.

- (10) **Jan kietelt hem*.
Jan tickles him.

The assignment of reference in simple transitive structures such as (10) is governed by two different conditions: condition B, which in Reinhart & Reuland's framework is a condition that applies to semantic predicates,

(1996); for French, see Hamman, Kowalkski & Philip (1997); for Spanish, see Baauw (2000); for Italian, see Berger (1999), for Norwegian, see Hestvik & Philip (1997); and for Greek, see Varlokosta (1999).

repeated in (11), and the A-chain condition, repeated in (12), essentially superfluous in the case of simple transitives.

(11) *Condition B*

A reflexively interpreted predicate must be reflexive-marked.

(12) *Condition on A-chains*

A maximal A-chain ($\alpha_1 \dots \alpha_n$) has exactly one link: α_1 , which is both [+R] and marked for structural case.

Where an element is [+R] when it is referentially independent and specified for all Φ -features.

According to the Reflexivity model, allowing the DP *Jan* to bind the pronoun in transitive sentences, such as (10), would violate both Condition B and the A-chain condition. First, if *hem* were bound by *Jan*, the predicate would be interpreted reflexively, and this would violate condition B because this predicate is not reflexive-marked. This is the case because none of the arguments (*Jan* or *hem*) is realized as a SELF-anaphor (*zichzelf*) and the predicate *kietelen* is not lexically reflexive. Secondly, the condition on A-chains also rules out the interpretation where *Jan* binds *hem*. According to this condition, in a chain relation formed between the pronominal element and its antecedent, the foot of the chain must be occupied by an element that is not fully specified for Φ -features (number, gender or person). According to Reinhart & Reuland, such elements are referentially deficient or [-R] elements. The elements that are fully specified for Φ -features are [+R] elements. If the pronoun *hem* is bound by the DP *Jan* in (10), then these two elements must form a chain, and since the pronoun *hem* is fully specified for the above mentioned features, hence [+R], this chain relation is ruled out.

In the ECM sentence (8), however, condition B does not apply because the pronoun *hem* and its antecedent, the matrix subject DP *Jan*, belong to different semantic predicates and are not in a coargument configuration. The pronoun is theta-marked by another predicate, namely, the one heading the small clause [*hem dansen*]. The interpretation of anaphoric elements in ECM sentences is constrained solely by the A-chain condition (Reinhart & Reuland, 1993).⁵ In the ECM

⁵ The A-chain condition is also relevant in the instances where an inherently reflexive predicate such as *scheren* in Dutch is used with a pronoun in an object position.

(i) **Jan scheert hem.*
 Jan shaves him. (him=Jan)

sentence in (8), the pair *[Jan_i...hem_i] forms a chain, which violates the A-chain condition since the final element in the chain is [+R]. Note, however, that in Dutch *hem* can be replaced by the simplex anaphor (SE-anaphor) *zich* in (13), which makes the sentence acceptable under a reflexive interpretation. This SE-anaphor *zich* is not specified for the number feature (see Chapter 1, section 1.2.3.2), hence [-R], and this is why it is allowed as the foot of the chain [Jan_i...zich_i].

- (13) *Jan zag zich dansen.*
 Jan saw SE dance.

The Reflexivity model makes a distinction between the two structures in (8) and (10). The crucial difference between the two lies in the coargumenthood of the pronoun and the antecedent in the simple transitive sentence in (10) and the lack of it in the ECM sentence in (8). The question addressed in Experiment 1 is whether agrammatic aphasic patients exhibit a difference in the interpretation of pronouns in the two different constructions.

2.1.4 Experiment 1

This experiment examines Dutch Broca's speakers' interpretations of pronouns and reflexives in two different structures: simple transitives (14) and ECM (15) constructions.⁶

- (14) *Jan kietelde zichzelf/hem.*
 Jan tickled himself/him.
 (15) *Jan zag zichzelf/hem dansen.*
 Jan saw himself/him dance.

The simple transitive constructions resemble the ones Grodzinsky *et al.* (1993) tested. The difference is that the present study includes only referential antecedents and no quantified antecedents.

Previous studies on the interpretation of pronouns in simple transitive sentences (Grodzinsky *et al.*, 1993 and Piñango, 2000) found that agrammatic Broca's patients perform at chance level on these structures. There are two studies that have examined the comprehension

Condition B is not violated in (i) because the predicate is reflexive marked in the lexicon; nevertheless, the interpretation is impossible because the foot of the chain is occupied by a [+R] element.

⁶ The data gathered in this experiment have also been published in slightly different form (Ruigendijk, Vasić & Avrutin, 2006).

of pronominal subjects of ECM sentences in patients with agrammatic aphasia. Edwards, Varlokosta & Payne (2003) conducted a study in English and found that Broca's patients have problems interpreting pronouns in ECM sentences. Baauw & Cuetos (2003) found the same for Spanish agrammatic patients.

2.1.4.1 Subjects

In this experiment eight Dutch speaking aphasic patients were tested. Three of these patients were female and five were male with an average age of 56.8 years (range 38-82 years). Seven of the eight patients had a single lesion in the left hemisphere, and patient AK had had two Cerebro Vascular Accidents (CVA) in the left hemisphere. He had been diagnosed as having Broca's aphasia after his first stroke and this diagnosis remained the same after the second stroke. However, his language problems became more severe after the second stroke. All of the eight patients that were tested were right-handed. Individual patient data can be found in Appendix A, Table A.1.1. All of the patients were diagnosed on the basis of the Dutch version of the Aachen Aphasia Test (AAT) (Graetz, De Bleser & Willmes, 1992). On the basis of their AAT scores, seven of them were classified as having Broca's aphasia by their speech therapist and an experienced clinical linguist. The symptoms of one of the patients (AD) could not be classified into one of the major syndromes with the help of AAT at the moment of testing. Since an earlier AAT did classify her with Broca's aphasia and her speech production did fit the pattern of agrammatism, I decided to include her in this study. The AAT scores of each of these patients are given in Appendix A, Table A.1.2.

The speech production of all patients was characterised as moderately to severely agrammatic based on the description of agrammatism in Menn, O'Connor, Opler & Holland (1995). Their speech production was non-fluent, and it contained non-finite utterances and relatively few pronouns and determiners.

The performance of the agrammatic speakers was compared to the performance of a control group of 15 Dutch non-brain-damaged speakers (8 male, 7 female; mean age 56.6, range 35-84 years) who were matched in age and education to the aphasic speakers.

2.1.4.2 Materials and procedure

A picture selection task was used to test the interpretation of pronouns and reflexives in transitive sentences and in ECM constructions. The experiment testing these two types of sentences was embedded in a

larger experiment examining comprehension of contrastive stress. The full experiment consisted of 120 items in total, testing eight conditions of which only three are discussed here. The rest of the experiment will be dealt with in Chapter 4. The complete test battery took the aphasic patients approximately 1.5 hours to complete. The test was administered in two separate sessions of approximately 45 minutes each. All 120 items were presented randomly and each session started with practice examples that were repeated when necessary. The experimental items were not presented until after the experimenter was convinced that the subject fully understood the task. The sentences were presented orally to the subjects and repeated as often as necessary. The same experimenter administered the test to all patients to keep the testing conditions as consistent as possible.

The conditions that were relevant for this study were represented by 45 sentences in total, 15 per condition (see Appendix B for all test sentences). The relevant conditions consisted of reflexives and pronouns in transitive sentences and reflexives and pronouns in ECM constructions, as in (16).⁷ The transitive sentences with a pronoun or a reflexive were identical apart from the pronominal element. The sentences with a reflexive were included as control items. No problems were expected with the comprehension of these sentences on the basis of previous experiments examining the same constructions (Grodzinsky *et al.*, 1993).

- (16) a. Reflexive in a transitive sentence:
 ... en daarna heeft de vrouw zichzelf aangeraakt.
 ... and then has the woman herself touched.
 ... and then the woman touched herself.

⁷ The condition with reflexives in ECM sentences was not a part of Experiment 1 and was tested additionally, as a part of another study. As will become clear in the discussion section, this condition is crucial for showing that the possible problems with pronouns in ECM sentences are not related to the possible higher complexity of these sentences as opposed to the simple transitive sentences containing pronouns. Therefore, additional testing was conducted and the complete Experiment 4 where reflexives in ECM sentences were tested comprised 4 conditions in total; the other three conditions were part of a study on the interpretation of pronouns in elided VPs, which will be discussed in Chapter 4.

- b. Pronoun in a transitive sentence:
 - ... en daarna heeft de vrouw haar aangeraakt.
 - ... and then has the woman her touched.
 - ... and then the woman touched her.
- c. Reflexive in an ECM construction:
 - ... en daarna zag de man zichzelf voetballen.
 - ... and then saw the man himself playing soccer.
 - ... and then the man saw himself playing soccer.
- d. Pronoun in an ECM construction:
 - ... en daarna zag de man hem voetballen.
 - ... and then saw the man him playing soccer.
 - ... and then the man saw him playing soccer.

The test items formed the second conjunct of two conjoined sentences and were preceded by the first conjunct that introduced two possible referents for the pronominal element. The introductory conjuncts preceding the examples above are given in (17) respectively.

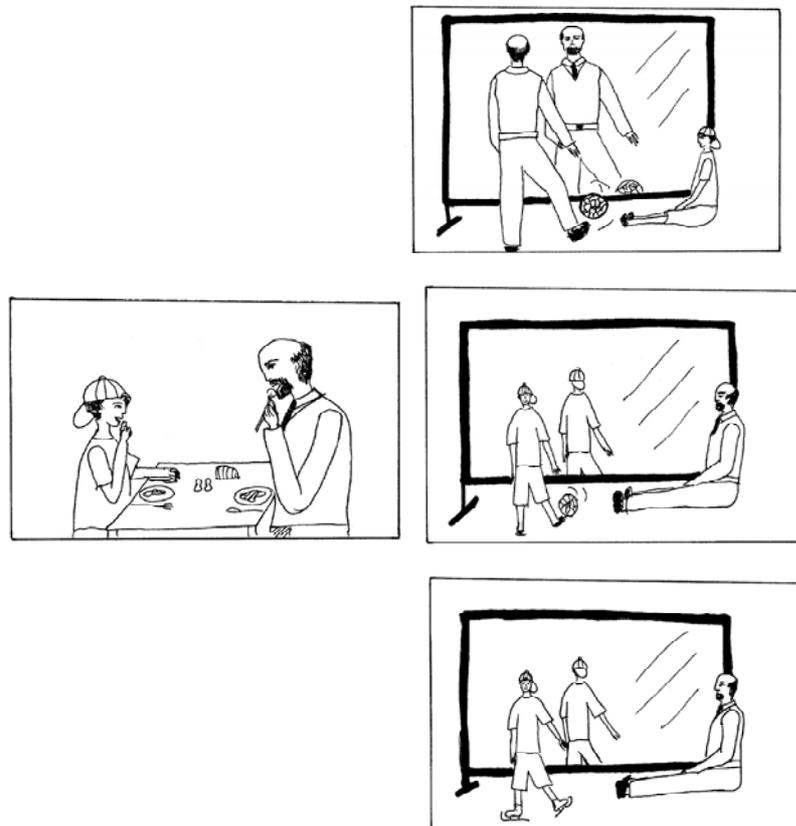
- (17) a. Reflexive/pronoun in a transitive sentence:
 - Eerst hebben de vrouw en het meisje gelachen, ...
 - First have the woman and the girl laughed, ...
 - First the woman and the girl laughed, ...
- b. Reflexive/pronoun in an ECM construction:
 - Eerst hebben de man en de jongen gegeten, ...
 - First have the man and the boy eaten, ...
 - First the boy and the man ate, ...

Each experimental item was accompanied with four pictures presented on two pages of A4 size (see Figure 2.1 for an example of a condition testing the interpretation of pronouns in ECM constructions). The interpretation of the first conjunct was always depicted in a single picture on the left page. There were three pictures on the right page. One of these pictures depicted the second conjunct of the sentence (the picture in the middle in Figure 2.1). The two other pictures were distractors. One (direct) distractor represented a local binding interpretation of the sentence (the upper picture in Figure 2.1: the man sees himself playing soccer); the other illustrated the same actors but another action (filler distractor: the lower picture in Figure 2.1: the man

sees him skating).⁸ The subject was asked to listen carefully to both parts of the sentence, look at the pictures and point at the one that depicted the experimental sentence best.

Figure 2.1

An example of the picture decision task. Testing ECM: First the *boy* and the man ate and then the man saw *him* playing soccer. The middle picture on the right depicts the correct response.



⁸ For the conditions with a reflexive, the direct distractor represented the (impossible) non-local binding interpretation.

2.1.4.3 Results

Table 2.1 shows the numbers of correct responses out of 15 tokens per condition per agrammatic patient. The percentages total correct responses for the group of agrammatic patients and the non-brain-damaged speakers are also given in the last two rows of this table. A Mann Whitney U (MWU) test reveals that the aphasic speakers performed significantly worse than the non-brain-damaged speakers on the ECM condition with pronouns (MWU for ECM: $Z=-4.194$, $p<0.001$).⁹ The agrammatic speakers also performed significantly worse than the control group on transitive sentences with pronouns (MWU: $Z=-2.586$, $p<0.05$). The difference between the two groups did not reach significance for reflexives in transitive sentences: $Z=-1.676$, $p=0.19$) nor for reflexives in ECM sentences ($\chi^2= 0.024$, $p<1$).

Table 2.1

Total number of correct responses per aphasic subject and percentages correct for the whole group on four experimental conditions (N.A. = not available).

	<i>Transitive sentence</i>		<i>ECM construction</i>	
	<i>Reflexive</i>	<i>Pronoun</i>	<i>Reflexive*</i>	<i>Pronoun</i>
AD	15/15	14/15	14/15	8/15
AN	15/15	14/15	15/15	10/15
MJG	15/15	15/15	N.A.	8/15
GK	15/15	15/15	N.A.	11/15
AK	11/15	12/15	N.A.	10/15
JW	14/15	15/15	15/15	8/15
AL	14/15	13/15	N.A.	7/15
IH	13/15	13/15	14/15	9/15
Tot. % correct	93.3	91.7	96.7	56.7
Controls	98.7	98.2	100	97.8

* In the additional testing of this condition, 10 non-brain-damaged speakers (mean age 38) were tested. They were not the same individuals as in the first experiment including the other three conditions reported here. The four agrammatic speakers (AD, AN, JW & IH), on the other hand, all participated in the first experiment reported here. Unfortunately, not all former participants could be traced. Nevertheless, these four can in principle be taken as reflecting the same behavior as the complete sample from the first experiment including the other three conditions.

To test whether the agrammatic patients' performance differed on the two crucial conditions (pronouns in transitive sentences and ECM constructions), their correct responses on these conditions were compared using a Wilcoxon Signed Ranks Test. A significant difference

⁹ The agrammatic data were analysed using non-parametric tests because of the relatively low number of subject tested.

was found ($Z=-2.539$, $p<0.05$) indicating that the performance on the ECM sentences was worse than on the transitive sentences. Finally, I examined whether the agrammatic speakers performed differently from chance-level on the two important conditions. The patients almost always pointed at the direct distractor (with four exceptions), erroneously choosing the local binding interpretation. They seemed to choose between the correct picture and the direct distractor only. For this reason I decided to assume that chance level performance on this task was 50%, although 33% would be the real chance level when randomly choosing between the three pictures. A binomial test showed that the patients' scores on the transitive sentences with pronouns did differ significantly from chance level ($p<0.001$), that is, the patients performed above chance on this condition. The scores on the ECM sentences did not differ from chance level performance ($p=0.096$).

The results of the four agrammatic patients on the condition with reflexives in ECM sentences clearly show that they do not have any problems interpreting reflexive elements in ECM constructions. In total, only two errors were made in the interpretation of a reflexive in ECM sentences, whereas these four patients made significantly more errors ($\chi^2=23.130$, $p<0.001$) with pronouns in ECM sentences.

2.1.4.4 *Discussion*

First, the results show that agrammatic patients did not have problems with the interpretation of reflexives in either transitive or ECM sentences, which is expected and supports the results obtained by Grodzinsky *et al.* (1993). Second, the interpretation of pronouns in ECM constructions was more problematic for agrammatic aphasic patients than the interpretation of pronouns in transitive sentences. Whereas they performed at chance level on ECM constructions, they made very few errors (10%) in the interpretation of pronouns in transitive sentences.

It is important to note that unlike the patients Grodzinsky *et al.* (1993) tested, whose performance on pronouns in simple transitive sentences was at chance level, the patients tested in the present study scored significantly above chance when interpreting pronouns in simple transitives. This difference could be ascribed to the difference between tasks used in Grodzinsky *et al.*'s (1993) study and the experiment discussed here. In the former a truth-value judgment task was used where the target sentence was presented in the form of a question to which the patients could answer by giving a *yes* or *no* response. After hearing the target sentence, the participants had to check whether the interpretation of that particular sentence fit the picture that was

presented to them. In the present experiment a picture selection task was used. However, from an experiment presented in the second half of this chapter (section 2.2.) it will become clear that the difference in methodology cannot be the factor affecting the results of Broca's patients.

The results thus show that pronouns in ECM sentences were significantly harder to interpret for agrammatic aphasic patients than reflexives in ECM sentences or pronouns in transitive sentences, in which almost no errors were made. The agrammatic speakers allowed coreference between the pronoun and the local antecedent in ECM sentences about half the time, which indicates a guessing pattern. Therefore, the difference agrammatic patients exhibited in their comprehension of these two types of sentences must be a consequence of a deeper linguistic difference between the two constructions. Reinhart & Reuland's (1993) Reflexivity model predicts this difference and distinguishes between the two types of structures linguistically.

Nevertheless, in order to pursue this line of reasoning, all other possible extra-linguistic causes for the pattern found in the data must be eliminated, such as factors that can potentially be ascribed to the experimental design of the study. One such potential factor is length of the test sentences. The experimental items were designed in such a way that they all had an equal number of words in all conditions, seven words per sentence. In Dutch, in matrix clauses the verb moves to the second position in the clausal structure. Thus, in simple transitive sentences, such as (18), the tensed verb normally moves to the second position as well, following the subject DP *de vrouw* and preceding the pronoun *haar*. The ECM constructions exemplified in (19), on the other hand, contain a lexical verb in the final position of the small clause complement.

- (18) *De vrouw aaide_i haar t_i.*
The woman patted her.
(19) *De man zag hem voetballen.*
The man saw him playing soccer.

In order to control for this difference, the test was designed in such a way that all experimental items contained two clauses, the introductory clause in (20a) and (21a) preceding the target clause in (20b) and (21b). The target clause contained an adverb plus an auxiliary construction, which forced the lexical verb *geaaid* (patted) in the transitive cases to remain in final position. Additionally, in all experimental items there

were no intervening words between the antecedent DP *de vrouw* (the woman) in (20b), or *de man* (the man) in (21b) and the pronoun or reflexive. Therefore, a potential difference in the distance between the experimental conditions that could affect the working memory capacity in these patients did not exist.

- (20) a. Eerst hebben de vrouw en het meisje gelachen, ...
 First have the woman and the girl laughed, ...
 First the woman and the girl laughed, ...
- b. ... en daarna heeft de vrouw haar/zichzelf geaaid.
 ... and then has the woman her patted.
 ... and then the woman patted her/herself
- (21) a. Eerst hebben de man en de jongen gegeten, ...
 First have the man and the boy eaten, ...
 First the boy and the man ate, ...
- b. ... en daarna zag de man hem/zichzelf voetballen.
 ... and then saw the man him playing soccer.
 ... and then the man saw him playing soccer.

It could be the case that the pictures used for the ECM constructions were visually more complicated than the pictures depicting transitive sentences. The pictures used in the ECM conditions portrayed the action reflected in a mirror (see Figure 2.1). It is difficult to imagine that this could be the case since the agrammatic patients exhibited excellent performance on reflexives in ECM sentences. If their problems with pronouns in ECM constructions were related to problems with pictures, one would think that they should have performed equally poorly on reflexives in the same type of sentences because the pictures used for these two conditions were the same.¹⁰

¹⁰ The subjects made it clear during testing that they understood the pictures with mirrors. One of the patients said during the testing: “you said ‘sees her’? Well, it is either this one, or that one (indicating the correct picture and its direct distractor), it’s really fifty-fifty”, showing that she understood the picture and the task. Moreover, the patients almost never pointed to the filler distractor, which indicates that they were not randomly picking one of the three pictures and that they were not that confused by the pictures with mirrors.

2.1.5 Reflexivity and ECM structures

Why do agrammatic Broca's aphasics commit comprehension errors in the process of interpreting pronouns in ECM sentences? From the perspective of Reinhart & Reuland's Reflexivity model there are various different steps where this process could break down. As we saw in section 1.1.3, the relevant constraint in the case of pronouns in ECM sentences is the A-chain condition. However, the proper application of Rule-I is also relevant and will be discussed below. Principle B of the Reflexivity model does not apply to these constructions because the pronoun and its antecedent are not coarguments of the same verb.

There are two possible sources of comprehension problems with pronouns in ECM sentences in agrammatism and these are the A-chain condition and Rule-I.¹¹ In the ECM example (19), coreference between *de man* and the pronoun *hem* is not ruled out. The two elements with different indices may still be able to refer to the same entity through covaluation, exemplified in (22).¹²

(22) The man_i saw [him_i playing soccer]. [i] = [j] (covaluation)

As we saw in section 1.1.2, the execution of Rule-I is supposed to be problematic for agrammatic patients in simple transitive sentences, according to Grodzinsky *et al.* (1993). However, the results of my experiment with pronouns in transitive sentences do not support this claim. The eight patients I tested in the experiment presented in section 1.2. performed significantly above chance on these sentences. In other words, if Rule-I were the problem in agrammatism, it would show up in the comprehension of pronouns in simple transitive sentences as well.

¹¹ It should be noted that Rule-I was revised by Reinhart (2000), and is given in (i).

- (i) *Rule-I (-an interface rule)*
 α and β cannot be covalued in a derivation D, if
- a. α is in a configuration to A-bind β (namely, α c-commands β), and
 - b. α cannot A-bind β in D, and
 - c. the covaluation interpretation is indistinguishable from what would be obtained if α A-binds β .

The notion coreference is replaced by the notion covaluation. According to Reinhart, covaluation is an interface strategy and is available regardless of the referential status of the antecedent.

¹² In the adult language coreference between a pronoun and its local c-commanding antecedent is only allowed in specific discourse contexts, such as in (i).

- (i) I dreamt I was Brigitte Bardot and I kissed *me*.

Here, *I* and *me* are two different guises representing the same person (Heim, 1982).

Another potential source of comprehension problems agrammatic patients exhibit when interpreting pronouns in ECM constructions is the A-chain condition, repeated in (23) for convenience.

(23) *Condition on A-Chains*

A maximal A-chain ($\alpha_1 \dots \alpha_n$) has exactly one link: α_1 , which is both [+R] and marked for structural case.

Where an element is [+R] when it is referentially independent and specified for all Φ -features.

First, the process of A-chain formation as such between the anaphoric element and the local c-commanding antecedent could be impaired in agrammatic Broca's aphasia. In a sentence such as (24), the establishment of an A-chain between the pronoun *him* and the c-commanding DP *John*, is prohibited because of the feature specifications of the pronoun. The pronoun is a [+R] element and therefore cannot occupy the foot of the chain = $*[John_i \dots him_i]$. Nevertheless, as we have seen in the previous experiment, approximately half of the time agrammatic patients allow *him* to refer to *John*, which could mean that they allow chain formation between these two elements.

(24) $*John$ saw [*him* dancing].

Why would agrammatic Broca's aphasic speakers have problems with A-chain formation? It is known that they have difficulties interpreting passive and other constructions exhibiting A-movement (for an overview, see Grodzinsky, 2000). Passive constructions, such as (25), are typical cases of A-movement where the subject DP moves to sentence-initial position and leaves a trace in its base position.

(25) $John_i$ was kissed t_i .

The moved subject and its trace form an A-chain through which the thematic role assigned *John* is mediated. However, the A-chain postulated by Reinhart & Reuland in the Reflexivity model is different from an A-chain that results from A-movement. Unlike the A-chain between the trace and the subject DP in (25), the A-chain between the c-commanding antecedent and the pronoun in (24) contains more than one thematic role. The problems of agrammatic patients with the interpretation of moved elements are ascribed to their inability to represent traces, i.e. they are supposed to lack that particular part of

their linguistic knowledge (see Grodzinsky, 2000). It is, however, unclear how the problems with A-chains that result from A-movement can be explained in terms of a lack of processing resources (for a detailed discussion, see Grodzinsky *et al.*, 1993).

In structures with pronouns, on the other hand, there are no traces but overt elements that need to be assigned a referential value. As I have already pointed out, Grodzinsky *et al.* (1993) assume that as a result of a limited working memory, agrammatic patients fail to apply Rule-I. A unified explanation that would treat these two different types of comprehension errors as a general problem with A-chains is unlikely. We are dealing with different types of A-chains, which seem related to two different types of deficit in agrammatism. Problems with A-chains that result from A-movement are supposed to be related to the lack of the knowledge of traces. Errors with A-chains that are established between an anaphoric element and its c-commanding DP are supposed to be related to the lack of processing resources, specifically, working memory limitations. These and other issues of what constitutes the underlying source of comprehension problems in agrammatism will be discussed in subsequent chapters. In Chapter 6 Broca's patients' general deficit in comprehension will be discussed and connected to their deficit in language production. A unified explanation of problems with different phenomena in both comprehension and production is needed in order to adequately explain the language deficit in this population.

For the time being, I restrict myself to the phenomena related to pronouns in ECM sentences. The A-chain condition relies on the specification of morphosyntactic Φ -features (number, gender, person) and their accessibility in language processing for the appropriate interpretation of pronouns in these instances. As we have seen, the A-chain condition rules out the possibility of having an element fully specified for Φ -features, such as the pronoun *him* in (24), as a foot in the A-chain = *[*John...him*]. It is possible that agrammatic speakers are incapable of accessing number and/or gender features information on the pronoun. In that case they would interpret the pronoun as a referentially deficient [-R] element and allow it to form a chain with the local c-commanding DP, without violating the A-chain condition.

The pattern of errors agrammatic aphasic patients exhibit with pronouns in ECM constructions resembles the pattern of errors found in pre-school children. Like aphasic patients, children often allow the pronoun in ECM sentences to refer to the c-commanding DP. In Chapter 5 the data gathered from children will be discussed in detail and evidence will be presented, which shows that children possess and can

use both gender and number information on the pronoun when they need to interpret pronouns in simple transitive and ECM sentences.

2.1.6 Summary

The results presented here show that agrammatic Broca's aphasic speakers make more errors with pronouns in ECM constructions than with pronouns in simple transitive sentences. I failed to replicate Grodzinsky *et al.*'s (1993) findings of chance performance on pronouns in simple transitive sentences in English. The agrammatic Broca's aphasic speakers I tested performed above chance level. The results discussed here undermine Grodzinsky *et al.*'s (1993) claim that agrammatic patients generally fail to apply Rule-I. I suggested that the comprehension errors with pronouns in ECM sentences of Broca's patients point to problems with the A-chain condition.

In the second part of this chapter a closer examination of the morphosyntactic features will be presented in relation to their role in the establishment of an A-chain between the anaphoric element and its local antecedent. In light of the results of the second experimental study presented in this chapter, the question will be addressed whether the Reflexivity model is the most adequate model for explaining the agrammatic data. This will result in a proposal of an alternative theoretical model, which provides a more sophisticated account of the data gathered in the present study and also connects the present findings with a body of data on comprehension in agrammatic aphasia in general.

2.2. Morphosyntactic features and pronoun interpretation

2.2.1 Introduction

The experimental study presented in this section builds on the results of the experimental study discussed in the first half of this chapter. Within the Reflexivity model, morphosyntactic features play a crucial role in determining whether an anaphoric element can enter an A-chain dependency. The problems agrammatic patients exhibit in assigning reference, particularly to pronouns in ECM sentences, could be related to problems they might have in either accessing or using these features.

2.2.2 Morphosyntactic features and Reflexivity

As we have seen, a referential dependency between a pronoun and a local antecedent DP in ECM sentences, repeated in (26), is ruled out by the A-chain condition.

- (26) **Jan zag hem dansen.*
Jan saw him dance.

In (26), the referential elements, the pronoun *hem* and its antecedent *Jan* enter an illegal dependency (chain) *[Jan_i...hem_i]. Reflexive *zichzelf*, on the other hand, is referentially deficient and, as such, acceptable as the final element of a chain [Jan_i...zichzelf_i], as in (27).

- (27) *Jan zag zichzelf dansen.*
Jan saw himself dance.

Let us now examine the predictions Reflexivity makes with regard to the errors in the interpretation of pronouns agrammatic patients exhibit in ECM constructions and their relation to morphosyntactic features. According to this model, the errors agrammatic patients make with pronouns in ECM sentences could perhaps be related to their inability to establish an appropriate chain (dependency) between an antecedent and a pronoun. It is possible that the agrammatic patients treat pronouns as referentially deficient [-R], because they are incapable of accessing number and/or gender features information on the pronoun. If this is the case, it should not matter whether there is congruence or incongruence in number or gender between the local antecedent and the pronoun. Both congruent and incongruent cases are expected to be equally problematic.

2.2.3 Previous studies

There have not been many experimental studies examining the effect of morphosyntactic features on the processing of pronouns. In an elegant lexical priming study with Italian non-brain-damaged adults, Vincenzi & Di Domenico (1999) tested the use of gender and number information in the process of establishing a referent for a pronoun. They asked their subjects to read sentences word by word from a computer screen. Immediately after the pronoun was encountered, the target word was presented and the subjects had to decide whether it was a word or a non-word. Half of the time, the target words were real words that were semantically related to the antecedent of the pronoun, and half of the time these were unrelated to the antecedent of the pronoun. In sentences such as (28), the two possible antecedents *bridegroom* and *pupils* have the same gender but a different number feature. The same sentences were presented with the third person singular pronoun *him* and the third person plural pronoun *them*. If number on the pronoun is used to

determine the antecedent, then after encountering the pronoun *him*, subjects are supposed to react faster to the target word *marriage*, which is semantically related to the antecedent *the bridegroom*, than to the semantically unrelated target *afternoon*. This difference is not expected in sentences with *them* in the same position because it can only refer to *the pupils* and none of the target words is related this antecedent in any specific way.

- (28) Lo sposo disse agli alunni che il vecchio generale in pensione voleva salutar**lo/-li** [MATRIMONIO/POMERIGGIO] quanto prima.
The bridegroom told the pupils that the old retired general wanted to greet-him/-them [MARRIAGE/AFTERNOON] as soon as possible.

In the other sentence in (29) the two potential antecedents *the uncle* (masculine) and *the student* (*laureanda* = feminine) have the same number, but a different gender feature. The same logic applies as in the sentences testing number. If gender information is used to assign reference to the pronoun *her* when it is encountered, then there should be a shorter response time for the target *thesis*, which is semantically related to the antecedent DP *the student* (fem.) than for the unrelated target *walnut*. In the same sentence with the pronoun *him* there should be no difference in reaction time because both targets are unrelated to the antecedent *the uncle*.

- (29) Lo zio disse alla laureanda che l'ingegnere conosciuto in vacanza poteva ricever**la/-lo** [TESI/NOCE] nel pomeriggio.
The uncle told the student (fem.) that the engineer met during vacation could receive-*her*/*-him* [THESIS/WALNUT] in the afternoon.

Vincenzi & Di Domenico found that very soon (1000ms) after the pronoun was presented, number was used to identify the antecedent, but not gender. In other words, the reaction times were different in the contrasting sentences within the two conditions and shorter for the related targets in (28) but not in (29). The authors suggest that while gender is relevant to the lexical/semantic level of representation, number is relevant to the syntactic level of representation during the initial structure building.

To my knowledge, there is only one study that has examined the effect of number or gender feature incongruence on the processing of pronouns in Broca's aphasia. Friederici, Weissenborn & Kail (1991) examined pronoun comprehension in agrammatic patients in an off-line study conducted in English, Dutch and French. Their study, however,

was designed in such a way that it was impossible to conclude whether the agrammatic patients they tested could use both number and gender, or just one of the two, to decide on the appropriate antecedent for the pronoun. Friederici, Weissenborn & Kail used a picture-matching task and their subjects were asked to choose one of two pictures that correctly depicted the action described in the target sentence, exemplified in (30).

- (30) De danseres toont *haar* aan het indianenmeisje.
The dancer shows her to the Indian girl.

Pictures accompanied the target sentence where the possible antecedent and the pronoun were not congruent in number. In one picture the dancer was showing a queen to the Indian girl and in the other picture the dancer was showing more than one queen (the paper is unclear on the exact number) to the Indian girl. Pictures also accompanied the target sentence where the possible antecedent and the pronoun were not congruent in gender. In one picture the dancer was showing the bride to the Indian girl and in the other picture the dancer was showing the groom to the Indian girl. All of these were mixed in one condition so it was impossible to tell whether the agrammatic performance was better on the gender or the number incongruence cases. Nevertheless, the authors report that, in all three languages they tested, the agrammatic patients were able to use gender and number information in the process of assigning reference to the pronoun.

2.2.4 Experiment 2

2.2.4.1 Introduction

An experiment was designed in order to test the ability of individuals with agrammatism to use number and gender information on pronouns in simple transitive and ECM sentences.¹³ I tested two types of simple transitive sentences, one where the pronoun and the antecedent were incongruent in number (32), and one where these two elements were incongruent in gender (33). The ECM sentences were also tested but only with incongruence in number between the two relevant elements, such as in (34).¹⁴ On the basis of the results obtained by Grodzinsky *et al.*

¹³ The data from this experiment have already been published in a slightly different form (Vasić & Ruigendijk, 2005).

¹⁴ In order to compare the results obtained in Experiment 1 (congruence in number between the pronoun and the local antecedent in ECM) with results on sentences with an incongruence in number in ECM sentences, the same task, picture selection,

(1993), we expect that the agrammatic patients should perform at chance level on simple transitive sentences where the pronoun and the antecedent are congruent in number and gender, such as in (31). If the agrammatic aphasic speakers can access and use the number and/or gender information on the pronoun to decide on the appropriate antecedent for the pronoun, then the cases where there is incongruence in number or gender between the two should make it easier for them to reject linking the pronoun and the antecedent in both types of constructions.

- (31) Het meisje kust *haar*.
The girl kisses her.
- (32) De meisjes kussen *haar*.
The girls kiss her.
- (33) Het meisje kust *hem*.
The girl kisses him.
- (34) Het meisje zag *hen* dansen.
The girl saw them dance.

If agrammatic aphasic patients show sensitivity to number and gender information, then it is not very likely that the A-chain condition is the source of their comprehension problems with pronouns in ECM constructions. In that case, it will be necessary to reconsider whether the Reflexivity model is the most appropriate theoretical model for explaining the data on ECM constructions obtained from agrammatic aphasic speakers.

2.2.4.2 *Subjects*

In the experiment with simple transitive sentences I tested six Dutch-speaking agrammatic aphasic patients. Four of the six patients (AD, AN, JW & IH) were tested in Experiment 1. Of the six agrammatic patients, four were female and two male with an average age of 58 years (range

had to be used with the same subjects. In Experiment 2, in order to test the effect of incongruence of features in simple transitives, a truth-value judgment task was used; therefore it was impossible to include ECM sentences in the same experiment. In order to test the effect of incongruence as opposed to congruence in ECM, the same subjects had to be tested as in Experiment 1 with the same method, picture selection, and not a truth-value judgment task. The ECM sentences with an incongruence in features between the pronoun and the antecedent were tested as fillers in the experiment that will be discussed in Chapter 4, where the interpretation of pronouns in elided VP constructions was tested by means of a picture selection task.

41-73 years). (Individual patient data and the AAT scores of each of these patients are given in Appendix A, Tables A.1.1 and A.1.2).

The performance of agrammatic patients was compared to the performance of a control group of nine Dutch-speaking, non-brain-damaged subjects (4 male, 5 female; mean age 43.4, range 27-69 years), who were matched to the aphasic speakers in age and education.

As was mentioned in footnote 13, the ECM constructions were embedded as filler sentences in an experiment testing the interpretation of pronouns in elided VPs, which will be discussed in detail in Chapter 4. In this experiment, six Dutch-speaking agrammatic aphasic patients were tested. All six patients also took part in the experiment testing simple transitive sentences.

The performance of agrammatic patients in this experiment was compared to the performance of a control group of 11 Dutch non-brain-damaged speakers (2 male, 9 female; mean age 31, range 19-69 years).

2.2.4.3 *Materials and procedure*

For the conditions with simple transitive sentences, subjects were tested with a truth-value judgment task (Crain & Thornton, 1998).¹⁵ First, the patients were made familiar with all the participants in the action portrayed in each picture that accompanied the target sentence. Each target sentence was presented to the subjects orally. After hearing the target sentence, subjects were asked to respond with *yes* or *no* indicating whether or not they found that the picture correctly portrayed the meaning of the target sentence. There were 4 conditions each containing 16 items (with a total of 64 experimental items) and 64 filler sentences (total number of 128 sentences in the experiment, see Appendix C for all test sentences). Each of the conditions contained items in two versions: one paired with a picture depicting a non-reflexive action where the expected response was YES, and another one with a picture that depicted a reflexive or reciprocal action with an expected NO response (see Figures 2.2 - 2.9 for examples of all YES and NO conditions). Experimental conditions for the simple transitive sentences:

¹⁵ This particular task was chosen in order to replicate the results of Grodzinsky *et al.* (1993), where agrammatic patients scored at chance level with pronouns in simple transitive sentences. In the experimental study discussed in the previous section, a picture selection task was used and the results obtained with pronouns in simple transitive sentences were significantly above chance.

(35) Number/gender congruence: SINGULAR-SINGULAR

Target sentence:

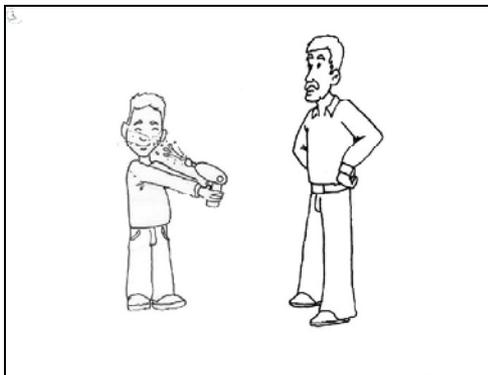
De jongen spuit *hem* nat.

The boy squirts *him* (wet).

Figure 2.2: picture SINGULAR-SINGULAR YES condition:



Figure 2.3: picture SINGULAR-SINGULAR NO condition:



In the SINGULAR-SINGULAR condition with *NO* as the expected response the target sentence was paired with a picture with a reflexive action; the antecedent was performing the action on her- or himself.

(36) Number incongruence: SINGULAR-PLURAL

Target sentence:

De man spuit *hen/hun* nat.¹⁶

The man squirts *them* (wet).

Figure 2.4: picture SINGULAR-PLURAL YES condition:



Figure 2.5: picture SINGULAR-PLURAL NO condition:



¹⁶ In standard Dutch grammar, the appropriate form for the direct object in Dutch is *hen* and for the indirect object it is *hun*. However, in spoken language *hun* is also commonly used form for the direct object. When I pre-tested a control group of healthy adults they preferred to use *hun* instead of *hen* in the test sentences. This form was more natural to them, which is why I used this form in all experimental items. Additionally, *hen* is acoustically similar to the third person singular pronoun *hem* (him) and can easily be misinterpreted as *hem*.

In the SINGULAR-PLURAL condition with *NO* as the expected response the target sentence was also paired with a picture with a reflexive action; the antecedent was performing the action on her- or himself.

(37) Number incongruence: PLURAL-SINGULAR

Target sentence:

De boeven wijzen *hem* aan.

The thieves point at *him*.

Figure 2.6: picture PLURAL-SINGULAR *YES* condition:

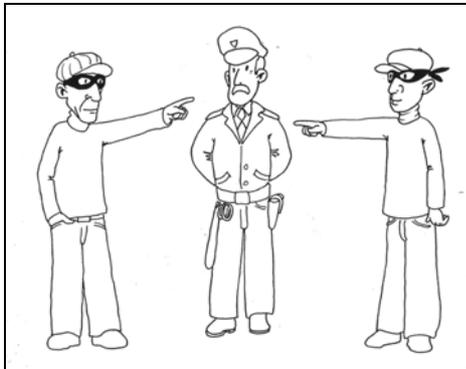
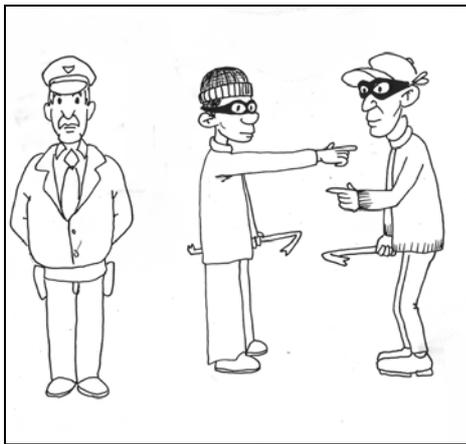


Figure 2.7: picture PLURAL-SINGULAR *NO* condition:



In the PLURAL-SINGULAR condition with *NO* as the expected response the target sentence was paired with a picture with a reciprocal action; the two characters presented as a group were simultaneously performing

the action on each other. In this case the thieves are both pointing to each other.

(38) Gender incongruence: MASC.-FEM./FEM.-MASC.

Target sentence:

De prinses wijst hem aan.

The princess points at *him*.

Figure 2.8: picture GENDER CONGRUENCE YES condition:

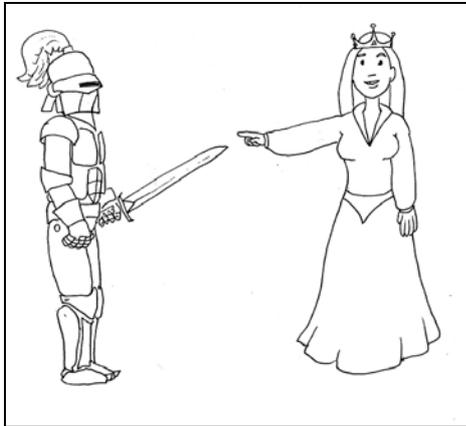
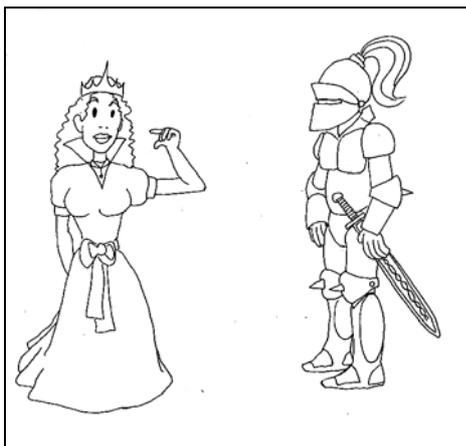


Figure 2.9: picture GENDER INCONGRUENCE NO condition:



In the Gender incongruence condition with *NO* as the expected response the target sentence was paired with a picture with a reflexive action, i.e. the antecedent was performing the action on her- or himself.

The test consisted of two versions, each comprising 64 sentences, which were tested in two separate sessions. The experimental items contained eight different verbs per condition. In version 1 these were used in the condition with *NO* as the correct response and in version 2 in the same condition but with *YES* as the correct response. This was done in order to control for the meaning of each verb so that I could exclude the possibility that the reason a subject was saying *YES* or *NO* was related to the semantics of a particular verb used in an experimental item.

The ECM sentences with incongruence in number between the pronoun and the antecedent were tested with a picture selection task. Only one type of number incongruence between the pronoun and its antecedent was tested; where the pronoun was plural and the antecedent singular. The test items formed the second conjunct of two conjoined sentences and were preceded by a conjunct that introduced two possible referents for the pronoun. The introductory conjunct and an example of a target sentence are given in (39a) and (39b).

- (39) a. First conjunct - introduction to ECM constructions:
 Eerst hebben de jongen en de mannen gefietst, ...
 First have the boy and the men biked, ...
 First the boy and the men biked, ...
- b. Second conjunct - ECM incongruent sentence:
 ... en daarna zag de jongen_i hun_{*i/j} zwaaien.
 ... and then saw the boy them wave.
 ... and then the boy_i saw them_{*i/j} wave.

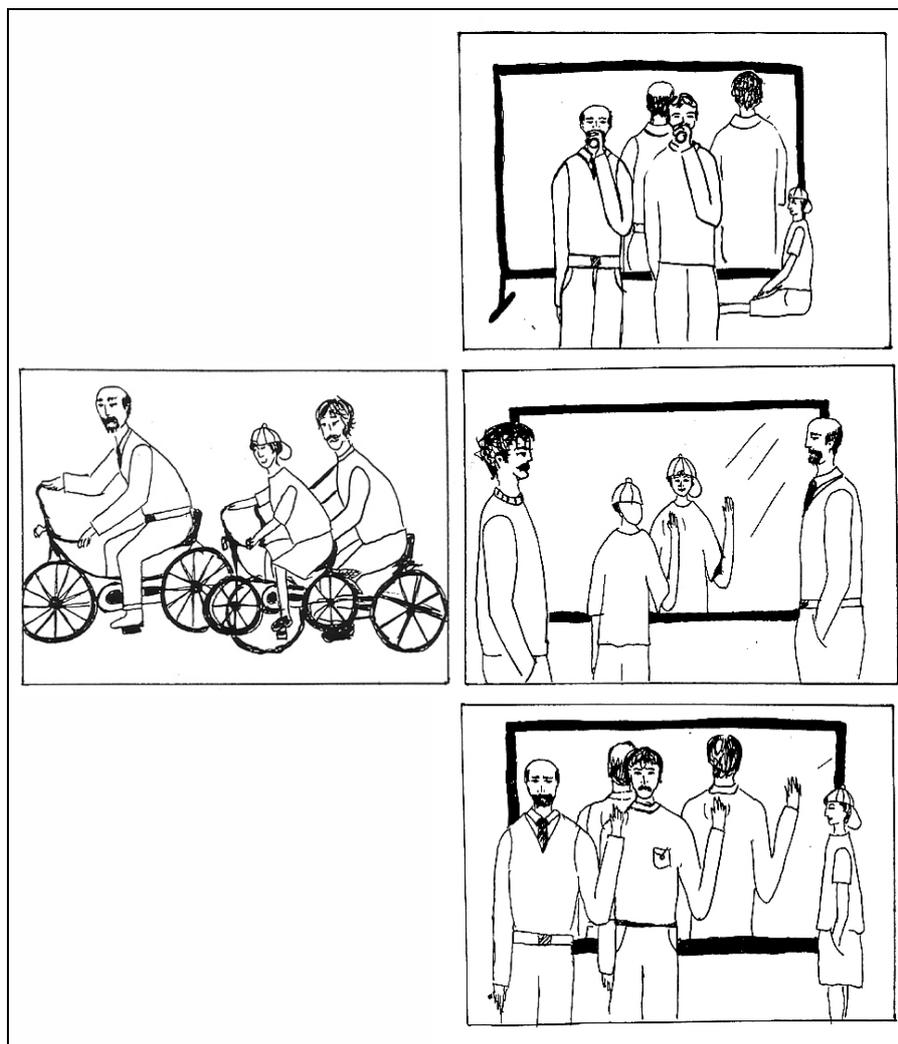
The procedure was the same as in Experiment 1 described earlier (see Figure 2.10 for an example of the ECM incongruence condition).

There were 15 target sentences in the ECM incongruence condition and in this particular experiment agrammatic aphasic subjects were tested twice with the same test with a six-month delay between the first and second measure points (see Chapter 4, section 4.3.2). The main reason for the repeated measurement was to increase the number of experimental items in order to have more data points (2 x 15 items = 30 total items). In the results section the results per subject will be given

separately for each measurement and they will then be collapsed and treated as the results for the incongruence condition.

Figure 2.10

An example of the picture decision task testing ECM incongruence: First the *boy* and the men biked and then the boy saw *them* waving. The bottom picture on the right depicts the correct response.



2.2.4.4 *Results*

Table 2.2 shows the overall results of the truth-value judgement task for both agrammatic speakers and controls for the conditions with NO as the expected answer. The agrammatic speakers performed worse than the controls on the singular congruence condition (Mann-Whitney test $Z = -2.928$, $p < .003$). Their performance on the plural-singular incongruence condition was also significantly worse than that of controls ($Z = -2.279$, $p < .023$), whereas in the singular-plural condition ($Z = -.816$, $p = .414$) and the gender incongruence condition ($Z = -1.793$, $p = .073$) it did not differ from that of the controls.

The difference between the singular-singular congruence condition and the three incongruent conditions was tested using the Wilcoxon Signed Rank test. The agrammatic patients scored significantly better on all incongruent conditions as opposed to the singular-singular congruent condition (singular-singular vs. singular-plural, $Z = -2.032$, $p < .042$; singular-singular versus plural-singular, $Z = -1.947$, $p < .052$; singular-singular vs. gender incongruence, $Z = -2.060$, $p < .039$). There was no significant difference in their performance on the singular-plural vs. plural-singular incongruence conditions ($Z = -1.633$, $p < .102$).

Table 2.2

Total number of correct responses per aphasic subject and percentages correct for the whole group on the four experimental conditions with NO as the expected response.

	<i>Singular-Singular congruence NO</i>	<i>Singular-Plural incongruence NO</i>	<i>Plural-Singular incongruence NO</i>	<i>Gender incongruence NO</i>
AD	13/16	16/16	15/16	14/16
AN	14/16	16/16	16/16	15/16
JW	16/16	16/16	15/16	16/16
IH	10/16	16/16	12/16	16/16
MK	14/16	16/16	16/16	16/16
EM	15/16	16/16	16/16	16/16
Tot. % correct	85.4	100	93.8	96.9
Controls	98.9	98.9	100	100

Table 2.3 shows the overall results for both agrammatic speakers and controls for the control conditions with YES as the expected answer. The agrammatic patients' performance did not differ from the performance of the control group in any of these conditions (singular congruent condition - Mann-Whitney test, $Z = -.199$, $p < .842$; singular-plural

condition, $Z = -.454$, $p = .650$; plural-singular condition, $Z = -1.793$, $p < .073$; and gender incongruence condition, $Z = -.398$, $p = .690$).

There was no difference between the singular-singular congruent condition and the three incongruent conditions (Wilcoxon Signed Rank test - singular-singular vs. singular-plural, $Z = -.816$, $p < .414$; singular-singular vs. plural-singular, $Z = -.816$, $p < .414$; singular-singular vs. gender incongruence, $Z = -.447$, $p < .655$).

Table 2.3

Total number of correct responses per aphasic subject and percentages correct for the whole group on the four experimental conditions with YES as the expected response.

	<i>Singular-Singular congruence YES</i>	<i>Singular-Plural incongruence YES</i>	<i>Plural-Singular incongruence YES</i>	<i>Gender incongruence YES</i>
AD	16/16	16/16	16/16	16/16
AN	16/16	16/16	15/16	16/16
JW	16/16	13/16	16/16	14/16
IH	16/16	15/16	14/16	16/16
MK	16/16	16/16	16/16	16/16
EM	15/16	16/16	16/16	16/16
Tot. % correct	98.9	95.8	96.9	97.9
Controls	100	100	100	100

Finally, Table 2.4 shows the overall results for the agrammatic patients and controls for the ECM pronoun condition from Experiment 1 with congruence in number between the pronoun and its antecedent. It also contains the results on the ECM incongruence condition (where the pronoun and its antecedent are incongruent in number) from both measurements and the total. The agrammatic patients scored significantly better on the ECM incongruence condition than on the ECM congruence condition (Chi-square = 16.304, $p = 0.001$). Their scores were 68 out of 117 correct responses (58% correct \approx chance level performance) for the congruence condition and 154 out of 180 correct responses (86% correct) for the incongruence condition.

Table 2.4

Total number of correct responses per aphasic subject and percentages correct for the whole group on four experimental conditions (N.A. = not available).

Subjects*	ECM congruence	ECM incongruence		
	Experiment 1	Test 1	Test 2	Total
AD	8/15	11/15	13/15	24/30
JW	8/15	13/15	13/15	26/30
AN	10/15	12/15	14/15	26/30
IH	9/15	11/15	12/15	23/30
MK	N.A.	15/15	13/15	29/30
EM	N.A.	13/15	13/15	26/30
MJG	8/15	N.A.	N.A.	N.A.
GK	11/15	N.A.	N.A.	N.A.
AK	10/15	N.A.	N.A.	N.A.
AL	7/15	N.A.	N.A.	N.A.
Tot. % correct	56.7	83.3	87.8	85.6
Controls	97.8	100	100	100

*Only four of the eight patients that took part in Experiment 1 could be tested with the ECM incongruent condition. Because each of the four patients that took part in both experiments performed significantly better on the incongruent condition I assume that the pattern they exhibit is a general pattern of the agrammatic group. Therefore, I compare the results of the two groups of patients regardless of the fact that the two groups are not homogeneous.

2.2.4.5 Discussion

The results show that agrammatic patients' performance improves drastically in simple transitive sentences with incongruence in number or gender between the pronoun and its antecedent in comparison with sentences where the two are congruent in number and gender. The agrammatic speakers' performance also improves with incongruence in number in ECM sentences. These results indicate that agrammatic patients have access to the number and gender information on the pronoun and use it when they need to decide on the referent for the pronoun. Therefore, our results indicate that morphosyntactic information can be accessed in agrammatism and is used to aid the comprehension of sentences containing pronouns.

Similarly to the results discussed in Experiment 1, the results of Experiment 2 deviate from the results obtained by Grodzinsky *et al.* (1993). In their study, the agrammatic patients scored at chance level when interpreting pronouns in simple transitive sentences. The baseline condition with a congruence in number and gender between the pronoun and the antecedent is the same as the condition tested by Grodzinsky *et al.* (1993), yet I fail to replicate their findings. Unlike the first experiment (section 2.1.4), in which a picture selection task was

used, this second experiment used the same methodology, a truth-value judgement task, which was used in Grodzinsky *et al.*'s (1993) study. The reason the same methodology was used was to replicate the chance performance on the baseline condition (singular-singular) in order to check whether incongruence in number or gender would improve their performance. Our results for the singular-singular congruence condition, where the agrammatic patients score significantly above chance (85.4 %), are surprising and they indicate that pronominal reference assignment in simple transitive sentences is not impaired to such a degree in these patients as was claimed by Grodzinsky *et al.* (1993). They tested six agrammatic patients and had six data points per condition. I tested six patients and had 30 data points per condition, which gives more statistical power and, therefore, makes our results more convincing.^{17,18}

2.2.4.6 Preliminary conclusion

The errors agrammatic Broca's aphasic patients make when assigning reference to pronouns in ECM sentences are not related to a kind of morphosyntactic underspecification or inability to access these features of pronouns. As was discussed in the previous section, it is also unclear how and why the A-chain condition, as postulated in the Reflexivity model, should be impaired in agrammatism. Additionally, the results obtained from both experiments discussed in this chapter show that agrammatic aphasic patients perform above chance on pronouns in simple transitive sentences in Dutch, contrary to what was expected on the basis of previous results in English. My analysis thus raises doubts about the proposal that assumes a general problem with the application of Rule-I in Broca's agrammatic patients.

I conclude that the agrammatic data observed in my experiments cannot be adequately explained on the basis of the Reflexivity model. In the remainder of this chapter I will discuss an alternative theoretical model, the Primitives of Binding proposal (Reuland, 2001) and I will show that it provides tools for unifying different phenomena that are problematic in agrammatic patients in relation to reference assignment.

¹⁷ They actually tested eight patients, but two patients were excluded from the analysis because of their deviant performance (see Grodzinsky *et al.*, 1993).

¹⁸ One could argue that there is a cross-linguistic difference affecting patients' performances since Grodzinsky *et al.* (1993) tested sentences in English and I tested the same type of sentences in Dutch. Nevertheless, I could not find any difference between the two languages that could account for the better performance in Dutch.

2.3 The Primitives of Binding model

The Reflexivity model fails to provide a unifying account for the pattern of comprehension errors agrammatic Broca's aphasic patients make when assigning reference to pronominal elements in ECM and simple transitive constructions. On the one hand, based on previous findings (Grodzinsky *et al.*, 1993), these patients are expected to exhibit problems with the implementation of Rule-I as a consequence of working memory limitations. In other words, the linguistic knowledge is present, but they fail to implement it. Nevertheless, in both experimental studies presented here, they do not seem to have problems applying Rule-I to pronouns in simple transitive sentences. On the other hand, they appear to have problems that, given the assumptions of the Reflexivity model, can be ascribed to difficulties with the A-chain condition. It is unclear how the latter could be related to a lack of processing resources or a limitation of working memory capacity. One would need to postulate a lack of a particular part of knowledge, in this case the A-chain condition, in order to account for the patients' errors with ECM sentences. We end up with an unclear picture, since the problems agrammatic patients exhibit when interpreting pronouns are supposed to be a result of both lack of knowledge and lack of processing resources to apply the relevant knowledge. A unifying explanation for the comprehension errors is necessary not only with respect to pronominal reference assignment but also with regard to other structures.

A theoretical framework that I would like to put forth as a more appropriate model for explaining the pattern of errors in the comprehension of anaphoric elements is Reuland's (2001) economy-based approach, so-called Primitives of Binding. The fact that it possesses a more appropriate toolkit for explaining the data presented here than other models of reference assignment is not the only reason to opt for this particular model. There are a few other aspects that make Primitives of Binding a more sophisticated model than other models of reference assignment. First, the mechanisms that govern pronominal reference assignment are derived from basic principles of grammar, rather than being postulated as separate rules or constraints, such as the A-chain condition of the Reflexivity model. Second, this particular theory of anaphora connects the notion of economy to the notion of cost in real time processing of anaphoric dependencies. Therefore, it lends itself to making predictions in terms of real time processing of particular structures that contain anaphoric elements. Finally, this model makes it possible to connect data on reference assignment to other comprehension

and production data obtained from agrammatic patients in aphasiology research. These three aspects will be discussed one by one in the subsequent sections.

2.3.1 A-chain condition

In Chapter 1 I discussed Reuland's revision of the A-chain condition of the Reflexivity model. In the Reflexivity model, the A-chain condition was postulated as a constraint on reference assignment in the instances where the (local, c-commanding) antecedent and the anaphoric element are not in a coargument configuration, such as in ECM sentences. Reuland derives the A-chain condition from more basic principles, such as constraints on feature-checking in the Minimalist framework (based on Chomsky, 1995, 2000). A-chain formation between an anaphoric element and another DP is established through a feature-checking procedure in narrow syntax and results in the formation of a syntactic dependency. According to Reuland, only one type of anaphoric element, such as SE-anaphors (e.g. Dutch *zich*), establishes a dependency with another DP through a feature checking procedure. In example (40a) an A-chain (a syntactic dependency) must be formed between *zich* and the subject DP of the matrix clause *Jan*.

- (40) a. *Jan zag zich dansen.*
 Jan saw SE dance.
 b. **Jan zag hem dansen.*
 Jan saw him dance.

However, pronouns can, in principle, form either a bound variable or coreference dependency with their antecedents. The question then arises why in (40b) *hem* cannot be interpreted as *Jan* if a binding dependency or a coreference dependency is an option. In order to answer this question, we will need to take a closer look at the notion of economy and its application in the Primitives of Binding model.

2.3.2 Economy hierarchy

As we saw in the theoretical introduction in Chapter 1, Reuland (2001) presents a number of constraints which together express the idea that one way of interpreting an anaphoric element is preferred over another. The three constraints are: Rule-BV, a constraint on bound variable interpretation; Rule-L, a constraint on logophoric interpretation; and Rule-I, a constraint on intrasentential coreference (adopted from Grodzinsky & Reinhart, 1993). Taken together, these constraints assume

a ranking whereby operations that take place within narrow syntax are more economical than operations that occur at the semantic level, and the latter are more economical than the processes that require accessing discourse.

The different grammatical levels and types of operations that take place at these different levels are repeated in (41).

(41)	LEVEL	OPERATION
	Narrow syntax	(feature checking)
	↓	
	Semantics	(bound variable)
	↓	
	Discourse	(coreference)
	↓	
	(Non-linguistic source)	(deixis)

The economy hierarchy represents the essence of Reuland's model, which relates representation to real time processing. It allows for predictions in terms of real time processing of referential dependencies. On the basis of this model I predict that an increase in the number of cross-modular operation results in an increase of the cost in terms of processing resources that is incurred when pronominal elements are interpreted. The operations that occur in narrow syntax are the most automatic and economical, hence establishing a syntactic dependency is the preferred way of assigning an antecedent to a pronominal element. Semantic operations are more costly because they imply an extra cross-modular operation. In order to establish a semantic dependency (bound variable interpretation) the interpretive system first needs to consult narrow syntax; in case a syntactic dependency is not possible, it moves to another level, in this case the semantic level, and establishes a dependency there. The same is true for moving onto the next level – discourse, where two modules are crossed. Finally, the non-linguistic source is assumed to be the most expensive option since the interpretive system needs to go outside the linguistic module and enter other domains such as world knowledge.

2.3.3 Pronouns in ECM and simple transitive sentences

The question posited in the previous section, why *hem* in an ECM sentence, repeated in (42), cannot be interpreted as *Jan* if a binding dependency or a coreference dependency are in principle an option, will be addressed here.

(42) **Jan zag hem dansen.*
Jan saw him dance.

- (43) a. $\text{Jan}_\phi \text{ zag } [\text{zich}_\phi \text{ dansen}]$ (feature checking - syntax)
 b. $\text{Jan } \lambda x (x \text{ zag } (x \text{ dansen}))$ (variable binding - semantics)
 c. $\text{Jan } \lambda x (x \text{ zag } (a \text{ dansen}))$ & $a = \text{Jan}$ (coreference - discourse)

As we have seen in the preceding section, the pronoun in (42) cannot enter a semantic (43b) or a discourse (43c) dependency because of economy considerations. A cheaper syntactic (43a) dependency is possible in this configuration if the element in question, the pronoun, is replaced by a SE-anaphor *zich*, such as in (40a). This possibility blocks the formation of any other type of dependency between the pronoun and the matrix subject.

Therefore, in the ECM sentence in (42) there are two reasons why *hem* cannot refer to *Jan*. As pointed out in Chapter 1 (section 1.2.3.2), the presence of a number feature blocks a formation of a syntactic dependency. The pronoun is specified for number feature and that is the first reason why it cannot enter into a syntactic dependency with the main subject. The second reason why this dependency is impossible is because the economy hierarchy rules out binding and coreference in ECM constructions. In principle, a syntactic dependency is possible if the pronoun is replaced by the SE-anaphor *zich*. This being a cheaper option blocks any other ways of establishing a referential dependency.

In the case of simple transitive sentences tested in our experimental studies and exemplified in (44), there is an additional constraint at work in addition to the economy hierarchy.

(44) **Jan kietelt hem*
Jan tickles him.

As we have seen, in ECM sentences the pronoun and its antecedent DP are not in a coargument configuration. In simple transitives, however, these two elements are arguments of the same predicate, hence, coarguments. Why can the two elements not be interpreted as one, referring to the same entity? In the Reflexivity model, the principle that constrains realisation of a reflexive predicate in these instances was Condition B. In the Primitives of Binding model, Reuland derives this condition from a general property of language, as a filter on arity reduction. A two-place predicate (relation) cannot be reduced to a one-place predicate (property) unless it is marked as a property in the lexicon

$(\lambda x \lambda y (xRy) \rightarrow \lambda x (xRx))$. Therefore, it is impossible to interpret (44) as $[[\lambda x (x \text{ kietelt } x)] (x=\text{Jan})]$ because this would mean that a relation of *kietelen* would be reduced to a property. The verb *kietelen* is not marked as reflexive in the lexicon, which is why it cannot be reduced to a property.¹⁹

2.3.4 Relation to real-time processing

In theoretical linguistics, the notion of economy has mainly been used as a representational notion. Nevertheless, proposals (Jackendoff, 1997; Fox, 2000; Reuland, 2001; Avrutin, 2004b) have recently emerged, which postulate that particular aspects of economy must have an observable effect on processing. These particular observable steps are the transitions from one level of representation to another, and during these transitions, an observable cost is incurred in terms of processing structures in real time. The processing literature provides evidence for this claim. A great many studies (Frazier, 1978; Shapiro, Zurif & Grimshaw, 1987, 1989; Vicenzi, 1991, 1996; Gibson, 1998; Piñango, Zurif & Jackendoff, 1999; Shapiro 2000, Burkhardt, 2004) have shown that syntactic operations are the least costly operations for the human parser. Semantic or discourse operations, on the other hand, are costlier in terms of processing resources. Reuland's economy hierarchy represents an important step towards unifying representation and processing of referential dependencies in real time. This model (see also Fox, 2000) assumes that when confronted with different types of referential dependencies, the language system will opt for the most economical way of encoding anaphoric relations, namely, through syntax.

2.4 Pronoun problems in agrammatism

In Chapter 1, section 1.1.5, I argued that syntactic structure building is slower-than-normal in agrammatic patients. Let us examine now how this slow-down in the building of syntactic structure affects the assignment of reference to anaphoric elements in agrammatism. If syntax is generally delayed and, therefore, not the most economical route in Broca's aphasic patients, then the establishment of a syntactic dependency between an anaphoric element and a c-commanding

¹⁹ As opposed to transitive verbs, inherently reflexive verbs such as *shave* in English (i) and *scheren* in Dutch (ii), are marked as reflexive in the lexicon.

- (i) *Jan* shaves.
- (ii) *Jan* scheert zich.
Jan shaves SE.

antecedent DP should be disturbed. Therefore, the economy hierarchy of referential dependencies as proposed by Reuland (2001) for non-brain-damaged adults may not be the same for agrammatic patients. The cheapest, most automatic route through which reference is assigned in the non-brain-damaged system, feature-checking in narrow syntax, becomes less economical in the agrammatic system. As a consequence of this change in the hierarchy, other ways of establishing reference such as semantic and discourse operations become relatively more economical (sooner available) and may win over syntax.

Let us return now to the agrammatic speakers' interpretation of pronouns in ECM constructions, repeated in (45). The patients incorrectly allow the pronoun *hem* to refer to the DP *Jan* about half of the time.

- (45) **Jan zag hem dansen.*
Jan saw him dance.

I claim that in these instances they are using non-syntactic ways of establishing a referential dependency between the pronoun and the local antecedent, that is through discourse (coreference). In principle, the agrammatic patients' syntactic knowledge is preserved and, as we have seen from the second experiment in this chapter, their feature specification of anaphoric elements is also preserved. However, syntactic dependencies are at least equally costly (or more costly) in these patients than discourse dependencies. Therefore, they may allow for a discourse dependency in ECM constructions.

The fact that patients do not perform 100% incorrectly on these sentences can be explained by the same processing account. The relationship between the syntactic and the extra-syntactic modes is dynamic in the sense that the balance can be easily tipped towards one of the two systems in competition. What exactly can change the balance is not clear at the moment, but in any case, the observed chance performance would be consistent with such a situation. In those cases where narrow syntax wins, patients would correctly reject a dependency between the subject DP and the pronoun because they retain the knowledge of the number feature on the pronoun. If narrow syntax in a particular case loses the competition, patients establish a discourse type of dependency without violating the economy hierarchy.

Agrammatic patients perform significantly better when interpreting pronouns in simple transitive sentences such as repeated in (46).

- (46) **Jan kietelt hem*
 Jan tickles him.

In simple transitive sentences the lexical restrictions on the verb help rule out the incorrect binding of *hem* by *Jan*.²⁰ The verb *kietelen* ('tickle') is specified in the lexicon as a two-place predicate and interpreting *hem* as *Jan* would result in interpreting the two arguments as one, which would violate restrictions on arity reduction (Reuland, 2001).²¹ The building of the syntactic structure is delayed but at some point in time it is completed. The patients will therefore correctly reject this interpretation and perform above chance on the interpretation of pronouns in simple transitive constructions. In the ECM constructions, on the other hand, the verb *zien* is also a two-place predicate but a reduction in the case of (45) would be impossible. The pronoun *hem* is a part of the internal argument, which is a small clause [*hem dansen*], and it is not an internal argument of the matrix predicate on its own. Therefore, reducing two arguments to one argument is out of question in the ECM cases, where the correct economy considerations are decisive in the interpretation of pronouns. In simple transitive sentences both economy considerations and lexical restrictions on the verb play a role in the process of interpreting the pronoun.

2.5 Conclusion

The results of the two experiments presented in this chapter indicate that the agrammatic patients experience more problems interpreting pronouns in ECM than in the simple transitive sentences. On the basis of these results, I argue that the Reflexivity model previously used in the literature to account for comprehension errors with pronouns in Broca's agrammatic aphasia fails to provide a unified account for the errors with pronouns in the two different types of construction.

I further propose that these results can be better explained using the Primitives of Binding model. The essence of this model is the economy hierarchy of referential dependencies, which assumes that operations taking place at different linguistic levels bear different costs in terms of processing. The most automatic and economical operation through which reference can be assigned is the syntactic feature checking

²⁰ Shapiro & Levine's (1990) experimental results showed that speakers with Broca's aphasia are sensitive to argument structure.

²¹ According to Reinhart & Siloni (2005), arity reduction is a lexical operation, which takes place before syntactic computation.

operation, followed by a semantic variable binding operation and discourse-related coreference operations. In combination with the assumption that agrammatic patients have a reduced capacity for syntactic processing, I propose that the economy hierarchy in these patients is different from the economy hierarchy in healthy non-brain-damaged adults. The economy hierarchy in agrammatism is disturbed, the most economical route through narrow syntax is more costly in these patients, and hence other levels such as discourse can be used to assign reference without any violations of their grammars.

Chapter 3

Assigning reference through discourse-operations

3.1 Introduction

As we have seen in the previous chapter, it was argued by Grodzinsky *et al.* (1993) that the comprehension problems agrammatic aphasic patients encounter when interpreting pronouns in simple transitive constructions are related to their inability to apply Rule-I, a constraint on sentence internal coreference that applies at the discourse level. However, the results obtained in the two experiments discussed in Chapter 2, where the interpretation of pronouns in simple transitive sentences in Dutch was tested, show that the agrammatic patients tested in these experiments performed above chance when interpreting pronouns in these constructions. These patients did not seem to have a problem with the execution of Rule-I. The aim of this chapter is to examine more closely whether agrammatic patients have a general problem in applying Rule-I or whether the problem underlying their deficit with regard to the interpretation of pronouns lies elsewhere. In order to do so I tested agrammatic patients' ability to assign reference to pronouns across sentential boundaries. In these instances the only operation available is coreference and Rule-I does not apply.

In Chapter 2, the agrammatic patients' comprehension of pronouns in ECM sentences was also tested. Their performance on these constructions was at chance level. I hypothesised that the comprehension problems agrammatic patients encounter when interpreting pronouns in ECM constructions are a specific instantiation of a more general phenomenon related to slower-than-normal syntactic processing. As a consequence of this slowdown, the syntactic information is not available on time for it to be used in the process of interpreting the pronoun. Consequently, the discourse information becomes available relatively faster and wins over syntax resulting in the establishment of a dependency that would be illegal in non-brain-damaged individuals. Nevertheless, the agrammatic patients occasionally manage to construct the syntactic structure on time, which results in a correct response. Their chance level performance in ECM sentences points towards a competition between various levels of grammatical information.

The view on the source of agrammatic errors in pronoun resolution propagated here resembles Grodzinsky *et al.*'s (1993) view in one respect.

In both views brain damage in agrammatic Broca's aphasia results in a reduction of the capacity to use and process language and not in a loss of linguistic knowledge. An important difference between the two views is in the way this lack of processing resources is assumed to manifest itself in agrammatic language comprehension.

The view held by Grodzinsky *et al.* (1993) is that because of short-term memory limitations in this population they fail to apply Rule-I, which is a very specific claim concerning one particular part of linguistic knowledge, a particular constraint, and its implementation. They fail to hold two representations in their short-term memory. I assume that because of a reduction in their capacity to implement syntactic knowledge in time, Broca's aphasic speakers allow alternative ways of encoding information, such as through discourse, to take over. This claim is a more general one that can account for errors committed in different constructions, which are not only related to anaphoric reference assignment.

As was already mentioned, in the experiment that will be discussed here I tested the ability of Broca's aphasic patients to interpret pronouns in structures where the only way to assign reference to a pronoun is by establishing a discourse type of dependency (through coreference). These are instances where the potential antecedent for the pronoun does not c-command it and where the two elements cannot establish a syntactic or variable binding dependency. In such environments Rule-I does not apply since both syntactic or bound variable interpretations are excluded on the basis of structural considerations. If Grodzinsky *et al.*'s (1993) assumption is correct and the source of the agrammatic errors with pronouns lies in their failure to execute Rule-I, then we should see no problems with constructions where Rule-I does not apply. If, on the other hand, these patients experience problems interpreting these constructions, then an alternative explanation for their problems will need to be considered.

The aim of this chapter is twofold:

- Provide more evidence for the claim that the problems agrammatic patients experience with pronouns are not related to a failure to execute Rule-I;
- Examine the pattern of errors agrammatic patients exhibit with pronouns in coordinated constructions and relate this pattern to the findings reported in the previous chapter.

In the following section the types of sentences that were tested in the experiment presented in this chapter will be considered and the constraints that govern reference assignment to the pronoun in these constructions will be described.

3.1.1 Coreference

Two different types of sentences containing pronouns were tested in this experiment. These were complex sentences with two conjuncts joined into one coordinate construction. The first of the two conjuncts contained two referential DPs as potential antecedents for the pronoun that was part of the second conjunct. The difference between the two sentences, exemplified in (1) and (2), was in the position of the pronoun in the second conjunct.

- (1) [Eerst heeft *het meisje* de vrouw geknepen] en [daarna heeft *zij* de man geknepen].
First the girl pinched the woman and then she pinched the man.
- (2) [Eerst heeft het meisje *de vrouw* geknepen] en [daarna heeft de man *haar* geknepen].
First the girl pinched the woman and then the man pinched her.

In (1) the pronoun is in the subject position of the second conjunct and in (2) it is in the object position of the second conjunct.

In both types of sentences a syntactic or a bound variable dependency between the pronoun and the antecedent is impossible. Syntactic chain formation (Reuland, 2001) is barred because both potential antecedents in the first conjuncts in (1) and (2) do not c-command the pronoun, hence cannot form a syntactic chain with the pronoun. Moreover, in both (1) and (2) A-binding as defined by Reinhart (2000) (see Chapter 1, footnote 18) is excluded. According to the definition of A-binding, the crucial requirement for binding is that the antecedent c-commands the pronoun. The potential antecedent *the girl* for the pronoun in (1) does not c-command it, which excludes a bound variable interpretation in this sentence. The same applies to the example in (2), the antecedent DP *the girl* does not c-command the pronoun and variable binding is ruled out.

Nevertheless, if the bound variable interpretation were somehow possible in (1) and (2), then it would be equivalent to the coreferential interpretation. The two would be indistinguishable in these sentences, so an additional test must be performed in order to show that a bound variable interpretation is impossible in these two sentences. This is illustrated in (3) and (4) where a quantified DP *ieder meisje* (every girl) is

used instead of the referential DP *het meisje* (the girl) in (3), and a quantified DP *iedere vrouw* (every woman) instead of the referential DP *de vrouw* (the woman) in (4). Quantified antecedent DPs are non-referential and therefore can only give rise to a bound variable interpretation. In these sentences the quantified DPs do not c-command the pronouns, explaining the absence of the bound variable reading.

- (3) *Eerst heeft *ieder meisje* de vrouw geknepen en daarna heeft *zij* de man geknepen.
First every girl pinched the woman and then she pinched the man.
- (4) *Eerst heeft het meisje *iedere vrouw* geknepen en daarna heeft de man *haar* geknepen.
First the girl pinched every woman and then the man pinched her.

There are two operations through which reference can be assigned to the pronouns in (1) and (2). First, the coreference interpretation relies on discourse conditions, which will be discussed in the following sections. Second, the so-called deictic interpretation is a non-linguistic way of assigning reference. The pronouns in (5) and (6) can in principle refer to an individual not mentioned in the linguistic discourse but present in the visual context and referred to by pointing at this individual. In the case of the example sentences this third individual that is pointed at could be somebody like *grandmother*.

- (5) Eerst heeft *het meisje* de vrouw geknepen en daarna heeft *zij* de man geknepen.
First the girl pinched the woman and then she pinched the man.
(she = girl/woman) (*coreference*)
(she = grandmother) (*deixis*)
- (6) Eerst heeft het meisje *de vrouw* geknepen en daarna heeft de man *haar* geknepen.
First the girl pinched the woman and then the man pinched her.
(her = girl/woman) (*coreference*)
(her = grandmother) (*deixis*)

In the experiment that will be discussed here, the task used was a picture selection task and the coreferential interpretation was the only correct picture given to the participants as an option; the deictic interpretation was not provided and, therefore, I assume that the participants would not consider it. The method and the materials used in the experiment will be dealt with in detail in section 3.2. The deictic interpretation was excluded because the aim of this experiment was to

check the agrammatical patients' pronoun resolution in instances where coreference was the only possible way of assigning a referent to a pronoun.

3.1.2 Parallelism

In the experimental sentences in (1) and (2), identifying the reference of the pronouns *zij* (she)/*haar* (her) is additionally constrained by the requirement of parallelism of grammatical roles (Akmajian & Jackendoff, 1970). Given this requirement of parallelism, the pronominal subject of the second clause in (1) refers to the DP subject of the first clause. Similarly, the DP pronominal object in the second clause in (2) refers to the object of the first clause. However, parallelism can be overridden by pragmatic factors (Kehler, 2000):

- (7) *Mary* hit Sue and then Mr. Smith punished *her*.

According to the parallelism constraint, the pronoun in (7) should refer to the object DP of the matrix clause. However, it is obvious that in a situation where one person hits another, the person that performed the hitting will most likely be punished for doing so; the pronoun in (7), naturally refers to the subject DP, in this case *Mary*.

The pronominal elements in both (1) and (2) can be stressed, which causes a shift in reference. In such cases parallelism is also overridden:¹

- (8) Eerst heeft het meisje de vrouw geknepen en daarna heeft ZIJ de man geknepen.
First the girl pinched the woman en then SHE pinched the man.
- (9) Eerst heeft het meisje de vrouw geknepen en daarna heeft de man HAAR geknepen.
First the girl pinched the woman en then the man pinched HER.

Akmajian & Jackendoff (1970) first brought to attention the effect of stress in shifting the reference of the pronoun. In order to correctly establish reference in this case, one first needs to establish reference on the unstressed reading according to the parallelism constraint, and then shift it.² The contrastive stress rule is a two-step operation. For the

¹ Contrastive stress is indicated by capital letters.

² We have seen in (7), repeated in (i) for convenience, that parallelism can be overridden by pragmatic factors (Kehler, 2000). If contrastive stress is applied to the structure where parallelism is overridden by other factors, reference will once again be shifted back to the object in (ii) DP Sue.

sentences in (8) and (9), the first step entails establishing reference for the pronoun in the unstressed structure under the parallelism constraint. The second step results in shifting or cancelling reference that was established in the first step. The stress rule could be seen as a rule of inhibition; it does not determine which DP should become the antecedent for the pronoun but rather which DP is ruled out as a candidate antecedent for the pronoun. This can be seen in cases where there are more than two such DP candidates.

- (10) Mary introduced *Sue* to Patty and then John introduced *her* to Lisa.
 (11) *Mary* introduced Sue to *Patty* and then John introduced **HER** to Lisa.

In (11) both *Mary* and *Patty* could be interpreted as potential antecedents for *her* but it could never be *Sue*, which is the only possible antecedent in the unstressed sentence (10).

3.2 Experiment 3

In the experiment discussed in this chapter, I tested the ability of agrammatic Broca's aphasic patients to interpret pronouns in sentences such as (1) and (2). As discussed in sections 3.1.1 and 3.1.2, in order to assign reference to the pronoun in these structures, agrammatic aphasic speakers need to be able to assign reference through a discourse operation of coreference. The syntactic and bound variable (semantic) dependencies are excluded on the basis of structural considerations. In addition, participants need to be able to implement the parallelism constraint. Besides the structures in (1) and (2), I also tested sentences where the pronouns were stressed, e.g. (8) and (9), in order to check whether agrammatic patients are sensitive to the fact that stress shifts reference established under the parallelism constraint. This implies that in order to assign reference to pronouns in constructions where they are stressed, the patients must possess the knowledge of the parallelism constraint and be able to apply this knowledge. The conditions where the pronoun is not stressed are the focus of this experiment and the stress conditions are expected to be an extra source of difficulty for the agrammatic patients because they require an additional operation of reversing the interpretation that is established under the parallelism constraint.

-
- (i) *Mary* hit Sue and then Mr. Smith punished *her*.
 (ii) *Mary* hit *Sue* and then Mr. Smith punished **HER**.

3.2.1 Subjects

I tested eight Dutch speaking aphasic patients (the same group of patients as in Experiment 1 discussed in Chapter 2, see section 2.1.4.1).

The performance of the agrammatic speakers was compared to the performance of a control group of 15 Dutch non-brain-damaged speakers (the same group of controls as in Experiment 1) who were matched in age and education to the aphasic speakers.

3.2.2 Materials and procedure

A picture selection task was used to test the participants' interpretations of pronouns in sentences testing subject and object parallelism. The experiment testing these two types of sentences was embedded in a larger experiment examining comprehension of pronouns and reflexives in simple transitive and ECM sentences, which was discussed in the previous chapter (see section 2.1.4.2. for a detailed description of the materials and the procedure). The full experiment consisted of 120 items in total, testing eight conditions of which four are discussed here.

The conditions that were relevant for this study were represented by 60 sentences in total, 15 per condition (see Appendix D for all test sentences). The relevant conditions consisted of pronouns in subject parallelism constructions, stressed and unstressed exemplified in (1) and (2), and pronouns in object parallelism constructions, stressed and unstressed exemplified in (8) and (9).

Similar to the set-up in Experiment 1 discussed in the previous chapter, in the present experiment each experimental item was accompanied by four pictures presented on two pages of A4 size (see Figures 3.1 and 3.2 for examples). The first conjunct was always shown in a single picture on the left page. There were three pictures on the right page. One of these pictures depicted the second conjunct of the sentence; the two other pictures were distractors. The unrelated distractor depicted the same actors but another action (the upper picture in Figures 3.1 and 3.2). In the *Unstressed subject pronoun* condition the related distractor depicted the interpretation where the pronoun referred to the DP functioning as the object of the first conjunct (Figure 3.1, bottom picture: the woman (object DP in the first conjunct) pinching the man). The correct picture is the middle picture, where the girl (subject DP in the first conjunct) is pinching the man. In the *Stressed subject pronoun* condition reference shifts so the correct picture is the bottom picture and the related distractor is the middle picture. In the case of the *Unstressed object pronoun* condition the direct distractor depicted the interpretation where the pronoun referred to the DP functioning as the subject of the

first conjunct (Figure 3.2, bottom picture: the man pinching the girl (subject DP in the first conjunct)). The correct picture is the middle picture, where the man is pinching the woman (object DP in the first conjunct). In the *Stressed object pronoun* condition, again reference is reversed, so the correct picture is the bottom picture and the direct distractor is the middle picture. The subject was asked to listen carefully to both parts of the sentence, look at the pictures and then point at the one that depicted the experimental sentence best.

There were two sessions in which the items were presented in blocks. The first block consisted of 15 sentences in the unstressed conditions mixed with fillers followed by 15 sentences in the stressed conditions mixed with fillers. The second block was the same as first. The reason for this block design was because the pre-test showed that mixing the stressed and unstressed conditions made the experiment too difficult for agrammatic patients. In addition, this type of design allows for an interpretation of the data as belonging to two different experiments, one testing parallelism and the other testing the effects of contrastive stress.

Figure 3.1

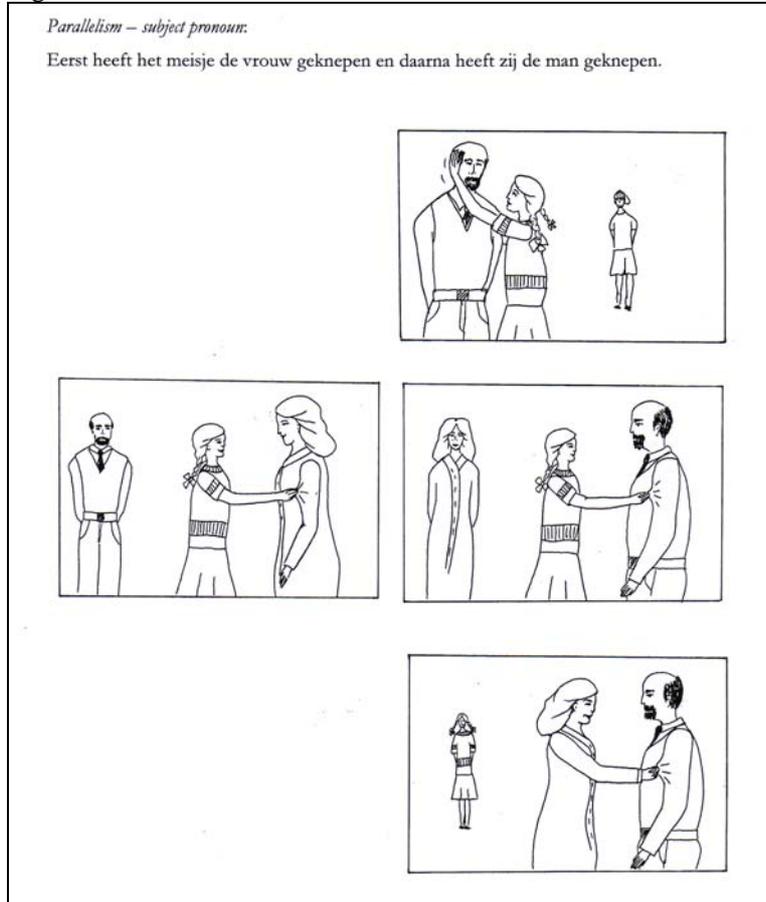
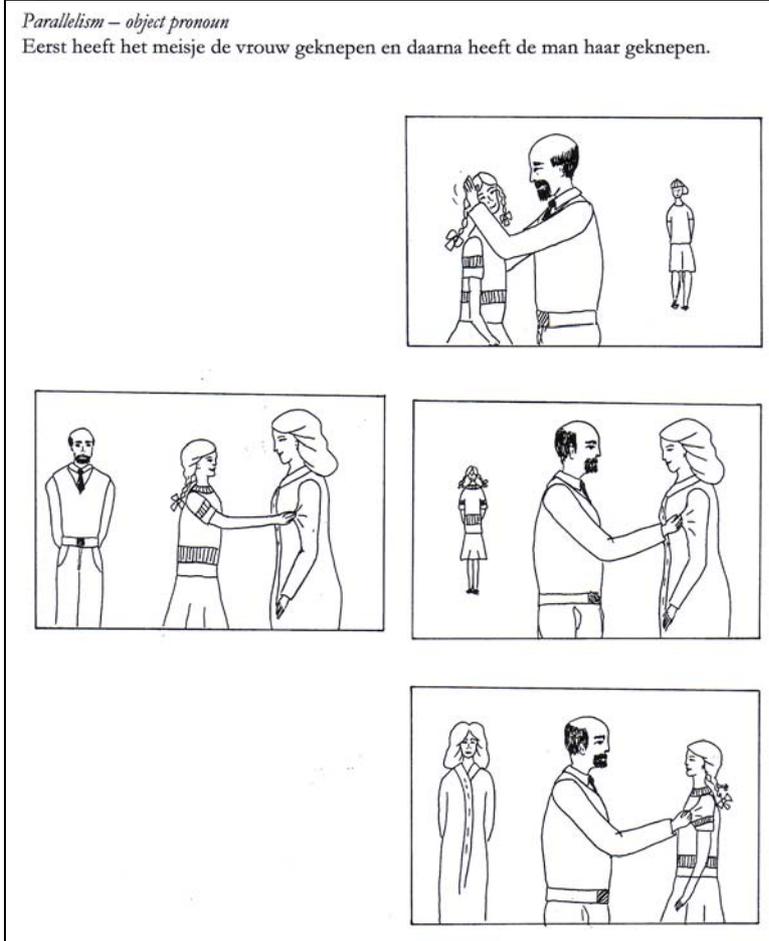


Figure 3.2**3.2.3 Results**

The overall results of the agrammatic patients and the controls, as well as the individual data of aphasic patients are given in Table 3.1. The responses of the agrammatic patients were compared to the responses of the control group using a Mann Whitney U test. The agrammatic patients scored significantly worse on all conditions than the non-brain-damaged speakers (*Unstressed subject pronoun*, MWU: $Z=-3.522$, $p<0.000$; *Stressed subject pronoun*, MWU: $Z=-3.093$, $p<0.001$; *Unstressed object pronoun*, MWU: $Z=-2.506$, $p<0.011$; *Stressed object pronoun*, MWU: $Z=-2.731$, $p<0.005$).

Table 3.1

Total and mean number of correct responses on pronouns in the four experimental conditions for aphasic speakers and the control group.

<i>Broca's</i> (n=8)	<i>Unstressed subject</i> <i>pronoun</i>	<i>Unstressed object</i> <i>pronoun</i>	<i>Stressed subject</i> <i>pronoun</i>	<i>Stressed object</i> <i>pronoun</i>
AD	14/15	8/15	6/15	10/15
AN	11/15	5/15	6/15	13/15
AK	13/15	6/15	6/15	9/15
JW	13/15	9/15	6/15	7/15
AL	10/15	7/15	8/15	8/15
IH	13/15	10/15	7/15	12/15
MJG*	7/15	11/15	4/15	7/15
GK*	11/15	13/15	12/15	2/15
Tot. % correct	76.6	57.5	45.8	56.7
Controls (n=15)	96.4	80.0	81.3	83.5

Note: * indicates two patients who exhibit the reverse response pattern from the rest of the group.

To test whether the agrammatic patients' performance differed on the two crucial conditions (*Unstressed subject pronoun* and *Unstressed object pronoun*), their correct responses on these conditions were compared using a Wilcoxon Signed Ranks Test ($Z=-1.684$, $p<0.09$). No significant difference was found between their performances on these two conditions. The two stressed conditions also did not differ from each other (Wilcoxon: $Z=-1.185$, $p<0.236$). For the controls, on the other hand, a significant difference was found between the two unstressed conditions (Wilcoxon: $Z=-2.944$, $p<0.03$), indicating that their scores were significantly higher on the *Unstressed subject pronoun* condition than on the *Unstressed object pronoun* condition. There was no difference between the two stressed conditions (Wilcoxon: $Z=-0.460$, $p<0.645$).

Taking a closer look at the individual subject data of the agrammatic patients in Table 3.1 reveals an interesting pattern of errors for the unstressed conditions. There are two patients (MJG and GK) who commit more errors on the *Unstressed object pronoun* condition than on the *Unstressed subject pronoun* condition. The six other patients (AD, AN, AK, JW, AL and IH) all exhibit the reverse pattern, making significantly more errors on the *Unstressed subject pronoun* condition (Wilcoxon: $Z=-2.214$, $p<0.03$), like the healthy controls. Because of the two patients whose response patterns deviate from those of the rest of the patients, the difference between the two experimental conditions is obscured and statistically insignificant.

Finally, I examined whether the agrammatic speakers performed differently from chance-level on the four conditions. The patients always

pointed at the direct distractor. Therefore, I assume that chance level performance on this task was 50%, although 33% would be the real chance level when randomly choosing between the three pictures. A binomial test showed that the patients' scores on the *Unstressed subject pronoun* condition did differ significantly from chance level ($p=0.0001$), that is, the patients performed above chance on this condition. The scores on the *Unstressed object pronoun* ($p=0.06$), *Stressed object pronoun* ($p=0.171$) and *Stressed subject pronoun* ($p=0.411$) conditions did not differ from chance level performance.

3.2.4 Discussion

The agrammatic patients performed significantly worse than the non-brain-damaged speakers on all four experimental conditions. They experienced problems with the interpretation of pronouns in structures where a discourse type of dependency must be established between the pronoun and an antecedent DP that does not c-command it. I will first discuss the results on the *Unstressed* conditions, since in order to correctly interpret contrastive stress, the parallelism requirement must first be applied correctly. When treated as a group, all eight patients performed above chance when they needed to interpret the pronoun in the subject position of the second conjunct and at chance level in the condition where the pronoun was in the object position of the second conjunct, that is, in conditions where no stress was applied. Their group performance did not differ between the two unstressed experimental conditions. The controls' performance, on the other hand, did differ in the two conditions. Their scores were significantly higher in the condition where the pronoun was in the subject position of the second conjunct. It should be pointed out that in the condition where they made more errors, *Unstressed object pronoun*, their scores were still significantly above chance (80% correct), which is higher than the agrammatic performance on the *Unstressed subject pronoun* condition.

The agrammatic patients performed at chance level on the two experimental conditions where contrastive stress was applied to shift reference, the *Stressed subject pronoun* and the *Stressed object pronoun* conditions. Their performance did not differ between these two conditions. The chance performance on these conditions is not surprising because these patients already had problems with the unstressed items to which stress must be applied. Applying stress adds yet another operation, which they cannot deal with and they resort to guessing in the cases where contrastive stress is applied to the pronoun. The control subjects performed significantly above chance (80%) on the two stressed

conditions and their performance did not differ between the *Stressed subject pronoun* and *Stressed object pronoun* experimental conditions.

Even in those instances where Rule-I does not apply, agrammatic patients still experience problems in assigning the appropriate referent to the pronoun. They performed at chance level on structures where the pronoun was in the object position in the unstressed condition and on both experimental conditions where contrastive stress was applied. Baauw, Ruigendijk & Cuetos (in preparation) found a similar pattern for Spanish agrammatic patients using the translation of the same materials and the same methodology. Avrutin (personal communication) obtained the same results for Russian agrammatic patients using the same materials and the same method. Avrutin, Lubarsky & Green (1999) tested English Broca's patients' comprehension of parallelism and contrastive stress in constructions with the pronoun in the object position of the second conjunct. Avrutin *et al.* (1999) used the same method as in the experiment discussed here, the picture selection method; they also found chance performance on both parallelism and contrastive stress in the experimental conditions they tested. Unlike in the study presented here, however, they did not test sentences where the pronoun was in the subject position.

I will now focus on the two unstressed experimental conditions. In order to explain the difference in performance on the two conditions, a closer look needs to be taken at the individual data of the agrammatic patients. These reveal two distinct patterns of responses. Six of the eight patients performed significantly worse when they had to interpret structures where the pronoun was in the object position. They interpreted the pronoun significantly more often as referring to the subject DP of the first conjunct where it was supposed to refer to the object DP of the preceding conjunct. The results of the control group also show that the non-brain-damaged subjects performed less well on the condition where the pronoun is in the object position of the second conjunct. The reverse pattern was found with two other agrammatic patients, who performed worse interpreting the pronoun in the subject position. The reverse pattern of these two patients obscures the difference between the two conditions, which as we have seen from the results is not significant in the agrammatic group.

I propose that these two patterns point towards two different ways agrammatic patients assign reference to the pronoun in both types of experimental sentences. One group, the two agrammatic patients that made more errors with pronouns in the subject position, relies on a strategy that implies "go for the most recently activated (closest)

available DP". There are different experimental studies that support the hypothesis that the closer the potential antecedent for the pronoun, the easier it is to process. It has been shown that the reading times for a word for healthy adults increase as linear distance increases between that particular word and the position of the element on which it is dependent (Gibson, 1998, 2000; Grodner, Watson & Gibson, 2000; Gibson & Warren, 2004). Similarly, in a number of studies it has been established that it is easier to assign reference to an antecedent in the same clause than if it is one clause away from the pronoun (e.g. Clark & Sengul, 1979). The difficulty increases as the number of intervening clauses increases, which seems natural since working-memory is also limited so there must be a limit to the distance at which coreference can occur.

In the *Unstressed subject pronoun* experimental condition, exemplified in (12), the object DP *de vrouw* in the first conjunct is the closest or the most active DP in memory at the point at which the pronoun *zij* is encountered. In this case, establishing a dependency between the pronoun and the closest DP results in an incorrect response.

- (12) Eerst heeft *het meisje* *de vrouw* geknepen en daarna heeft *zij* de man geknepen.
First the girl pinched the woman en then she pinched the man.

In the *Unstressed object pronoun* experimental condition, exemplified in (13), the most active and the closest DP that matches the pronoun in person, gender and number is the object DP *de vrouw*, which by accident happens to be the correct response in this condition.

- (13) Eerst heeft het meisje *de vrouw* geknepen en daarna heeft de man *haar* geknepen.
First the girl pinched the woman en then the man pinched her.

I propose that the other group of six patients often fails to implement the parallelism constraint and relies on a discourse rule according to which, in a neutral context, the topic of an utterance is the highest ranked candidate to serve as an antecedent for a pronoun in a consequent utterance. The non-brain-damaged subjects correctly apply the parallelism constraint. However, they also occasionally opt for the topic of an utterance to serve as an antecedent for the pronoun in the following utterance. In the case of example (13) they chose the subject DP *the girl* instead of the object DP *the woman* regardless of the fact that this led to a violation of parallelism. Nevertheless, they did this significantly

less often than the agrammatic patients. In the following sections I will discuss why the agrammatic patients occasionally fail to apply parallelism and why they apply the topic rule, which is what the healthy adults sometimes do, but less frequently.

In order to answer these questions we must take a closer look at the discourse representation. In the following section a model of discourse representation will be presented. Given this model I will describe the discourse operation through which reference is assigned to the pronoun in these sentences. The parallelism constraint will then be rephrased as a syntax-discourse constraint and the failure to apply this constraint in agrammatism will be related to the slow-down in syntactic structure building hypothesized in Chapter 2. Finally, I will discuss the topic preference and explain why agrammatic aphasic patients resort to it when they fail to apply parallelism in the constructions tested in the present experiment.

3.3 General discussion

3.3.1 Discourse model and coreference

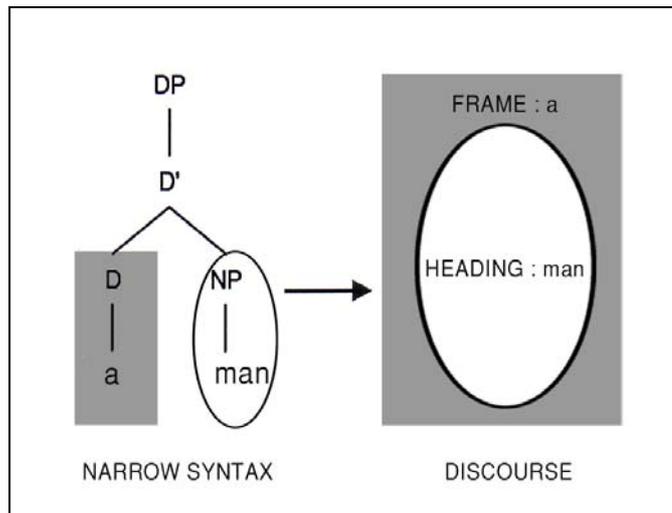
As we have seen in previous chapters, c-command is one of the requirements for the establishment of syntactic dependencies (chains) and semantic dependencies (variable binding). In these cases where the pronoun and the antecedent DP are not arguments of the same predicate and where the antecedent DP does not c-command the pronoun in question, a dependency between the two elements must be established at a different grammatical level. In the sentences tested in this experiment a dependency between the pronoun and an antecedent DP is established through discourse representation. Discourse is a linguistic level at which the information about referents and events is maintained by constantly keeping track of new information and updating the old information. In this section, I will first outline the discourse model that will be used throughout the rest of the study. Secondly, I will describe the way referential dependencies through coreference are created at the level of discourse.

The discourse model I will adopt here is based on Heim's (1982) *File Change Semantics* model and has been elaborated by Avrutin (1999, 2000c, 2004b). It is also known as the *syntax-discourse model* because it explains how the two linguistic modules, narrow syntax and discourse, communicate through the so-called syntax-discourse interface. This communication is essential for the transfer of information since the particular units of the computational system (narrow syntax) are

translated into units of discourse. The information units of discourse are *file cards*, which correspond to functional categories in the syntactic structure. Every time a new functional category is created in the syntactic representation, DP or TP, a new file card is created in the discourse representation. A DP in the syntactic representation initiates the creation of an *individual file card* and a TP triggers the creation of an *event file card*. Here I will focus on individual file cards because pronouns, which are the focus of my study, are generated in the D position of a DP in syntactic structure (Abney, 1987) and trigger the creation of individual file cards.³

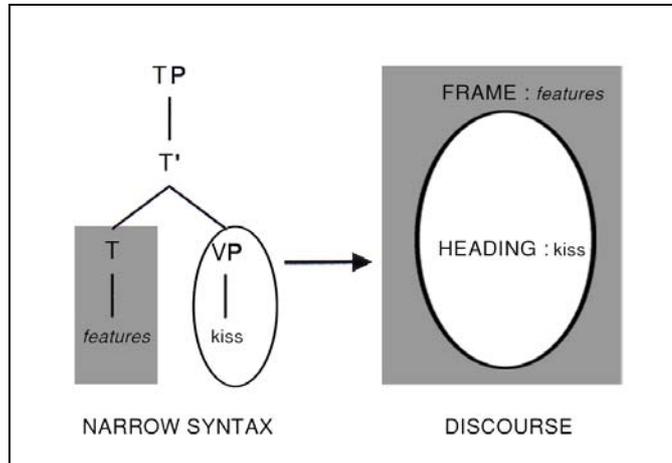
Let us examine the structure of file cards and the way they are created and related to one another through the creation of discourse dependencies. According to Avrutin (2004b), each file card must have a *frame* and a *heading*. An individual file card is exemplified in (14) and an event file card in (15).

(14)



³ According to Abney (1987), similar to the syntactic position of definite articles, pronouns are generated in the D position selecting a *pro* as a NP complement. They also resemble definite articles in their function within discourse; they do not introduce discourse-new topics but refer to an individual or an object already introduced in the discourse.

(15)



In an event card (15) a frame is introduced by a functional category T° (tense features) and in an individual file card (14) it is introduced by a functional category D° , which is the indefinite article *a*. A heading in an event card is introduced by a lexical category VP, a complement of T° (VP *kiss*), and in an individual card by the NP complement of D° (NP *man*). Hence, the frame contains the information about the type of discourse unit, and the heading provides the information about referential content of the unit (person, object, place, event etc.).

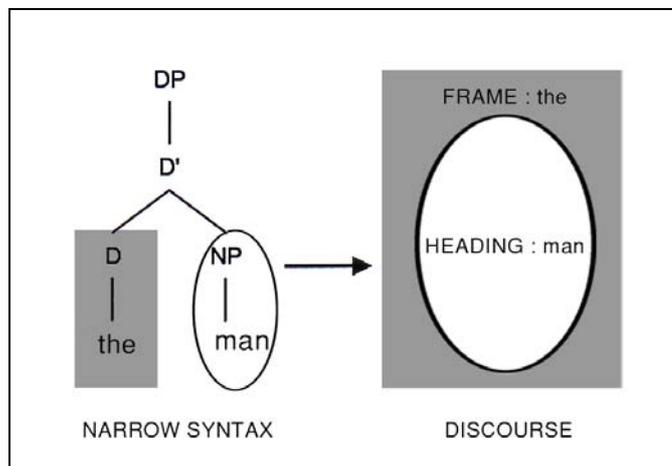
Given Heim's (1982) assumptions about definiteness, an indefinite DP in the syntactic structure triggers the creation of a new file card (discourse-new information), which represents a unique discourse referent. A file card created by a definite DP, on the other hand, refers to discourse-old information and must be connected with an existing card, i.e. an existing discourse referent. This operation is referred to as *incorporation* and it results in the updating of the information associated with an existing file card.

(16) John saw *a man*. *The man* ran away. *He* was terrified.

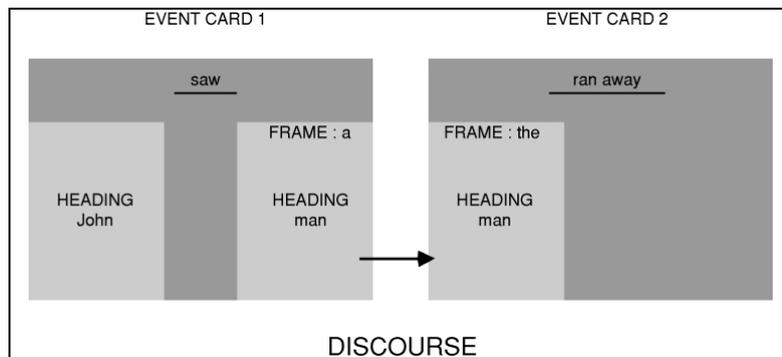
In (16) the indefinite DP *a man* triggers the creation of a new file card, such as in (14), and becomes a unique discourse referent. The definite DP *the man* refers to this particular discourse referent. The definite DP in the second sentence in (16) triggers the creation of a file card with a frame marked for definiteness, see (17), which is a referentially deficient and weak frame. The first two sentences in (16) are represented in discourse by two event cards (event 1 and event 2), illustrated in (18). The heading

of the newly created individual card with a definite and weak frame initiates a search for a file card with a matching heading, which can be found in the previous event.⁴ The information on the new individual file card is then updated through *incorporation*. The information about the discourse referent *a man*, who was specified as *having been seen by John*, is now updated to *having been seen by John & having run away*.

(17)



(18)

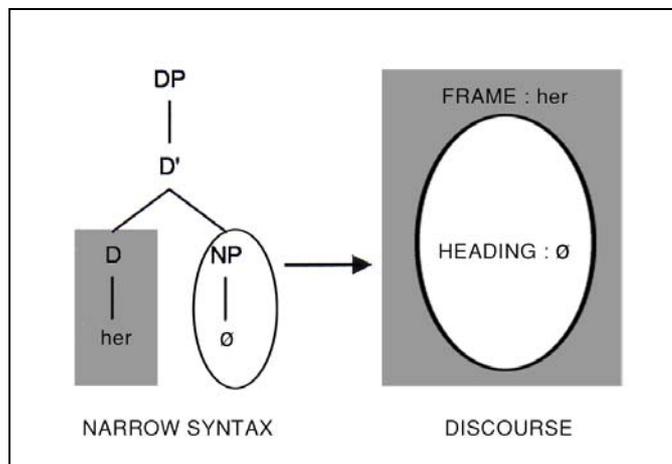


⁴ In the case of an individual file card created by a definite DP both a heading and a frame are present so it might appear unclear why the file card created by a definite DP should be connected a file card created by an indefinite DP. It is beyond the scope of the present chapter to go into this matter in detail. I will limit myself to postulating that a definite DP triggers a creation of a referentially deficient (weak) card and needs support from a full-fledged individual card introduced by an indefinite DP.

3.3.2 Pronouns and file cards

Pronouns are referentially deficient DPs and, unlike full DPs, cannot be interpreted on their own but need to be connected to an antecedent in order to receive full interpretation. Structurally, they are DPs without a complement; therefore, they introduce a file card with a frame but without a heading, as is illustrated in (19).

(19)



As such they violate one of the two conditions of well-formedness on file cards as formulated by Avrutin (2004b), and given in (20). The two constraints are the minimal requirements for the interpretability of any file card.

- (20) a. *There can be no Frame without a Heading.*
 b. *There can be no Heading without a Frame.*

Pronouns must be connected to an appropriate antecedent that will provide them with referential content. The discourse operation through which such a discourse dependency can be established is the *cut & paste* operation.⁵ In the case of the pronoun *he* in (16), the file card

⁵ I follow Avrutin's (2004b) argument that the *copy & paste* operation should be replaced with the *cut & paste* operation because the former would allow the creation of an ungrammatical coreferential dependency between the pronoun and the local antecedent in a simple transitive sentence such as (i), which is represented by a single event card in discourse.

(i) **Mary* kissed *her*.

created by the pronoun will be linked to the file card of the most appropriate antecedent DP available. What determines the most appropriate antecedent will be discussed in the following paragraph in relation to the examples that were tested in the experiment. For the time being, I am focusing on the procedure of establishing a coreference dependency between the pronoun and an antecedent. In example (16) the most appropriate antecedent DP is *the man*. The *cut & paste* operation will update the pronoun's file card, which will receive the referential content of the antecedent file card and a discourse dependency will be formed between the two elements. Through this procedure the pronoun becomes a well-formed discourse unit with a heading carrying referential meaning.

I will now examine the way discourse dependencies are created between pronouns and their antecedent DPs in the two different types of sentences that were tested in the experiment, repeated in (21) and (22).

- (21) Eerst heeft *het meisje* de vrouw geknepen en daarna heeft *zij* de man geknepen.
 First the girl pinched the woman and then she pinched the man.
- (22) Eerst heeft het meisje *de vrouw* geknepen en daarna heeft de man *haar* geknepen.
 First the girl pinched the woman and then the man pinched her.

The two possible antecedents in both sentences are the two DPs given in the first conjunct of the sentence. In the second sentence in (22), the subject DP *the man* in the second conjunct could in principle also be

The *copy & paste* operation allows the file card instantiated by DP *Mary* to update the missing information (heading) on the deficient file card created by the pronoun *her*, which only contains the frame. However, the old individual file card containing information about DP *Mary* remains, which allows for the creation of an illegal coreferential dependency between *Mary* and *her* within the same event. The *cut & paste* operation, on the other hand, correctly disallows the creation of such a dependency because the information contained in the individual file card created by the DP *Mary* cannot be cut and copied onto the file containing the pronoun in the same event card. The event card created by the verb *kiss* contains the information on arity of that particular predicate; since it is a two-place predicate requiring two arguments (two individual file cards in the discourse representation), reducing it to one argument (one file card) would make this event card uninterpretable. Avrutin assumes that there is no transfer of information within the same information unit, event or individual file card. Another operation through which a discourse dependency can be formed is *bridging* or *accommodation*. It will not be discussed here further since it is not relevant for the structures tested in the experiment discussed in this chapter (for details see Avrutin, 2004b).

considered as a potential antecedent. However, an antecedent must match the features (e.g. person, gender, number) that are specified by the frame of the file card instantiated by the pronoun, which is not the case between the DP *the man* and pronoun *her*, as the two do not match in gender. We are left with two potential antecedents, the subject and the object DP of the first conjunct. As saw in section 3.1.2, in (21) and (22) syntactic information about the grammatical role of the constituent plays a role in the way reference is assigned: subject pronoun in the second clause refers to the subject DP in the first clause and object pronoun refers to the object DP. However, it has been suggested that it is not only the parallelism of grammatical roles but also the parallelism of thematic roles that determines reference assignment in these cases (Goodluck, 1991). In the following paragraph, an attempt will be made to reformulate the parallelism constraint.

3.3.3 Parallelism revisited

As was already discussed in section 3.1.2, the parallelism constraint was originally defined as a condition of parallelism of grammatical roles, subject goes to subject and object goes to object. A subject of an utterance is configurationally defined and refers to a syntactic position [Spec, IP] and an object in an utterance, such as the ones tested in this experiment, is a DP complement of a verb. A DP in the subject position of an active sentence is most likely to carry the thematic role of an *agent* and a DP in an object position is most likely to be the *patient* of the action expressed by the verb in question. Like any other DP in the syntactic structure, both subject and object DPs trigger the creation of individual file cards in discourse representation. The file card instantiated by the subject DP is marked as *agent* and an object DP instantiates an individual file card specified as carrying a *patient* thematic role.

The parallelism constraint can now be reformulated as the parallelism of thematic roles applying at the syntax-discourse interface. The information about the thematic role of a particular DP is mapped onto a file card created in discourse as *agent* or *patient*. In the case of the experimental sentences such as (21), the pronoun file card is marked as *agent* and referentially deficient, i.e. it lacks a heading. Therefore, it will establish a discourse dependency through a *cut & paste* operation with a file card that matches the thematic information of being *agent*. The same applies to sentences such as (22); the pronoun file card is marked as *patient*; it will be connected with a file card marked as *patient* too in order to receive its referential content.

pronoun in the second conjunct in (23), which is also the *patient*, refers to the *patient* DP of the first conjunct regardless of the fact that the two are not parallel in terms of grammatical roles. The same applies to the example in (24): the subject pronoun, which is the *agent*, refers to the grammatically non-parallel *agent* of the first conjunct.

It seems that what is parallel in the interpretation of pronouns in sentences such as the ones I tested are not only the grammatical roles but also the thematic roles. I will describe now how the parallelism constraint should work at the level of discourse representation and be applied to the experimental sentences repeated in (25) and (26).

- (25) Eerst heeft *het meisje* de vrouw geknepen en daarna heeft *zij* de man geknepen.
First the girl pinched the woman en then she pinched the man.
- (26) Eerst heeft het meisje *de vrouw* geknepen en daarna heeft de man *haar* geknepen.
First the girl pinched the woman en then the man pinched her.

The *agent* of the second conjunct in (25) is a DP *zij*, which in discourse triggers the creation of an individual file card marked as *agent*. Because this file card lacks a heading, it will establish a discourse dependency through a *cut & paste* operation with a matching file card that is also marked as *agent*. In the case of (25) it is the individual file card instantiated by the *agent* DP *het meisje* of the first conjunct. The information from this file card will be cut and pasted onto the pronoun file card in order to provide it with referential content (heading). Similarly, the file card associated with the *patient* DP *haar* in the second conjunct in (26) will establish a dependency with the file card that is marked as *patient* in the first conjunct. This is the file card associated with the *patient* DP *de vrouw* in the first conjunct.

So, in order to correctly interpret such coordinated sentences three different kinds of information need to be consulted. First, the syntactic structure must be computed and become available for the patients in order to assign the grammatical roles to the DPs, in the first conjunct first and then in the second conjunct. Secondly, the lexical-semantic knowledge of thematic roles has to be supplied by the verbs in relation to the syntactic structure in both conjuncts. Thirdly, the discourse knowledge of parallelism must be applied, according to which the relationship between entities must first be established in the first conjunct and then applied in parallel in the second conjunct. Finally, all

this information must be retained in short-term memory for both conjuncts in order to apply parallelism.

As I put forth in the previous chapter, the brain damage in Broca's aphasic patients results in protracted syntactic structure building which, in turn, allows other linguistic levels, such as discourse, to provide the source of reference although it should not. Following the same reasoning, I assume that the syntactic structure building in the sentences tested in the present experiment is also protracted. In addition to the timely availability of syntactic information in these sentences, the semantic information must also become available on time and the discourse constraint on parallelism, dependent on both syntactic and semantic information, also needs to be computed on time. The timely availability of both structural and semantic information is disturbed in agrammatic patients; this information is also not retained in memory long enough for it to be used while computing parallelism. They therefore fail to apply parallelism but their errors are not random. There is another rule, an escape hatch provided by discourse which takes over as a kind of a default rule when their system runs into trouble with these types of sentences. This rule is the topic preference also at play in healthy adults who use it as an escape route when there is ambiguity in the form of a number of different antecedent candidates for the pronoun. In the following section I will discuss topic preference.

3.3.4 Topic preference

Theories of discourse representation and formal approaches to discourse coherence have assumed that assignment of reference to a pronominal element in ambiguous contexts with more candidates for an antecedent follows a rule-guided ranking of the candidate DP antecedents. Both Ariel's (1990) Theory of Accessibility and Centering Theory (Grosz, Joshi & Weinstein, 1995) hypothesise that when two DPs appear in an utterance (n) and a pronominal element appears in utterance (n+1), the DP that is the topic of the utterance (n) is more likely to be interpreted as the referent of the pronominal element than any other DP.⁶ This preference for the topic is demonstrated in (27) below:

⁶ The reason the notion topic is used instead of subject is because I am discussing rules that apply at the level of discourse representation. Subject is a syntactic notion that is not applicable at discourse level.

- (27) a. A long time ago *Mary* quarrelled with Sue.
b. *She* thought that was the end of their friendship.
c. Peter thought *she* would never get over it.

In (27a) both *Mary* and *Sue* are possible candidates for the reference of the pronoun *she* in (27b) and in (27c). However, most speakers have a strong preference for the topic in utterance (27a) as the antecedent for the pronoun in (27b) and (27c). Although this preference for the topic can be overridden by pragmatic cues (e.g.: *Mary gave Sue a present. She was grateful*), it is taken to be a basic principle in reference resolution, one that might serve as a default option when no other cue is available. This principle will become an important factor in explaining the aberrant aphasic performance in relation to the parallelism constraint.

Evidence for the validity of the topic preference comes from corpus studies which show that in both spoken and written language a pronoun which is preceded by two gender/number matching DPs is more likely to refer to the DP that is the topic of an utterance. Pander Maat & Sanders (submitted) analysed 100 passages from newspaper articles in Dutch. They focused on instances where the pronoun could refer to more than one possible antecedent in the previous utterance. From the 100 tokens they checked, in 70 cases the pronoun had two candidate antecedents in the preceding clause. In 76% of the cases the referent for the pronoun was the topic of the preceding utterance. An additional piece of evidence for the validity of topic preference comes from speakers' judgements of discourse coherence and is given in Grosz *et al.* (1995). These authors show that even in cases where speakers show little or no preference for the topic, such preference can be uncovered through judgements of utterances that follow the relevant pronoun. This is demonstrated in (28).

- (28) a. Suzan gave Betsy a pet hamster.
b. She reminded her that such hamsters were quite shy.

Grosz *et al.* (1995) report that many people at this point did not show a clear preference for the topic (DP *Suzan*). However when a third utterance was added, it drastically affected people's judgments and revealed that a hidden preference for the topic antecedent was present from the moment the pronoun was encountered. This is demonstrated in (29).

- (29) a. Suzan gave Betsy a pet hamster.
b. She reminded her that such hamsters were quite shy.
c. She asked Betsy whether she liked the gift.
d. She told Suzan that she really liked the gift.

The authors report that people's judgments changed into disfavoured and sometimes rejecting sentence (29d). If at the point of the second utterance there was no preference towards *Suzan* as the antecedent, we should have expected no difference between (29c) and (29d). The fact that such preference is attested can be taken as evidence that *Suzan* was ranked higher than *Betsy* as a possible antecedent. Additional evidence is provided by experimental studies (Hudson, Tanenhaus & Dell, 1986; Hudson-D'Zmura & Tanenhaus, 1997; Gordon & Searce, 1995) which show that ambiguous pronouns refer to the subject of the previous utterance even in situations where there are competing cues, such as pragmatic plausibility and causal bias associated with verbs (see also Chambers & Smyth, 1998).

This is a very important finding, which I assume was also at work in the healthy adults when they were tested experimentally, on the sentences described in this chapter. However, I will first reconsider the results on parallelism reported by Solan (1983). He claimed that the adults he tested relied equally on the parallelism of grammatical and thematic roles. I would like to suggest that they relied either on the parallelism of thematic roles or the topic preference, rather than what Solan claimed. In the sentences he tested, a mismatch between grammatical roles and a match between thematic roles gave a correct response. The pronoun (see examples (23) and (24)) in the second conjunct was always in the subject position and so the match of thematic roles had to involve a mismatch of grammatical roles. It is also the case that the match in grammatical roles allowed the subject pronoun to refer to the subject of the first conjunct. It could be the case that instead of using parallelism of grammatical roles as a condition on pronoun resolution, the subjects were relying on topic preference. There is no way of distinguishing between the two options on the basis of Solan's results.

In the experiment discussed in this chapter, besides pronouns in the subject position of the second conjunct, I also tested pronouns in the object position of the second conjunct. The latter is the crucial condition that points towards a competition between topic preference and parallelism of thematic roles. The healthy adults in my experiment made significantly more errors in the object pronoun condition than in the subject pronoun condition. Their performance was nonetheless above

chance on this condition. This means that they allowed the pronoun in this condition to refer to the subject, which was also the topic of the preceding utterance. This choice represents a violation of the parallelism constraint, allowing the topic preference to occasionally take over. In the subject pronoun condition, on the other hand, they hardly ever allowed the pronoun to refer to the object of the preceding utterance because both parallelism and topic preference point to the same referent – topic of the first conjunct.

The same competition is at work in agrammatic patients and crucially it is more expressed than in the healthy adults. The agrammatic patients perform at chance with pronouns in the object position. The slower-than-normal syntactic structure building in agrammatism results in other cues, such as topic preference, becoming available sooner than in healthy adults and competing with syntax even more prominently in providing the information for pronoun resolution. To my knowledge, there have been no other comprehension studies examining topic preference in agrammatic Broca's aphasia.

3.3.5 Agrammatic data

The results of the experiment discussed in this chapter showed individuals with Broca's aphasia performed at chance level in the condition, repeated where the pronoun is in object position and they performed above chance in sentences where the pronoun is in subject position. It appears as if the agrammatic patients obey the parallelism constraint in one experimental condition and in the other condition they fail to do so. I argue that they generally fail to implement the parallelism constraint in both conditions. As a result of this failure they are often left with an ambiguous context and they resort to topic preference as the default mechanism for assigning reference in such contexts.⁷

As we have seen in the previous chapters, the Primitives of Binding model assumes a hierarchy of levels and consequently of the operations that occur at these levels through which reference can be assigned to a pronominal element (in healthy adults). What seems to be the case is that if reference can be assigned through a syntactic operation, this option will block all other operations through which reference can possibly be assigned. The system works in such a way that there is a competition between modules and its core, narrow syntax, always wins because it is the most automatic and economical route of resolving reference. The

⁷ The controls also perform less well on the object condition but they are still significantly above chance.

rules that apply at this level are absolute and structures are either grammatical or ungrammatical. The discourse level, on the other hand, can be influenced by pragmatics so the competition between these two levels is different and the outcome is less clear than when a syntactic route is an option. The more one gets removed from the core, the easier it is to use the alternative routes, the less strict the rules are, hence, the more options there are. At the level of discourse there are no absolute rules but preferences, often couched in terms of a competition between different constraints.

As we saw in the previous chapter, the agrammatic performance on pronouns in ECM sentences reveals a competition between the grammatical levels, syntax and discourse, in which one of the two will provide the information on the assignment of the appropriate referent for the pronoun. In the case of the experimental sentences tested and discussed in this chapter, the competition is not between different levels but between two discourse mechanisms. One mechanism is the parallelism constraint, which requires an amount of resources that exceeds their capacity. The other is the topic preference, which seems to operate as a basic rule of pronoun resolution in ambiguous situations.

The relationship and the competition between the grammatical levels discussed in the previous chapter and the constraints discussed here is dynamic and what makes one win over another is not yet clear. However, chance performance is an indicator of such a competition. In section 3.3.3, I addressed the issue of why the agrammatic patients often fail to apply parallelism. In order for them to correctly apply this constraint, they need to have the syntactic and lexical-semantic information for both conjuncts available on time in order to map it onto discourse. They also have to retain in their working memory the relations between the entities; the file cards in each event. This exceeds their processing capacity and the default topic preference comes into play and provides the antecedent for the pronoun. In the subject pronoun condition (25), there is no difference between the antecedent assigned through parallelism and through topic preference. In both cases it is the topic, which is the correct antecedent for the pronoun and that is why most Broca's patients score above chance in this condition. However, in the object pronoun condition (26) applying topic preference yields an incorrect response.

Finally, I predict that in order to provide additional evidence for the failure of agrammatic patients to correctly apply the parallelism constraint, it would be interesting to test sentences (23) and (24) discussed in section 3.3.3. In these sentences the first conjunct is identical

to that of the experimental sentences in (25) and (26), and it is an active sentence. The second conjunct is a passive sentence where the thematic roles are reversed; the subject carries a patient role and the second DP carries an agent role. The agrammatic patients are predicted to perform at chance level on sentences such as (23) as a result of the competition between the parallelism constraint and the topic preference; they are predicted to perform above chance in (24) because the agent is also the topic of the first utterance.

3.4 Conclusion

The aim of this chapter was to examine the comprehension of pronouns in environments where Rule-I does not apply. I tested two types of conjoined constructions with the pronoun in the subject or object position of the second conjunct. The only way to establish reference in such sentences is through the discourse operation of coreference. The agrammatic patients performed at chance level on these sentences, which indicates that the errors they make when interpreting pronouns are not limited to instances where Rule-I is at work.

The error pattern Broca's patients exhibited, was related to a competition between two different constraints that apply at the level of discourse. The competition discussed here differs from the one discussed in the previous chapter in that it is a competition between rules within the same module and not between different modules. In the present chapter I argued that in the experimental sentences parallelism of thematic roles and topic preference compete in both healthy adults and in agrammatic aphasic patients. In the non-brain-damaged adults parallelism of thematic roles seems to be the preferred way of assigning reference to the pronoun and topic preference occasionally comes into play when pragmatic cues create an ambiguity which imposes more load on the processing. In the agrammatic patients, the slower-than-normal syntactic processing argued for in the previous chapter creates an ambiguous situation where the patients resort to a default rule of topic preference that comes into play when they are in doubt and need to interpret the pronoun without all the thematic information available to rely on the constraint of parallelism of thematic roles.

Chapter 4

Interpretation of pronouns in elided VP constructions

4.1 Introduction

In Chapter 2 I explored the relationship between the syntactic and the discourse modules and the way this relationship is reflected in the comprehension of pronouns in agrammatism. I argued that the error pattern observed in this population could best be explained on the basis of a disturbed hierarchy of referential dependencies. As a consequence of brain damage, the most automatic and economical module, narrow syntax, becomes slower, which allows other ways of encoding information to take over. In particular, the discourse module takes over, and the coreferential interpretation becomes available sooner than, or at least as soon as the syntactic interpretation, and the agrammatic patients use it to assign reference to the pronoun. In Chapter 3 I discussed results that show that in coordinated constructions where Rule-I does not apply, agrammatic patients have difficulties with the coreferential (discourse) interpretation of pronouns. The results of this study also point towards a competition of two different constraints operating at the level of discourse. So, the focus of the two previous chapters was on the competition between two modules, syntax and discourse, as well as on the competition between two types of constraint that apply at the level of discourse.

In the present chapter the focus will be on the interpretation of possessive pronouns in VP-ellipsis constructions, such as (1).

- (1) John paints his car and Steven (does) too.

These constructions represent one and the same structure where two different operations belonging to two distinct linguistic modules, variable binding (semantics) in (2) and coreference (discourse) in (3), give rise to two different interpretations.

- (2) Bound variable interpretation:
John paints John's car and Steven paints Steven's car.

(3) Coreference interpretation:

John paints John's car and Steven paints John's car.

As such, VP-ellipsis constructions represent an ideal test case for the availability of different interpretations in agrammatism and the relationship between the semantic and the discourse modules in this population.

First, I will discuss the formal characteristics of elided VPs, with the focus on structures that contain pronouns. I will also discuss experimental studies that have examined the processing of these structures in healthy adults and relate the results of these studies to the economy hierarchy of the Primitives of Binding model. Then the experiment testing the comprehension of pronouns in these structures in agrammatic patients will be presented and the results revealed. Finally, in the general discussion section I will relate the error pattern agrammatic patients exhibit in this domain to the general slow-down in syntactic processing, already argued for in the preceding chapters, which affects the timely availability of interpretations related to the semantic and discourse levels. As will become clear from the results of my experiment, agrammatic patients rely heavily on semantic information in assigning reference to the pronoun in the elided VPs tested in this experiment.

4.2.1 VP-ellipsis

The classical elided VPs such as (4a) have received considerable attention in linguistic theory (Sag, 1976; Williams, 1977; Fiengo & May, 1994; Reinhart, 2000; among others).

- (4) a. Peter likes cars and Stuart <e> too.
 b. Peter likes cars and Stuart <likes cars> too
 c. Peter (λx (x likes cars)) and Stuart (λx (x likes cars))

The second conjunct in (4a) is realised as the phonetic string *Stuart too*. Yet, it is interpreted as *Stuart likes cars too* (4b). It has been assumed that the verb phrase in the second conjunct is reconstructed as a copy of the verb phrase of the first conjunct. Specifically, the process of predicate abstraction forms a mental representation of the first conjunct. Then this abstract predicate is pasted into the empty predicate slot indicated as <e> in (4a) through a process of conversion giving rise to the interpretation represented in (4b) and (4c). Specifically, through the process of lambda abstraction the argument DP of the first conjunct is

replaced by a variable bound by a lambda (λ)–operator, exemplified in (4c). This abstract predicate is then copied into the empty predicate slot in the second conjunct. Finally, through a process called lambda conversion the variable (x) in the second conjunct receives the value of its local specific argument NP *Stuart* and the whole predicate in the second conjunct is interpreted as *Stuart likes cars*.

The situation becomes more complex and the sentence becomes multiply ambiguous when the first conjunct contains a pronoun, as exemplified in (5a) and (5b).

- (5) a. Bill touches *his* dog and John < e > too.
 b. Bill touches *Bill's/third person's* dog and John <touches *John's/Bill's/third person's* dog>

The second conjunct, when reconstructed, gives rise to different interpretations. The second conjunct in sentence (5a) has three possible interpretations derivable from different sources of information through which reference can be assigned. Let us look closely at the different interpretations and their sources, in particular at the levels of grammatical representation at which they are established.

The *semantic interpretation* of (5a) derived from *variable binding* is represented in (6a and 6b), and is also known as the “sloppy reading” (Reinhart, 1983, 1986, 2000; Fiengo & May, 1994; Johnson, 2001).

- (6) a. Bill touches Bill's dog and John touches John's dog
 b. Bill (λx (x touches x 's dog)) and John (λx (x touches x 's dog))

At the semantic level the pronoun is treated as a variable (x) that receives a referential value locally. In the first conjunct it derives its reference through variable binding and is bound to the local DP *Bill* where *Bill touches (his own, i.e. Bill's dog)*. Similarly, in the second conjunct the semantic formula is copied and the “pronoun” also derives its reference through variable binding and is bound to the local DP *John* where *John touches (his own, i.e. John's dog)*.

The second possible interpretation of (5a) is the *discourse interpretation*, derived from *coreference* and exemplified in (7a) and (7b).

- (7) a. Bill touches Bill's dog and John touches Bill's dog.
 b. Bill (λx (x touches z 's dog) & z =Bill) and John (λx (x touches z 's dog) & z =Bill)

The pronoun is assigned a fixed discourse referent in the first conjunct, a file card instantiated by the DP *Bill* in this case, and then the whole event card is copied in the second conjunct. The discourse interpretation is also known as the “strict reading”.

Finally, there is a third interpretation of (5a), represented in (8a) and (8b), which is derived through *deixis*, also known as the “other strict reading” (Fiengo & May, 1994; Thornton & Wexler, 1999; Johnson, 2001).

- (8) a. Bill touches Sam’s dog and John touches Sam’s dog.
 b. Bill (λx (x touches z’s dog) & z=Sam) and John (λx (x touches z’s dog) & z=Sam)

This interpretation is similar to the *discourse* interpretation in (7a) & (7b) because here too the pronoun is assigned a fixed referent in the first conjunct, which is then copied in the second conjunct. However, the pronoun in the first conjunct in (8a) does not refer to a discourse referent but to some individual called *Sam*, which is an antecedent not present in the sentence (discourse). I refer to this interpretation as “*non-linguistic*” because the antecedent for the pronoun in the first conjunct is not derived from the linguistic context but from a general context and consequently copied in the second conjunct.

4.2.2 Processing in non-brain-damaged adults

The correct interpretation of elided VPs with pronouns, therefore, requires co-ordination of various kinds of information. The listener needs to be able to construct the syntactic representation of both conjuncts in real time. Specifically, in order to obtain the appropriate interpretation (or interpretations) of the second conjunct, first the syntactic representation of the first conjunct needs to be constructed and its meaning computed, and then this needs to be copied into the second conjunct. As will be discussed below, these operations need to be co-ordinated in time.

There are a few online experimental studies (Shapiro & Hestvik, 1995; Shapiro, Hestvik, Lesan & Garcia, 2003; Frazier & Clifton, 2000) that have examined the processing of anaphoric elements in VP-ellipsis in unimpaired adults. Adult speakers exhibit a preference for the bound variable interpretation (semantic dependency), such as (6a) and (6b), over coreference (discourse dependency), exemplified by (7a) and (7b). An explanation why this semantic dependency is preferred can be found in the economy hierarchy of referential dependencies (Reuland, 2001), as outlined in detail in Chapter 1, section 1.2.3.1.

4.2.3 Processing in Broca's aphasia

The present chapter addresses the comprehension of VP-ellipsis by individuals with agrammatic Broca's aphasia. In Chapter 2 I argued that Broca's patients' limited processing resources results in a slower-than-normal lexical access. The slow-down in accessing lexical items affects the process of insertion of lexical items in the numeration in narrow syntax, which is why the construction of syntactic structure is also protracted. Nevertheless, there is a point at which syntactic structure is fully formed but this point is delayed in comparison to that of non-brain-damaged adults.

So, how does this slow-down affect the processing of VP-ellipsis constructions with pronouns? If the building of syntactic structure in agrammatism is indeed slower-than-normal, then all other levels such as semantics and discourse may be affected as well. I argue that the sequential order of operations as stipulated in the theoretical approach here is actually reflected in real time. A conservative hypothesis is that in real time these two operations are ordered as well; semantic operations take place before discourse operations. In the case of VP-ellipsis, the first conjunct needs to be interpreted for the information to be copied into the second conjunct. In agrammatic patients, the costlier interpretations of the first conjunct become available "too late" for the second conjunct to receive the meaning associated with these interpretations. If this is the case, I expect to find better performance on one of the available interpretations that is "cheaper" and available earlier in time, and possibly poorer performance on the interpretation that is more "costly" and available later in time. According to the economy hierarchy, the semantic (bound variable) interpretation is cheaper than the discourse (coreference) interpretation. Therefore, I expect that agrammatic patients will perform better when dealing with semantic dependencies than when interpreting discourse dependencies.

4.3 Experiment 4

In this experiment elided VP constructions in Dutch, such as the one illustrated in (9), were examined.^{1,2}

¹ The sentences I tested here are slightly different from the classical elided VP constructions discussed in section 4.2.1., repeated in (i).

(i) De oma fotografeert haar paard en de vrouw ook.

The grandmother photographs her horse and the woman too.

In this experiment I focused on the ambiguity between the two possible ways pronouns can be interpreted in the elided VP. Therefore, it was crucial that the two interpretations, bound variable (sloppy interpretation) and coreference (strict

- (9) De oma fotografeert haar paard en de vrouw **doet dat ook**.
The grandmother photographs her horse and the woman does so too.

The aim of this experimental study was:

- To investigate whether agrammatic patients can obtain both *semantic* (bound variable) and *discourse* (coreference) interpretations for the pronoun in the elided VP;
- To determine whether one of the two is preferred if agrammatic patients are given a choice between the two interpretations;
- To determine whether the preference these patients exhibit correlates with the economy hierarchy.

In the remainder of this chapter the experiment testing the aphasic comprehension of pronouns in VP-ellipsis constructions will be described and its results discussed. In the discussion section I will argue that the hierarchy of referential dependencies as proposed in Primitives of Binding is reflected in the way the referential dependencies in these particular constructions are processed.

4.3.1 Subjects

I tested six Dutch-speaking agrammatic aphasic patients (of the eight patients tested in Experiment 2 discussed in Chapter 2). Of the six agrammatic patients, four were female and two male with an average age of 58 years (range 41-73 years). (Individual patient data and the AAT scores of each of these patients are given in Appendix A, Tables A.1.1 and A.1.2).

The performance of the agrammatic patients was compared to the performance of a control group of eleven Dutch non-brain-damaged speakers (2 male, 9 female; mean age 31, range 19-69 years).

interpretation), are both plausible in these sentences. When I pre-tested the classical VP-ellipsis sentences such as (i), the adult Dutch informants rejected the coreferential interpretation overwhelmingly. In sentences such as (10), the two interpretations were both plausible for the informants that were pre-tested, which is why I chose to test these particular constructions. As far as I am aware, the status of the structure, i.e. it being true VP ellipsis or not, does not affect the ambiguity between the two interpretations and subjects' preference for one of the two.

² The data gathered in this experiment have also been published in a slightly different form (Vasić, Avrutin & Ruigendijk, 2006).

4.3.2 Materials and procedure

A picture selection task was used to test the participants' comprehension of the target sentences. Prior to the presentation of the target sentence, the characters that would perform actions were introduced in a separate picture presented on the left side (see Figures 4.1, 4.2, 4.3 and 4.4 for examples). The introduction of the characters was done extremely carefully, making sure that the participants would pay close attention to the animals that the characters were associated with. Each participant was presented with the target sentence orally and was then asked to choose one out of three pictures that corresponded best to the sentence they heard. The experiment consisted of three conditions with 10 items per condition and 30 filler sentences (giving a total of 60 items, see Appendix E for all items from the test conditions).

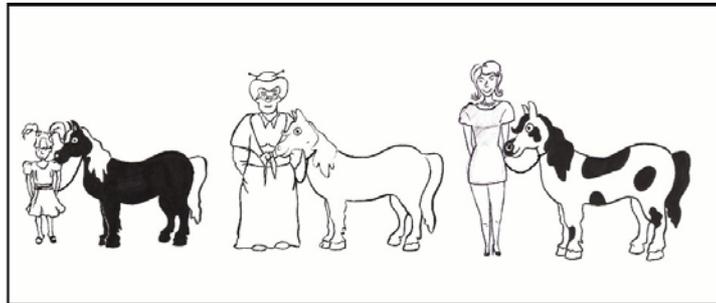
Introduction of characters (see Figure 4.1):

Dit is een meisje met haar eigen paard dat zwart is, een oma met haar eigen paard dat wit is en een vrouw met haar eigen paard dat zwart-wit is.

This is a girl with her own horse that is black, a grandmother with her own horse that is white and a woman with her own horse that is black and white.

Figure 4.1

Introduction picture



In the first half of the experiment patients were presented with the following conditions:

1. BOUND VARIABLE ONLY (BV-only) (see Figure 4.2)

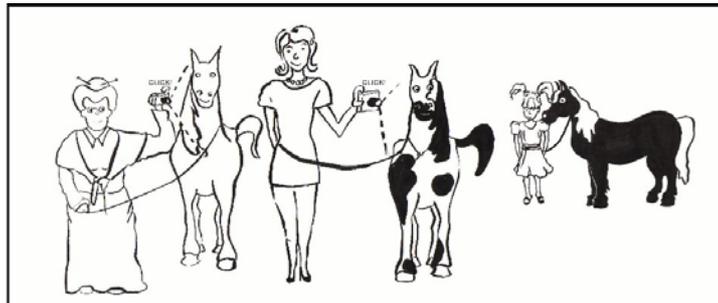
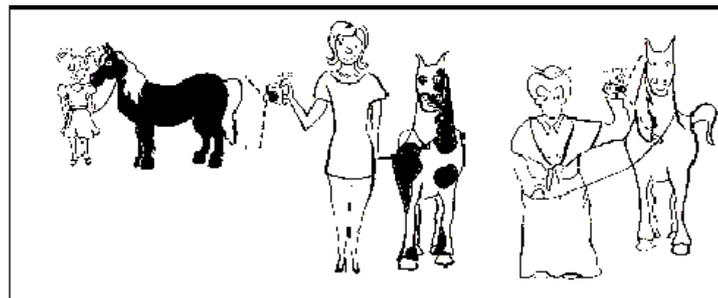
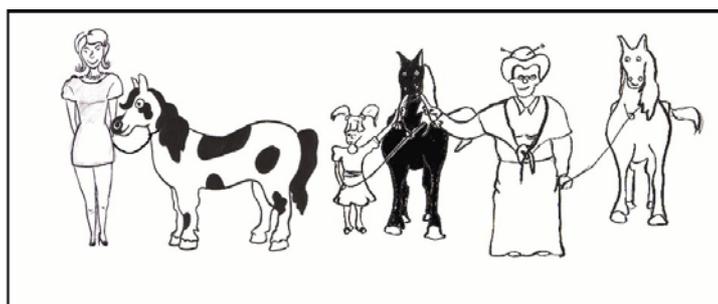
TARGET sentence:

De oma fotografeert haar paard en de vrouw doet dat ook.

The grandmother photographs her horse and the woman does too.

Picture 1 (correct picture): grandmother photographs grandmother's horse and woman photographs woman's horse (girl standing next to them with her own horse);*Picture 2* (related distractor): grandmother photographs grandmother's horse and woman photographs girl's horse;*Picture 3* (unrelated distractor): the same participants performing a different action or different participants performing the same action (photographing).**Figure 4.2**

Example BOUND VARIABLE – only condition

Picture 1*Picture 2**Picture 3*

If the bound variable interpretation (semantic dependency) is available, then *Picture 1* should be chosen; otherwise the participants could choose a related distractor - *Picture 2* or an unrelated distractor - *Picture 3*.

2. COREFERENCE ONLY (CO-only)

TARGET sentence:

De oma fotografeert haar paard en de vrouw doet dat ook.

The grandmother photographs her horse and the woman does too.

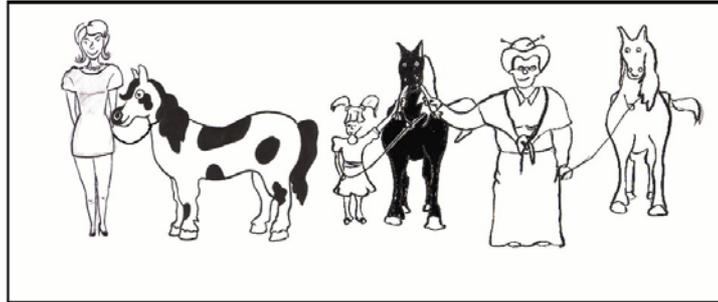
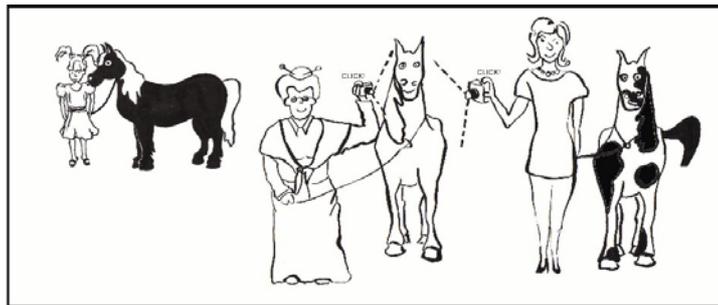
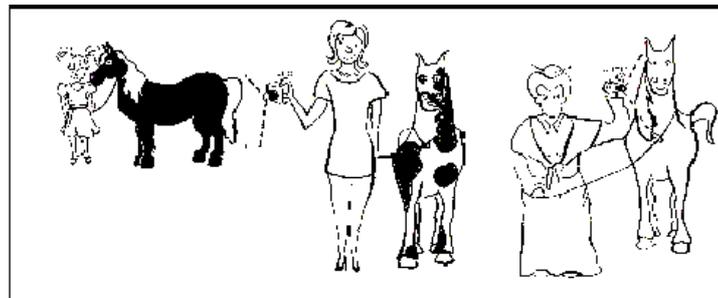
Picture 1 (unrelated distractor): the same participants performing a different action or different participants performing the same action;

Picture 2 (correct picture): grandmother photographs grandmother's horse and woman photographs grandmother's horse (girl standing next to them with her own horse);

Picture 3 (related distractor): grandmother photographs grandmother's horse and woman photographs girl's horse.

Figure 4.3

Example COREFERENCE – only condition

Picture 1*Picture 2**Picture 3*

If the coreference interpretation (discourse dependency) is available *Picture 2* should be chosen, otherwise the participants could choose an action related distractor - *Picture 3*, or an unrelated distractor - *Picture 1*.

In order to test a possible preference, in the second half of the experiment subjects were presented with the condition where they could choose between the two possible interpretations:

3. BOUND VARIABLE vs. COREFERENCE (**BVCO**)

TARGET sentence:

De oma fotografeert haar paard en de vrouw doet dat ook.

The grandmother photographs her horse and the woman does too.

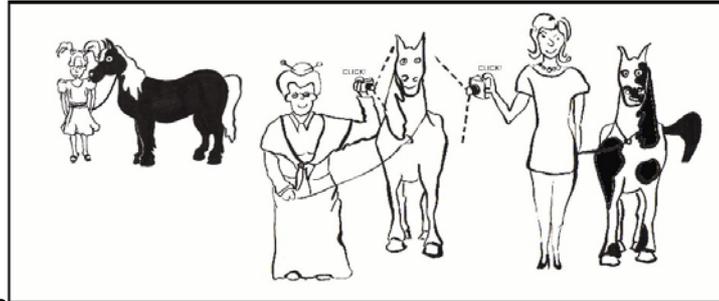
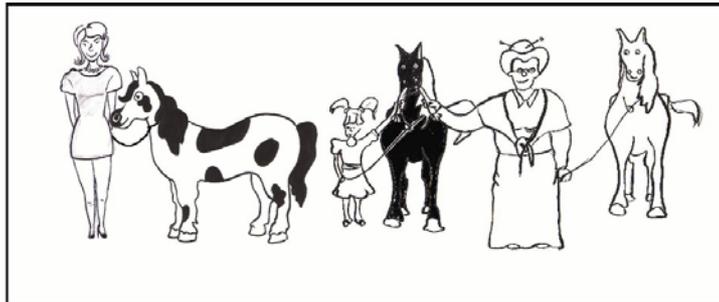
Picture 1 (correct picture, coreference): grandmother photographs grandmother's horse and woman photographs grandmother's horse (girl standing next to them with her own horse);

Picture 2 (unrelated distractor): the same participants performing a different action;

Picture 3 (correct picture, bound variable): grandmother photographs grandmother's horse and woman photographs woman's horse (girl standing next to them with her own horse).

Figure 4.4

Example BOUND VARIABLE vs. COREFERENCE condition

Picture 1*Picture 2**Picture 3*

The agrammatical aphasic subjects were tested twice with the same test with a period of six months between the two test moments. The main reason for the repeated measurement was to increase the number of experimental items in order to have more data points (2 x 10 items per condition, total 2 x 30 items), which in turn gives more statistical power. In the analysis I will first look at the two tests separately and compare

their outcomes. I will then also combine the results of the two measurements into one test.

4.3.3 Results

The results for agrammatic Broca’s aphasic patients of each measurement separately (Test 1 and 2) and both tests taken together are presented in Table 4.1 as percentages correct responses for the Bound variable-ONLY and Coreference-ONLY conditions (individual patient data are given in Table 4.2). In the case of the choice condition, Bound Variable vs. Coreference (BVCO) where they were offered both interpretations, the numbers represent percentages of bound variable interpretation chosen.

Table 4.1

Results of agrammatic patients, percentages correct responses for BV-only and CO-only, percentage bound variable picture chosen for BVCO.

<i>Agrammatic patients (n=6)</i>	<i>BV-only</i>	<i>CO-only</i>	<i>BVCO</i>
Test 1	76.6	65.0	83.3
Test 2	83.3	41.7	96.7
Tests 1&2 combined	80.0	53.3	90.0
Controls (n=11)	96.3	90.9	62.5

Table 4.2

Individual results of all agrammatic patients, for BV-only and CO-only numbers correct, for BVCO numbers bound variable picture chosen.

Patients	<i>BV-only</i>			<i>CO-only</i>			<i>BVCO</i>		
	<i>Test1</i>	<i>Test2</i>	<i>total</i>	<i>Test1</i>	<i>Test2</i>	<i>total</i>	<i>Test1</i>	<i>Test2</i>	<i>total</i>
JW	9/10	8/10	17/20	7/10	5/10	12/20	10/10	10/10	20/20
AD	9/10	9/10	18/20	6/10	3/10	9/20	9/10	10/10	19/20
EM	6/10	7/10	13/20	3/10	3/10	6/20	10/10	10/10	20/20
MK	7/10	10/10	17/20	6/10	4/10	10/20	10/10	9/10	19/20
IH	7/10	7/10	14/20	9/10	6/10	15/20	9/10	9/10	18/20
AN	8/10	9/10	17/20	8/10	4/10	12/20	2/10	10/10	12/20

A binomial test indicates that in both the first and the second measurement the agrammatic patients scored significantly above chance in the Bound variable-ONLY condition (Test 1: $p < .0001$; Test 2: $p < .0001$). In the Coreference-ONLY condition there was a difference between the two measurements; in the first one they scored significantly above chance level (Test 1: $p = .03$) and in the repeated measurement they were at chance (Test 2: $p = .12$). It should be noted that in all erroneous

responses subjects chose the related distractor, the unrelated distractor was never chosen. Therefore, I assumed, once again that chance level corresponds to 50% and not 33%, which would be chance level when choosing between three pictures.

In order to test whether their overall performance was worse than that of the controls I used the Mann-Whitney test. In the first measurement the participants performed less well than the controls on both the Bound variable-ONLY condition (Test 1: $Z=-2.577$, $p<.010$) and the Coreference-ONLY condition (Test 1: $Z=-2.666$, $p<.008$). In the repeated test they scored equally well as the controls on the Bound variable-ONLY condition (Test 2: $Z=-1.712$, $p<.122$), but worse on the Coreference-ONLY condition (Test 2: $Z=-3.443$, $p<.001$) The agrammatic patients preferred the bound variable interpretation above coreference in both measurements (Test 1 & Test 2: $p<.0001$). In Test 1 there was no significant difference between their scores on the Bound variable-ONLY and Coreference-ONLY conditions (Test 1: Wilcoxon Signed Ranks test - $Z=-1.361$, $p<.17$), but in the repeated measurement their performance on the Coreference-ONLY condition was significantly worse than on the Bound variable-ONLY condition (Test 2: Wilcoxon Signed Ranks test - $Z=-2.207$, $p<.03$).

From these results I conclude that the only difference between the first and the repeated measurement is in magnitude and not in the direction of the results. The subjects' scores were in the same direction and their performance was significantly worse on the Coreference-ONLY condition in Test 2 versus Test 1 ($Z=-2.041$, $p<.04$). Typically, in a repeated measurement one would expect an improvement of performance as an effect of repetition. Nevertheless, the subjects performed worse which makes the effect of poorer performance on the Coreference-ONLY condition more robust. Therefore, I treat the two measurements as one test with 20 items per condition and the analysis that follows deals with all the data pooled together.

Overall, the agrammatic patients scored significantly above chance in the Bound variable-ONLY condition ($p<.0001$) and were at chance ($p=.26$) in the Coreference-ONLY condition. Their performance on the Coreference-ONLY condition was significantly worse than on the Bound variable-ONLY condition (Wilcoxon Signed Ranks test - $Z=-2.003$, $p<.05$). They performed significantly worse than the controls on both the Bound variable-ONLY condition ($Z=-2.303$, $p<.021$) and the Coreference-ONLY condition ($Z=-3.337$, $p<.001$). Both the agrammatic patients and controls preferred bound variable interpretation above

coreference (agrammatic patients: $p < .0001$; controls: $p = .02$ – binomial test).

4.4 General discussion

The agrammatic patients performed differently from the unimpaired subjects.³ They scored significantly above chance in the condition (Figure 4.2) that tested whether they can interpret the pronoun in the elided VP as a bound variable. This indicates that they can represent a semantic dependency, which is established at the level immediately following the syntactic level in the economy hierarchy of referential dependencies proposed by Reuland (2001). Their performance on the condition where coreference is the only possible correct interpretation offered to them was at chance level. This guessing pattern suggests that the agrammatic patients had problems processing discourse dependencies, which are, according to the economy hierarchy, more costly, even for the unimpaired speakers. I conclude that the levels following syntax, the semantic and discourse levels in the economy hierarchy, are not equally accessible in agrammatism. Specifically, Broca's agrammatic patients can process semantic dependencies (bound variable), but fail to process discourse related dependencies (coreference) in real time.

Another aim of the experiment was to examine whether the agrammatic speakers, when confronted with the choice between the bound variable (semantic) interpretation and the coreference (discourse) interpretation, exhibit a preference for either of the two interpretations. If the order of levels in the economy hierarchy is preserved in agrammatism, I expected them to exhibit a preference for semantic dependencies, similarly to the unimpaired subjects. The responses show that the agrammatic patients clearly preferred the bound variable interpretation to coreference (90%), which is not surprising when their chance performance on the Coreference-ONLY condition is taken into account. The unimpaired control subjects in our experiment did not seem to have a preference for one of the two interpretations. This result, at first sight, may seem to deviate from the results obtained by previous studies (Shapiro & Hestvik, 1995; Shapiro *et al.*, 2003; Frazier & Clifton, 2000), where the unimpaired adults exhibited a clear preference for a bound variable interpretation. It seems that the controls in the present experiment were affected by the way the materials were presented to them. Recall that in the first half of the experiment they were presented

³ In the discussion section I refer to the combined results of Tests 1 and 2 as *the results* for the group of agrammatic subjects.

with either the Bound variable-ONLY condition or Coreference-ONLY condition. In each item, either of the two interpretations were the only correct choice. This made both interpretations equally active. In other words, it made the subjects aware of both possible interpretations without having to rely on their preference for one of the two interpretations. Subsequently, in the second half of the experiment the subjects were presented with the choice condition where both interpretations were available. Both interpretations were equally active as candidates and no preference was found because it was enough for the subjects to see a picture with either one of the two interpretations to choose as the preferred one.

In order to examine whether this was the case, I tested an additional group of controls (N=10) where the order was reversed. In first half of the experiment the choice condition (BVCO) was presented to the subjects followed by the second half with the Bound variable-ONLY and Coreference-ONLY conditions. The control subjects exhibited a higher preference for the bound variable interpretation (80%) when the experimental conditions were presented in this order. There was no such priming in the case of the aphasic patients. Although the agrammatic speakers were also presented with both interpretive options in the experimental items in the first half of the task, this clearly did not 'prime' the coreference interpretation, as indicated by their very strong preference for the bound variable interpretation in the second half of the task. These results would also predict that there should be no difference in the performance of agrammatic patients with the reversed order, i.e. the choice condition (BVCO) presented in the first half of the experiment followed by the Bound variable-ONLY and Coreference-ONLY conditions in the second half of the experiment.

The results show that the pattern in agrammatism does not fully resemble the pattern in the unimpaired speakers. The economy hierarchy is preserved in agrammatism, yet, the agrammatic patients scored significantly worse than the unimpaired subjects, which indicates that they did have difficulties interpreting constructions that involve pronouns in elided VPs. In section 3.3, I compared the agrammatic speakers' performance on the condition where the only correct option available involved a semantic dependency to their performance on the condition where the only correct response involved the formation of a discourse dependency. They performed significantly worse on the latter than the former condition. Given this in combination with the overwhelming preference for semantic dependencies in the choice condition, I wish to argue here that the more cross-modular steps need

to be made to get a particular interpretation, the more difficult it becomes for the agrammatic patients. According to the economy hierarchy, the discourse level follows the syntactic and the semantic levels respectively. The more cross-modular operations are performed, the more cost is incurred in terms of processing resources required for pronoun resolution. The same is true for the controls; however, their processing system is unimpaired and can deal with more costly operations in real time processing. Hence, the difference between the two populations is in the amount of resources available to perform certain operations in time.

There is more evidence supporting the reality of the economy hierarchy in healthy adults and agrammatic patients. Piñango, Burkhardt, Brun & Avrutin (2001) examined the interpretation of reflexives (logophors vs. anaphors) in unimpaired adults using a cross-modal lexical decision task. Piñango & Burkhardt (2001) (see also Burkhardt 2004) tested the same phenomena using the same method in agrammatism. The aim of both studies with neurologically intact speakers and aphasic patients was to examine the processing load related to syntactic versus discourse dependencies.⁴ The results of these studies show that in both populations more cost is associated with the processing of discourse dependencies than with the processing of syntactic dependencies. In an eye-tracking experiment, Koorneef (in progress) tested the processing of bound variable versus coreferential dependencies in situations where both interpretations are plausible in healthy adults. He found longer reading times for the coreferential interpretation over the semantic interpretation. His results indicate that the dependencies established at the semantic level are less costly than the dependencies established at the level of discourse. It is, therefore, not surprising that in our experiment the problems in agrammatism are expressed at the discourse level. The costlier the operations by which reference is assigned in particular sentences become, the more difficulty agrammatic patients will encounter in processing these sentences.

⁴ In all three experimental studies mentioned here the authors refer to the logical-syntax as syntax, therefore, the dependencies established at this level are labelled as syntactic dependencies. Following Reuland's (2001) model, in my study the term syntactic dependency was reserved for a dependency established in narrow syntax. The dependencies instantiated at the level of logical-syntax I treat as belonging to the C-I interface and as already mentioned in Chapter 1, footnote 17, I refer to them as semantic dependencies.

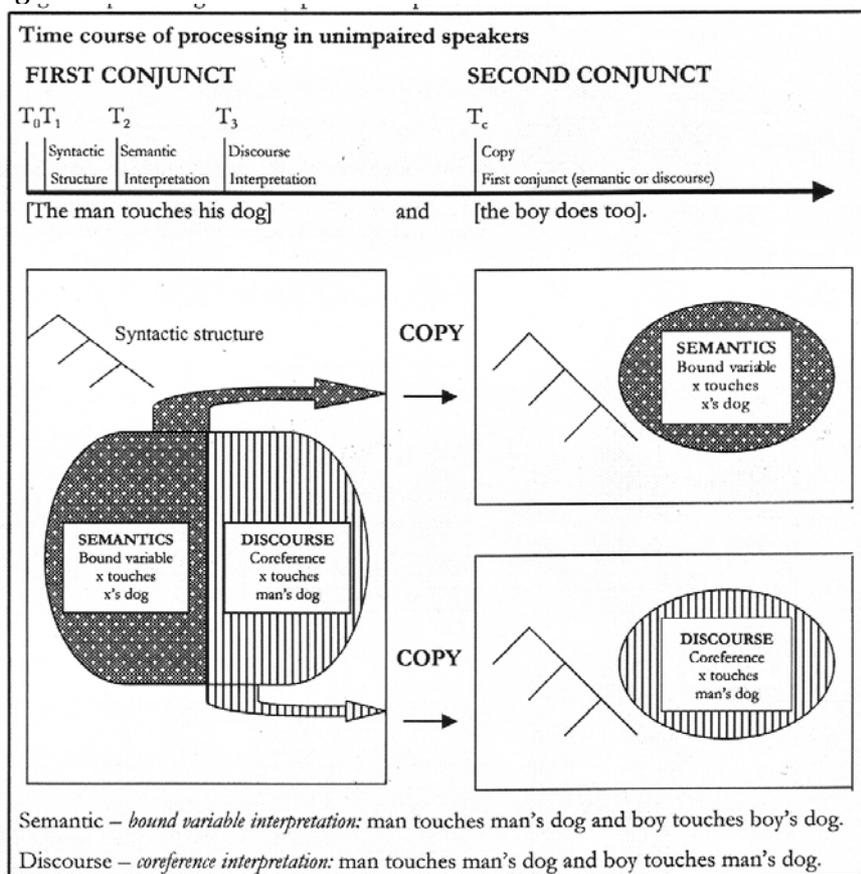
4.4.1 Real-time processing considerations

As was already mentioned in the introductory section, the processing of VP-ellipsis constructions in real time requires a few steps that are necessary for the appropriate interpretation of the elided VP (second conjunct) including that of the elided pronoun. This process will be examined closely with the help of the example in (10).

- (10) a. [The man touches his dog] and [the boy does <e> too].
 b. man touches man's dog & boy touches boy's dog – *semantic – bound variable interpretation*
 c. man touches man's dog & boy touches man's dog – *discourse – coreference interpretation*

It is natural to assume that in order to be able to process the second conjunct, the hearer must construct the syntactic structure (T_1) and assign reference to the pronoun in the first conjunct (T_2 and T_3) in order to copy this information onto the second conjunct (T_c) where the VP is elided. The hearer first constructs the VP in the first conjunct, *the man touches his dog*, and assigns reference to the pronoun *his*. At the same time the second conjunct is being processed. As we have seen in section 4.2.2, the hierarchy of referential dependencies assumes that the semantic (bound variable) interpretation is less costly than the discourse (coreference) interpretation. The bound variable interpretation in the first conjunct will be available sooner in time than the coreference interpretation because it is more economical. Hence, the bound variable representation will also be copied faster into the second conjunct. Nevertheless, it will not block a possible coreference interpretation, which will also become available, but at a later point. The coreference interpretation will be available in the first conjunct but will not be the preferred interpretation in the second conjunct simply because it is the more costly option for the unimpaired adults (see Figure 4.5).

Figure 4.5



So, why do agrammatic patients perform worse than the unimpaired subjects? The VP-ellipsis structures with pronouns represent cases where particular elements must be kept in store in order to be integrated with other elements that they form a dependency with. As the comprehension of these structures unfolds, the previously heard and not yet integrated material, such as the antecedent for the pronoun, needs to be connected to the pronoun once it is encountered. As was argued in the previous chapters I assume the syntactic structure building is delayed, which in turn affects the comprehension process in agrammatism. Syntactic structure building is a dynamic process that takes place in real time, therefore, the availability of particular bits of information that come from different sources is crucial for language processing. In the elided VP constructions first the syntactic structure of the initial VP phrase *the man*

touches his dog has to be built and a referent needs to be assigned to the pronoun *his*. At the same time the second conjunct is being constructed as a copy of the first one.

In agrammatism, on the other hand, in an off-line task such as the one used in this experiment the picture becomes different (see Figure 4.6). Because the syntactic structure is built slower (T_1 and T_2 are later in time than the same points in the neurologically intact individuals) the assignment of reference is also adversely affected. While the agrammatic patients are trying to construct the first conjunct and assign reference to the pronoun in the first conjunct, they are confronted with the second conjunct *the boy does too*. In order to interpret the second conjunct, they will have to have built the structure and assigned reference to the pronoun in the first conjunct. Because they 'so-to-say' take longer to build the syntactic structure, which needs to be consulted and copied (T_c) into the empty slot of the elided VP, economy considerations will become more important to them than to the unimpaired speakers simply because they will be running out of time. Just like the unimpaired interpretive system, the agrammatic system has to assign some sort of an interpretation to the elided VP and the pronoun in it. The semantic dependency is cheaper and established faster (T_2) than the coreference dependency in the first conjunct. The pronoun in the second conjunct is more likely to be interpreted as a bound variable before the system is out of resources, specifically, out of time. The process of assigning a fixed discourse referent to the pronoun and then copying this referent into the elided VP, on the other hand, is a more costly and a more time consuming procedure. As illustrated in Figure 4.5, the point at which the discourse interpretation of the pronoun (T_3) is completed in the first conjunct will be delayed relative to the same point (T_3) in the unimpaired adults. In the agrammatic patients the coreference interpretation will not be ready on time to be copied into the second conjunct. This is why in Figure 4.6 the interpretation that is copied in the second conjunct is the semantic bound variable interpretation, which is what we see reflected in the results of the experiment. The agrammatic patients perform above chance (80% correct) on the condition where bound variable is the only correct response. When they are given a choice between the two possible interpretations, they prefer the bound variable interpretation (90% bound variable chosen) to coreference. When the agrammatic patients are confronted with the condition where the only correct response is coreference, they resort to guessing between the correct picture and the erroneous related distractor (53% correct). This indicates that the

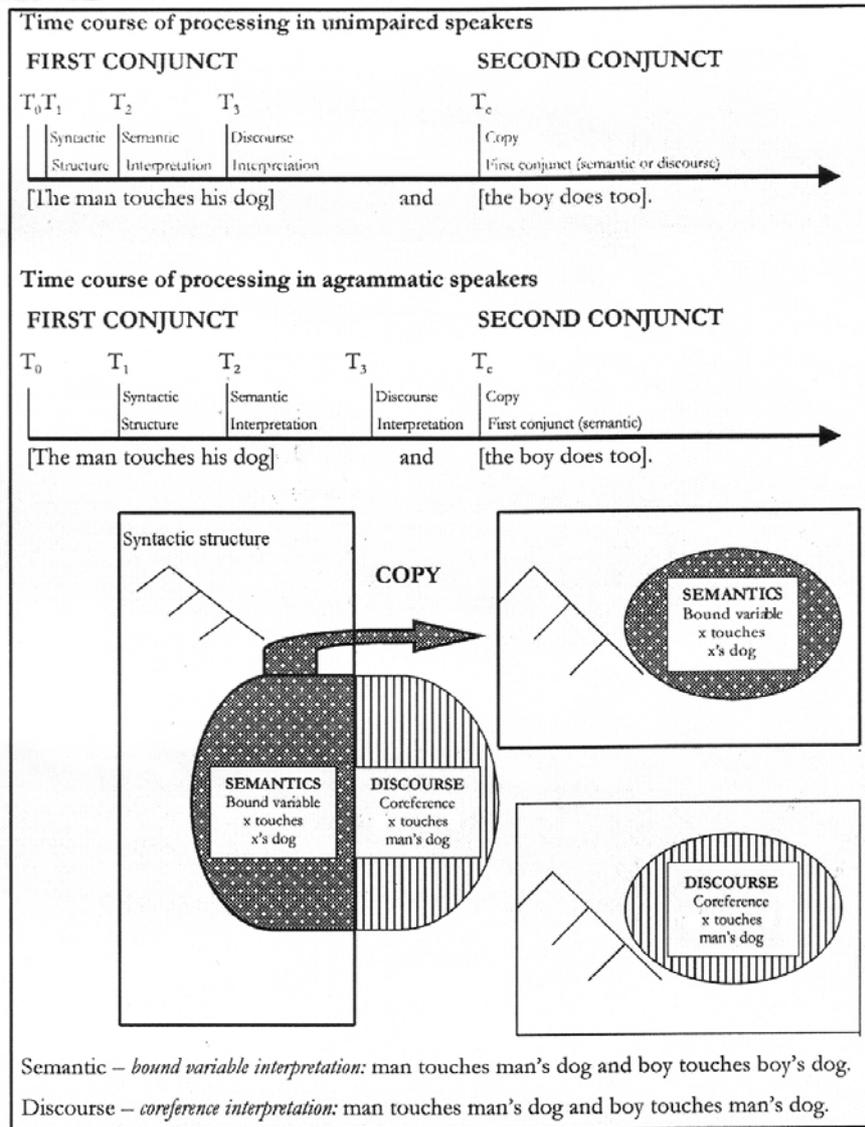
coreference interpretation of the pronoun in the first conjunct is not ready on time for it to be copied into the second conjunct.⁵

⁵ One could argue that the distance between the site of the reconstruction of the elided VP and the local DP₂ (bound variable interpretation) is shorter than the distance to the non-local DP₁ subject of the first conjunct (coreference interpretation).

(i) [DP₁ The man] touches his dog and [DP₂ the boy] does too.

As such, the more local DP₂ could be more active in memory and accessed more readily. However, the more active DP at the point of reconstruction is actually the non-local DP₁ because at this point the whole VP (the event) of the first conjunct is being reconstructed and copied. This would actually predict that the coreference interpretation should be easier for the agrammatic patients, which is obviously not the case. Another way of interpreting the data would be to assume that frequency plays a role and that the more frequent interpretation (bound variable) is less difficult. Online results obtained by Shapiro & Hestvik (1995) and Shapiro *et al.* (2003) show that this cannot be the case. Both interpretations are activated at the point of the reconstruction of the elided VP.

Figure 4.6



So, the agrammatic patients fail to obtain the coreference interpretation because their system runs out of time and resorts to the cheaper and faster available option. It could be the case that if these sentences, first conjunct in particular, are presented to the agrammatic patients in a slower-than-normal speech-rate, the coreference interpretation could

become equally available as the bound variable interpretation.⁶ This is only a suggestion, which would clearly need further investigation.

4.5 Conclusion

To conclude, agrammatic aphasic speakers are capable of obtaining the semantic (bound variable) interpretation for the possessive pronoun in VP-ellipsis constructions. However, they are incapable of establishing a discourse (coreference) dependency in the normal time course for the pronoun in the same constructions. The agrammatic patients also exhibit a preference for the bound variable interpretation that is much stronger than what the controls show. This preference reflects the processing hierarchy, which is related to complexity of these constructions. I propose that their grammatical knowledge of these constructions is not impaired and that their errors are not the result of a lack of knowledge but a consequence of a slower-than-normal syntactic processing. The results presented here support the approach that treats agrammatism as a reflection of an insufficiency of resources that are necessary to carry out linguistic operations in real time.

⁶ Swinney *et al.*, (in preparation) (see also Zurif, 2003) conducted a priming study where they presented agrammatic patients with non-canonical sentences involving filler-gap dependencies at a slower-than-normal speech rate (input rate reduced from six syllables per second to one syllable per second). Broca's patients did reactivate the displaced constituents at the gap positions. In other words, they could establish the dependency between the gap and the antecedent.

Chapter 5

Agrammatic and child data compared

5.1 Introduction

In this chapter the data obtained on the performance of agrammatic patients (discussed in Chapters 2, 3 and 4) will be compared to data obtained on the performance of pre-school children. All four experimental studies were administered to children using the same materials and the same experimental techniques in order to examine their comprehension of pronouns in different constructions.

In the following section I will discuss the validity of comparative studies in language acquisition and language breakdown and the role of linguistic theory in comparative studies. The experiments will be then discussed one by one in greater detail and the results obtained from children will be compared to the results of the agrammatic patients. As will become clear, the pattern of errors with pronouns is similar but not exactly the same for the two populations. I will relate these errors to the lack of processing resources that results from a lower activation level of the brain in both populations.

5.1.1 Why compare agrammatic and child language data?

There are two main reasons why it is useful to compare language comprehension data from Broca's aphasic patients with those of language-learning children. The first one is related to a crucial neurological characteristic the two populations share: the capacity of their brain is reduced in comparison with that of healthy adults. In agrammatic aphasic speakers the activation of the brain (or particular parts of the brain) is reduced as a result of neurological damage. In children the brain is not completely mature and, therefore, cannot be used to its full capacity as in adults. The second important characteristic the two populations share is a consequence of the first one. As a consequence of brain damage in Broca's patients and the immaturity of the brain in children, the comprehension patterns of both populations deviate from the comprehension patterns of healthy adults. The pattern of errors with pronouns is similar but not the same in the two populations, as will become evident from the present chapter.

I assume that in both children and agrammatic patients, the linguistic knowledge is within the constraints of UG and its implementation

requires processing resources. In general, computations that need to be performed in order to process language incur cost. The null hypothesis for the adult language processing system is that it will use the least costly operations to reach an interpretation in language comprehension. The same should hold for both children and agrammatic patients. However, what is cheap for adults does not necessarily need to be cheap for children and Broca's patients. As I argued in the previous chapters, the agrammatic patients' error pattern in pronominal reference assignment is a consequence of a reduced capacity for syntactic processing. For them, unlike in healthy adults, dependencies established through syntactic operations are not the cheapest ones. In order to avoid syntactic operations that are more costly for their system, they allow alternative dependencies, at the semantic or discourse level. Normally, these are costlier and therefore blocked in healthy adults, but in agrammatic patients they may win over the syntactic option.

In this chapter I examine whether the error pattern observed in children's comprehension of pronouns is the result of a similar mechanism. I assume that, as in agrammatism, children's errors are a consequence of a reduced capacity to use narrow syntax as a means of encoding pronominal dependencies. However, the difference between the two populations is that the child's language system is dynamic; it matures over time and the child eventually reaches the adult stage where syntactic dependencies are the most economical way of assigning reference to pronominal elements.

In the recent past various studies have compared the comprehension of pronouns in children and Broca's aphasic patients and have found similar error patterns in these two populations (Grodzinsky *et al.*, 1993; Kolk, 2000a; Bastiaanse, Bol, Mol, van & Zuckerman, 2002; Baauw & Cuetos, 2003; Zuckerman, Vasić, Ruigendijk & Avrutin, 2002 and Avrutin, 2000a, 2000b, 2004a, 2004b). I will discuss these separately in relation to each experiment presented in this chapter. In order to properly compare the data on the comprehension of pronouns in the two populations, I administered the same experiments to both pre-school children and Broca's aphasic patients. Before moving onto a detailed description of each experiment, I will first discuss what I understand by child language acquisition in this study.

5.1.2 Acquisition issues

Generative linguistics assumes an innate language blueprint, *Universal Grammar* (UG), which provides elements of language that children cannot infer on the basis of the language input that they receive from

their environment as they learn their first language. This innate language faculty guides the development of language in children. According to the *Maturation Hypothesis* (Borer & Wexler, 1987), particular linguistic principles that are part of UG may become available to children at particular stages of language acquisition. Following Avrutin (1999), I propose that language learning is a process of maturation of the brain, the biological organ used to implement linguistic knowledge, among other things. In children the syntactic “organ” needs to mature in order to become fully operational. According to Avrutin, children fail to perform certain computations, which results in an output that seems to disobey certain linguistic principles. However, it is not that they lack the linguistic constraints themselves, but it is carrying out the computation, i.e. implementation of these principles, that is too costly for their language system. Language learning should therefore be examined as a process that encompasses representation as well as processing.

An adult language system will avoid computations that are costly if there are more economic options available. The child’s language system will in principle avoid more costly operations too. For the adult system syntactic operations are the cheapest and will be the most preferred way of transferring information. A few experimental studies examining on-line language processing in children support the claim that, unlike in adults and similarly for agrammatic patients, syntax may not be the economical route for children (Hahne & Friederici, 2001 and Sekerina, Stromswold & Hestvik, 2002). As was already discussed in Chapter 2, Grodzinsky *et al.* (1993) also argued that both agrammatic aphasic patients and young children have problems computing Rule-I due to a lack of processing resources.

5.2 Interpretation of pronouns in ECM and simple transitive constructions

5.2.1 Binding versus coreference

In Chapter 2, I discussed the interpretation of pronouns in simple transitive and ECM constructions by individuals with Broca’s aphasia and I pointed out that the pattern of errors exhibited by these aphasic patients mirrors the error pattern found in pre-school children. To summarise, previous experimental studies on the acquisition of reference have shown that children aged 4 to 6, like agrammatic patients, exhibit adult-like performance with regard to the interpretation of reflexives. The interpretation of pronouns, on the other hand, seems to be more problematic. From the numerous studies on the acquisition of

pronominal elements a particular pattern has emerged, known as the Delay of Principle B Effect (DPBE): Children often allow pronouns to refer to local c-commanding antecedents (e.g. for English: Jakubowicz 1984; Chien & Wexler, 1990; for Dutch: Koster 1993, Sigurjónsdóttir & Coopmans, 1996; Philip & Coopmans 1996; for Icelandic: Sigurjónsdóttir, 1992 and for Russian: Avrutin & Wexler, 1992).¹ As was originally observed by Chien & Wexler (1990), children's performance on pronouns in simple transitive sentences, such as (1), where the local c-commanding antecedent is a referential expression, is at chance level. However, in structures where the local antecedent is quantified as in (2), children's performance is much more adult-like (85%); they reject binding between the pronoun *him* and the local quantified DP *every boy*.²

- (1) **The boy* pointed at *him*.
 (2) **Every boy* pointed at *him*.

These findings suggest that, like agrammatic aphasic patients, children have problems with coreference and not with binding.³ Local coreference rests on the interpretation of pronouns as free variables and it is not completely impossible in languages such as English and Dutch, but it is limited to special contexts (see Chapter 2, footnote 11). As was discussed in Chapter 2 in detail, both children and agrammatic patients allow local coreference in contexts where non-brain-damaged adults reject it; and children and agrammatic patients do this as a consequence of a failure to implement Rule-I (Grodzinsky & Reinhart, 1993; Grodzinsky *et al.*, 1993).

¹Baauw & Cuetos (2003) point out that the term Delay of Principle B Effect used to refer to this phenomenon is inappropriate for two reasons. First, the same effect is found in agrammatic patients where there can be no delay because they are not acquiring language. The second reason is related to the observation that children do know binding principles but fail in instances where coreference is an option. For these reasons the authors refer to DPBE as the Pronoun Interpretation Problem (PIP), following Coopmans (2000).

²Elbourne (2005) questions the reality of the distinction between referential and quantified antecedents that has been claimed to be reflected in the experimental findings of numerous studies examining children's interpretation of pronouns with these antecedents, Chien & Wexler (1990); Thornton (1990); Boster (1991); Avrutin & Thornton (1994); Philip & Coopmans (1996); Thornton & Wexler (1999). He claims that a few experimental factors lessen the force of these studies.

³As observed by Bloom, Barss, Nicol & Conway (1994), Principle B Delay does not show up in children's spontaneous speech. This supports the claim that children observe Principle B. Apparently, when children want to express reflexivity, they use reflexive pronouns. Only when they are "forced" to judge the possibility of local coreference, as in an experimental setting, do they (often) allow this reading.

In addition, children exhibit an extra strong DPBE in ECM constructions. Philip & Coopmans (1996) and Baauw (2000) have shown that Dutch children allow the pronoun in ECM sentences, such as (3), to refer to the local antecedent in around 80% of cases tested. Reference assignment in these sentences is constrained by the A-chain condition of the Reflexivity model. This contrasts with the chance performance (50%) observed in simple transitive structures in (1) where Principle B of the Reflexivity model applies.⁴

(3) **Mary saw her dance.*

According to Philip & Coopmans, the extra strong DPBE in ECM sentences is a consequence of the incomplete acquisition of the [*case*] feature, which results in faulty assumption children make with regard to the [+/- R] property of the pronoun. Children misanalyse the pronoun as referentially deficient [-R], which in turn permits the matrix subject to bind the pronoun without violating the A-chain condition (for details see Philip & Coopmans, 1996). Philip & Coopmans also offer an elegant explanation for the 80% non-adult like performance in ECM structures. As children are supposed to be guessing with regard to whether a pronoun is [+R] or [-R], half of the time they will assume that it is [+R] and half of the time that it is [-R] (50% non-adult like performance). In the 50% of cases where they correctly assign [+R] to the pronoun, half of the times they will fail to implement Rule-I and therefore will still perform in a non-adult like fashion. This adds up to 75% non-adult like responses in total.

An alternative explanation but similar in spirit was offered by Baauw (2000), who proposed that the [*number*] feature is not fully acquired or cannot be accessed in children. As a result of an underspecification of the [*number*] feature, children often misanalyse third person pronouns as [-R] elements, treating them as SE-anaphors such as Dutch *zich*, which, in principle does not violate the A-chain condition. This proposal will be discussed in detail in section 5.3, where the results of the experiment testing children's ability to use the number and gender information on pronouns will be presented.

The aim of the experimental study discussed here is to replicate the results that have been found for children in the previous studies, examining comprehension of pronouns in simple transitive and ECM sentences using a picture selection task. In order to compare children's

⁴ See footnote 22 for references of studies conducted in other languages.

results with the results obtained from the Broca's aphasic patients, the same method and materials were used in experiments with both populations. Agrammatic patients performed at chance level with pronouns in ECM constructions and were above chance when interpreting pronouns and reflexives in simple transitive sentences. If the cause of the problems with pronouns is similar in children and agrammatic aphasic patients (i.e. a lack of processing resources, as has been proposed Grodzinsky *et al.* 1993), it is expected that the pattern found in agrammatic aphasic patients will also show up in children. Crucially, a difference in children's performance on pronouns in transitive and ECM constructions should be found, where the latter should be more problematic (in line with Philip & Coopmans, 1996 and Baauw, 2000). Such a pattern would be the same as the pattern found by the agrammatic patients as discussed in Chapter 2.

5.2.2 Experiment 5

5.2.2.1 Subjects

28 Dutch children (age 4:3-6:2, mean age 5.7) and 15 Dutch non-brain-damaged adults (age 35-84, mean age 56.6) participated in this experiment.

5.2.2.2 Materials and procedure

Children were tested using the same method as administered to agrammatic patients, picture selection task, discussed in detail in section 2.1.4.2. Chapter 2. However, the materials used with children differed from the ones used with agrammatic speakers in two ways. First, the characters performing the actions were different. In order to make the experiment appear as a game, which made it more enjoyable for the children to do, the four puppets from the TV programme *Teletubbies* were used instead of the characters used in the experiment with agrammatic speakers. These puppets were Tinky-Winky, Lala, Dipsy and Po (see Appendix F for all test sentences).

The experiment with the children also had one condition less than Experiment 1 (see examples of conditions in (4), (5), and (6)); the reflexives in ECM constructions were not tested in children because they had been tested extensively in children in many different languages and the same results had been replicated in all these languages; children do not have problems in interpreting reflexives (for references, see footnote 22).

- (4) Pronoun in a transitive sentence:
Eerst hebben Dipsy en Tinky-Winky gespeeld en daarna heeft Tinky-Winky hem geknuffeld.
First Dipsy and Tinky-Winky played and then Tinky-Winky hugged him.

[Picture on the left side showed both characters playing and the other three pictures on the right side showed Tinky-Winky hugging Dipsy (correct response), an unrelated filler and Tinky-Winky hugging himself (e.g. Figure 5.1).]

- (5) Reflexive in a transitive sentence:
Eerst hebben Dipsy en Tinky-Winky gespeeld en daarna heeft Tinky-Winky zichzelf geknuffeld.
First Dipsy and Tinky-Winky played and then Tinky-Winky hugged himself.

[Picture on the left side showed both characters playing and the other three pictures on the right side showed Tinky-Winky hugging Dipsy, an unrelated filler and Tinky-Winky hugging himself (correct response) (e.g. Figure 5.1).]

- (6) Pronoun in an ECM construction:
Eerst hebben Dipsy en Tinky-Winky gespeeld en daarna zag Dipsy hem dansen.
First Dipsy and Tinky-Winky played and then Dipsy saw him dancing.

[Picture on the left side showed both characters playing and the other three pictures on the right side showed that Dipsy sees (in a mirror) Tinky-Winky dancing (correct response), an unrelated filler and one that shows that Dipsy sees himself (in mirror) dancing (e.g. Figure 5.2).]

Figure 5.1

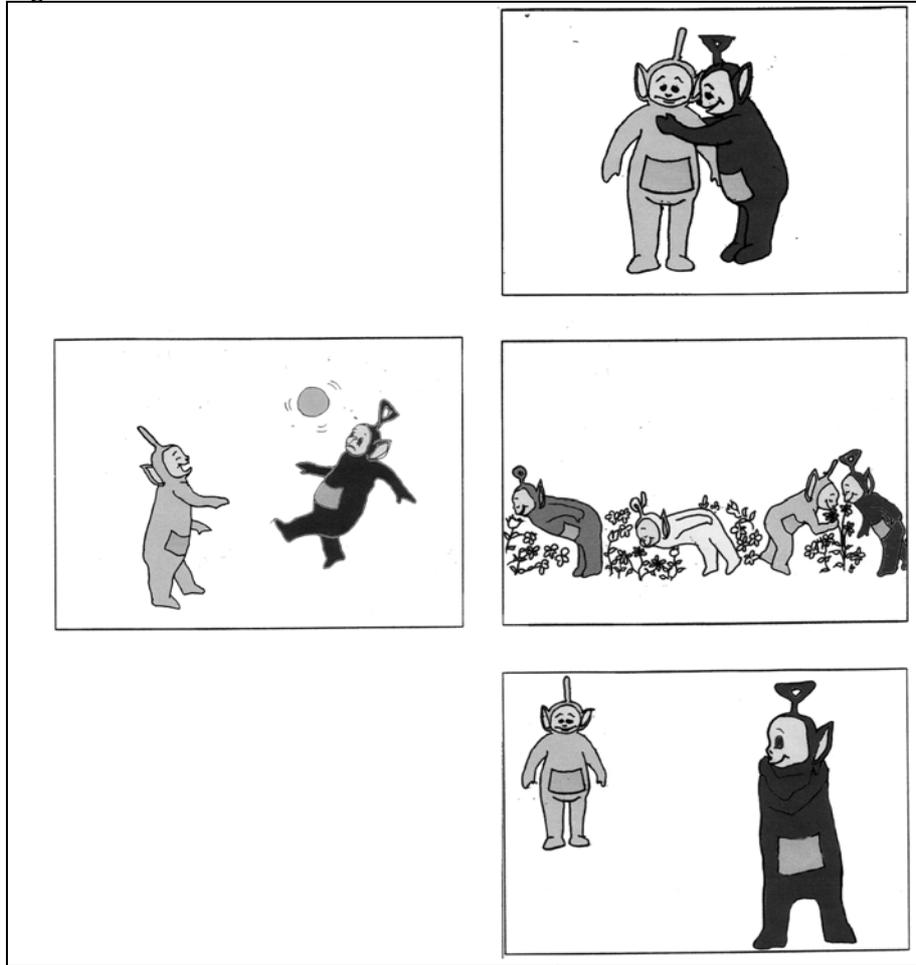
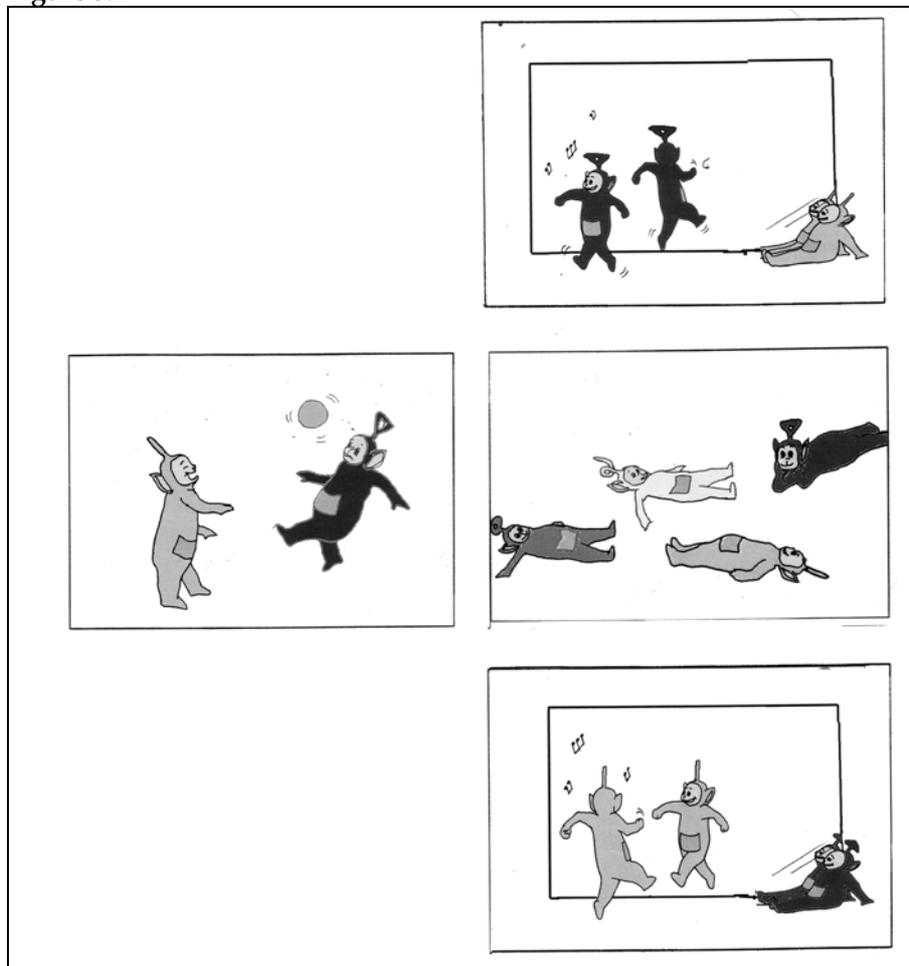


Figure 5.2



The experiment contained 6 items per condition, which after repeating the test two weeks later, led to a score of 0-12 for each of these conditions.⁵ Above chance performance on the various categories was

⁵ This experiment was embedded in another experiment testing the effect of contrastive stress on the interpretation of pronouns, which will be discussed in section 5.4, with five additional conditions and six filler sentences (6 items each x 2 sessions). Each of the two sessions of the test contained 54 sentences in total.

taken as evidence that children know the relevant principle and are able to implement it.⁶

5.2.2.3 Results

Table 5.1 shows the results of the experiment (for individual data, see Appendix F, Table F.1). Children performed significantly above chance on both pronouns (binomial test - $p < 0.0001$) and reflexives (binomial test - $p < 0.0001$) in simple transitive conditions. They performed at chance level with pronouns in ECM sentences (binomial test - $p < 0.25$). They made significantly fewer errors when interpreting pronouns in simple transitive sentences than in ECM constructions (t-test - $t = 7.018$, $df = 27$, $p < 0.001$). Moreover, they performed worse than the control group, with regard to the interpretation of pronouns in general (Mann Whitney U test - pronouns in simple transitives - $Z = -4.357$, $p < 0.01$; reflexives in simple transitives - $Z = -3.225$, $p < 0.01$ pronouns in ECM - $Z = -5.206$, $p < 0.01$).

The results reveal the same pattern as in agrammatic patients, who also performed above chance on both pronouns and reflexives in transitive sentences. Broca's patients' performance with pronouns in ECM sentences was at chance level as well (see Chapter 2, section 2.1.4.3.).

Table 5.1

Percentages correct on four experimental conditions. N.A.= not available. *Data from another control group of 13 Dutch speakers (mean age 42.6). **Data from 4 of the 8 Broca's subjects.

	<i>Transitive sentence</i>		<i>ECM construction</i>	
	<i>Reflexive</i>	<i>Pronoun</i>	<i>Reflexive</i>	<i>Pronoun</i>
Children	92.3	75.0	N.A.	46.7
Controls	98.7	98.2	100*	97.8
Broca's	93.3	91.7	96.7**	56.7

5.2.3 Discussion

In this experimental study two sets of results from previous studies have been replicated. First, children's performance on reflexives in simple transitive sentences was significantly better than their performance on pronouns in the same constructions. Second, the interpretation of pronouns in transitive sentences was less problematic for them than the

⁶ The chance performance was considered to be 50%, although there were three pictures to choose from, since all children avoided choosing the unrelated filler pictures.

interpretation of pronouns in ECM sentences. Children performed at chance level on pronouns in ECM sentences.

Unlike in many other previous studies on pronouns in children, in the present experiment children performed above chance (75%) when interpreting pronouns in simple transitive constructions. The better performance in this particular experiment can possibly be ascribed to the difference in tasks used in the present study, a picture selection task, and other studies that have mainly used the truth-value judgment task or a variant of this task (apart from Koster, 1993). There are two other experimental studies where a difference in scores was found for pronouns in simple transitive sentences. Baauw & Cuetos (2003) tested Spanish children and found that when using a picture selection task, children's scores were higher than the scores obtained using a truth-value judgment paradigm. Zuckerman, Baauw & Avrutin (2003) tested the same group of Dutch children with the same materials twice, once using a picture selection task and the second time using a truth-value judgment task. They found a task effect; children's scores were higher when tested with a picture selection task.⁷ In a truth-value judgment paradigm, the crucial condition is the one that elicits NO as the correct answer. According to Zuckerman *et al.* (2003), after hearing the target sentence in this condition, a child must search through all possible representations for that particular sentence in order to find out that there is no interpretation matching the picture that accompanies the target sentence. A picture selection task, on the other hand, is a less demanding task than the truth-value judgment task. Children search until they find the corresponding interpretation. They do not have to check all possible interpretations, some of which may be more difficult for them to process, such as the coreference interpretation in the case of the present experiment. They can simply opt for the interpretation whose acceptability they can check when they encounter the picture of this particular interpretation, such as the pronoun referring to an antecedent outside the sentence.

Comparing the children's results with those obtained from the agrammatic patients reveals similarities in the pattern of errors on these two types of sentences. Similar to children, agrammatic patients perform significantly better on reflexives than on pronouns in simple transitive sentences and their performance on pronouns in these sentences is above chance. In Chapter 2, we saw that for agrammatic patients the

⁷ See also Crain & Thornton (1998) for a detailed explanation of differences between the two methodologies and the results these methodologies yield.

methodology did not affect their scores on simple transitive sentences with pronouns. However, as will become clear from the experiment examining the knowledge and use of morphosyntactic features in children (see section 5.3.), the task does play a role in children's comprehension of pronouns. Their performance is worse when a truth-value judgement task is used.

The errors that children and agrammatic speakers make with pronouns in simple transitive sentences have been previously attributed to a problem in the execution of Rule-I. The source of the problem for both populations is supposed to be a consequence of a language processing limitation, and not of incomplete acquisition or loss of knowledge. The former explains why neither children nor agrammatic aphasic patients violate syntactic principles such as Principle B as is shown by their good performance on sentences with quantified subjects. The higher error rate on ECM constructions in children has been claimed to be related to the incomplete acquisition of morphosyntactic features in combination with a failure to apply Rule-I. This morphosyntactic source will be examined in the following experimental study.

These two proposals assume different underlying sources for children's errors. One views errors as a consequence of a lack of processing resources and the other combines a lack of processing resources with an incomplete acquisition of a particular part of knowledge. In the following section I discuss the experimental study testing children's knowledge and use of the morphosyntactic feature information on the pronoun. As will become evident from the results, like Broca's aphasic patients, children are aware of the information encoded in these features and use it appropriately when assigning reference to pronouns.

5.3 Morphosyntactic features and pronoun interpretation in children

In Chapter 2, section 2.2. I discussed in detail why a dependency (chain - *[Jan_i...him_i]) is not possible in an ECM sentence, such as (7), from the perspective of the Reflexivity model (Reinhart & Reuland, 1993).

- (7) **Jan zag hem dansen.*
Jan sees him dance

To summarise, this kind of dependency is ruled out by the A-chain condition, according to which a final element of such a chain has to be an element that is not fully specified for Φ -features or what Reinhart &

Reuland refer to as a [-R] element (e.g. reflexive or SE-anaphor). An element fully specified for these features would be [+R], such as a pronoun, and would be disallowed as the final element of a chain. In the case of the chain $*[Jan_i \dots him_i]$, the pronoun *him* is [+R], which makes this chain ungrammatical.

Elaborating on Philip & Coopmans' (1996) underspecification hypothesis, Baauw (2000) has suggested that children misclassify pronouns as [-R] because they have not yet fully acquired or cannot access the lexical feature specification for third person pronouns.⁸ Unlike Philip & Coopmans, he claims that it is the [*number*] feature specification that is not fully acquired or cannot be accessed, which is why children treat *him* in (7) as an element similar to *zich*. Baauw's hypothesis predicts that it would not matter for children whether there is agreement in [*number*] between the pronoun and the local antecedent DP or not. They are expected to perform equally poorly on both simple transitive and ECM structures, where the two elements agree and where they disagree in [*number*]. The aim of the experiment discussed here is to test this hypothesis.⁹ Alternatively, if children know and can use this feature, this incongruence should aid the comprehension process helping them to correctly reject the binding interpretation in simple transitive and ECM sentences.

5.3.1 Previous studies on morphosyntactic features in children

A few experimental studies have examined the interpretation of pronouns and the use of the Φ -features number and gender. Jakubowicz (1984) tested the effects of incongruence in gender and number between the pronoun and the c-commanding antecedent DP on children's interpretation of pronouns. She used an act-out task in her experiment and found that English three- to five-year-olds performed non-adult-like when there was number incongruence between the main clause subject and the embedded ECM-subject (8).¹⁰ According to Jakubowicz, in half of

⁸ In a later study, Baauw & Cuetos (2003) claim that children's knowledge of features of pronouns is intact but that the problems they have interpreting pronouns in ECM sentences are related to the lack of processing resources and children's inability to use (access) the number feature specification on pronouns.

⁹ I also tested children's ability to access and use the gender feature in these sentences. The person feature was left out because it was difficult to test, especially in the present experimental setting, and it is not directly relevant in the given theoretical framework.

¹⁰ Lente, van (2002) used a truth-value judgment task to test ECM constructions with congruence and incongruence in number between the pronoun and the local

the instances children failed to take into account the [*number*] feature of the pronoun and linked it to the closest c-commanding DP. Their performance improved considerably when there was gender incongruence, such as in (9).

- (8) Cathy said that Sue and Mary wanted her to kick the balls.
(± 50% adult like performance)
- (9) John said that Cathy wanted him to pet the cat.
(± 80% adult like performance)

There is an alternative explanation to the one offered by Jakubowicz for children's chance-level performance in sentences such as (8). It is not necessarily the inability to use the [*number*] feature that causes children to allow the pronoun *her* to refer to the closest c-commanding DP; in the case of (8) the closest c-commanding DP is *Mary*. The problem may lie in children's interpretation of plural DPs, such as [*Sue and Mary*], which can be interpreted as a collection of individuals (collective interpretation), meaning that both Sue and Mary wanted Cathy to kick the balls at the same time. The plural DP can also quantify members of a collection, in which case the plural DP is accompanied by a distributive operator (for details, see Roberts, 1987 and Heim, Lasnik & May, 1991). The members of a group [*Sue and Mary*] are then treated separately (distributive interpretation), meaning that Sue wanted Cathy to kick the balls now and Mary wanted the same thing yesterday. Avrutin & Thornton (1994) found that children have problems with the collective interpretation of plural DPs. The distributive interpretation seems to be less problematic for them. The errors children make in assigning reference to *her* in (8) could then be related to their preference for a distributive interpretation and not their inability to access or use the [*number*] feature. They could be interpreting the intended collective DP [*Sue and Mary*] as distributive DP [*Sue*] and DP [*Mary*], quantifying each member of the collection.

In the distributive scenario in (8), each of the DPs would be represented as a separate individual file card in discourse. Creating one event card would violate the number of arguments (individual file cards) the verb *want* selects. In that scenario the verb would have three

antecedent in French. The children she tested performed at chance level in all ECM conditions, with congruence and incongruence in number. She interpreted these results as providing evidence for the number underspecification hypothesis. The main problem with this experimental study is the fact that van Lente used only one item for each experimental condition. Needless to say, it could well be the case that a particular item could have affected children's responses.

arguments, two subject DPs *Sue* and *Mary*, which correspond to two individual file cards and one complement event card. The event of *wanting* must therefore be split. An event card would be created for each of these individual cards (DPs), resulting in two separate events of *wanting*. In Jakubowicz's experiment testing sentences such as (8), children are possibly allowing the pronoun to corefer with DP [*Mary*] as being a part of one event of *wanting* and with DP [*Sue*] as belonging to another event of *wanting*.¹¹ In that case they would be allowing a discourse dependency between the pronoun and each of the individual file cards. Therefore, the cause of children's mistakes in Jakubowicz's study with sentences such as (8) does not necessarily need to be related to their inability to interpret the *number* feature as such. It could be the case that they are unable to interpret plural DPs collectively.

In another study, Scholes (1981) examined whether children are sensitive to gender or number information on the pronoun using a picture selection task. He tested sentences such as (10) and (11) among others.

- (10) Someone is touching him.
 (11) Someone is touching them.

He found that children younger than four allow *him* in (10) to refer to a female individual or to several male individuals, and *them* in (11) to refer to several individuals or to just one. He concluded that this age group does not have the knowledge of gender or number. He further indicated that five-year-old children can use gender information, and at the age of six they become sensitive to number distinctions. The problem with this study lies in the materials used to test the relevant conditions. For example, the sentence in (10) was paired with two pictures from which children had to choose the one that corresponded to the target sentence best. The first picture represented a male individual touching with each of his hands two other male individuals. The second picture depicted

¹¹ Independent evidence from previous studies indicates that children tend to quantify over events rather than individuals (for data on children, see Philip, 1995, for data on Broca's aphasics, see Avrutin & Philip, 1998). Adult speakers also quantify over events. Take for example:

- (i) 10 cars passed by a tollbooth.

Most of the adult speakers would agree that it was 10 cars that passed by a tollbooth because the event of *passing by a tollbooth* is what counts and not the number of individual cars. After all it could be the case that only one car passed by the same tollbooth 10 times.

two different male individuals each one touching the same third male individual. Both of these pictures are correct responses to the target sentence since in each picture *someone is touching him* (another male person). The only difference between the two pictures is that the action of *touching* is distributed over two individuals in one picture and in the other it is collective in the sense that one and the same individual is being touched by two other men.

The two studies discussed in this section fail to provide conclusive evidence that children have problems using the information carried by [*number*] and [*gender*] features of third person pronouns. In order to test children's knowledge of these two features and their use of this knowledge, I tested their interpretation of pronouns in simple transitive and ECM sentences, where I manipulated the number and gender of the pronoun and of the antecedent DP. If children possess the knowledge of these features and can use it, then the incongruence between the pronoun and the local DP should help them correctly reject a dependency between the two elements. If this is not the case then their performance should not be different in sentences where there is such incongruence versus sentences where the pronoun and the local DP have the same number and gender.

5.3.2 Experiment 6

5.3.2.1 Subjects

In the experiment testing incongruence in number and gender in simple transitive sentences 33 Dutch children (mean age = 5.2) were tested. Their performance was compared to the performance of a control group of 11 Dutch adults (mean age = 31).

In the experiment testing the knowledge and use of the number feature in ECM sentences I tested 19 children (mean age = 5.3) and 11 controls.¹² In these sentences only the incongruence in number between the pronoun and the local antecedent DP was tested. It was impossible to include these sentences in the experiment testing the incongruence of features in simple transitive sentences because of the truth-value judgment task used to test the latter. In order to test the effect of number

¹² Like in the experiment testing number incongruence in ECM sentences in agrammatism discussed in Chapter 2, ECM sentences testing the same incongruence in children were a part of another experiment. These sentences served as fillers in the experiment testing children's interpretation of pronouns in VP ellipsis, which will be discussed in section 5.5.

incongruence in ECM constructions the same subjects had to be tested with the same method as in Experiment 1, i.e. a picture selection task.

5.3.2.2 *Materials and procedure*

The method used to test pronouns in transitive sentences is the same as the method used in Experiment 2. Two versions of a test (version A and version B) were designed. Each version contained 5 items for each condition in YES and NO form (see Appendix F for all test sentences). The total number of experimental items per version was 40. There were 15 filler sentences per version. The verb that was used in the YES version of a condition in version A was used in the NO version of the same condition of version B in order to control for the meaning of each verb (for examples of the experimental pictures, see Chapter 2, section 2.2.4.3).

- (12) Number/gender congruence (baseline): SINGULAR-SINGULAR

Target sentence:

De jongen spuit *hem* nat.

The boy squirts *him* (wet).

- (13) Number incongruence: SINGULAR-PLURAL

Target sentence:

De man spuit *hen/hun* nat.

The man squirts *them* (wet).

- (14) Number incongruence: PLURAL-SINGULAR

Target sentence:

De boeven wijzen *hem* aan.

The thieves point at *him*.

- (15) Gender incongruence: MASC.-FEM./FEM.-MASC.

Target sentence:

De prinses wijst *hem* aan.

The princess points at *him*.

The ECM sentences were tested with a picture selection task, as described in section 2.2.4.3, in Chapter 2 (see also Figure 2.1 and Figure 2.10 for examples of pictures that accompanied the Number congruence and the Number incongruence conditions respectively). There were 15 items per condition, exemplified in (16) and (17).

(16) Number congruence ECM:

Eerst hebben de man en de jongen gegeten en daarna [zag de man *hem* dansen].

First the man and the boy ate and then the man saw *him* dance.

(17) Number incongruence ECM:

Eerst hebben de man en de jongens gegeten en daarna [zag de man *hun* dansen]

First the man and the boys ate and then the man saw *them* dance.

5.3.2.3 Results

The results testing number and gender in transitive sentences will be discussed first. I examined the results of all 33 children that were tested in this experiment. As we can see in the first row of Table 5.2, the performance of the whole group of 33 children on the baseline condition with a pronoun in a transitive sentence congruent in number and gender with the c-commanding antecedent is significantly above chance. Examination of the individual data revealed, however, that there were children who performed at chance level and children that were above chance.

The assumption that children are supposed to have problems with morphosyntactic features had originally been postulated to account for the errors in the cases where there is congruence between the local antecedent and the pronoun in these features. In order to examine whether incongruence between these two elements had an effect on children's interpretation of pronouns, I had to look at children who had problems with pronoun congruence (baseline) condition. Therefore, I decided to separate children who made no errors in the baseline condition (n=21) from those who made at least one error on this condition (n=12). In Table 5.2, the results of the 12 children who made errors with pronouns in the baseline condition are given in the second row (for individual data, see Appendix F, Table F.2).

Table 5.2

Percentages correct responses on the NO version of the four experimental conditions for the whole group of tested children (n=33) and the group where each child had made at least one error in the baseline condition (n=12).

	<i>Singular-Singular congruence</i> NO	<i>Singular-Plural incongruence</i> NO	<i>Plural-Singular incongruence</i> NO	<i>Gender incongruence</i> NO
Children (n=33)	85.5	91.5	78.2	90.9
Children (n=12)	60.0	88.3	68.3	86.7

Table 5.3 shows the percentages of correct responses of children (n=12), controls and agrammatic patients (tested in the experiment discussed in Chapter 2, section 2.2.4.) in the conditions with NO as the expected answer. First, I will analyse the children's results on the conditions with NO as the correct response. In order to test whether these children performed differently on the singular-singular congruence condition (baseline) versus the three incongruence conditions, a Wilcoxon Signed Rank test was used. Children scored significantly better on two incongruence conditions in comparison with the singular-singular congruence condition (singular-singular vs. singular-plural - $Z = -2.555$, $p < .011$; singular-singular vs. gender incongruence - $Z = -2.873$, $p < .004$). There was no significant difference in their performance on the singular-singular vs. plural-singular incongruence conditions ($Z = -.829$, $p < .407$). As was already discussed in sections 2.2.4.4. and 2.2.4.5. in Chapter 2 (see also Table 2.2, Chapter 2), agrammatic aphasic patients exhibit exactly the same pattern.

Table 5.3

Percentages correct responses on the NO version of the four experimental conditions for the group where each child made at least one error in the baseline condition (n=12), controls and the agrammatic patients discussed Chapter 2, section 2.2.4.4.

	<i>Singular-Singular congruence</i>	<i>Singular-Plural incongruence</i>	<i>Plural-Singular incongruence</i>	<i>Gender incongruence</i>
	NO	NO	NO	NO
Children (n=12)	60.0	88.3	68.3	86.7
Controls	98.9	98.9	100	100
Broca's	85.4	100	93.8	96.9

Table 5.4 presents the percentages of correct responses of children, controls and agrammatic patients (tested in the experiment discussed in Chapter 2, section 2.2.4.) in the YES conditions. There was no difference between the singular-singular congruence condition and the three incongruence conditions (Wilcoxon Signed Rank test - singular-singular vs. singular-plural - $Z = -1.000$, $p < .317$; singular-singular vs. plural-singular - $Z = -1.000$, $p < 1.000$; singular-singular vs. gender incongruence - $Z = -1.000$, $p < 1.000$). Like for the NO conditions, the same pattern was found for agrammatic aphasic patients (see Chapter 2, section, 2.2.4.4, Table 2.3).

Table 5.4

Percentages correct responses on the YES version of the four experimental conditions for the group where each child made at least one error in the baseline condition (n=12), controls and the agrammatic patients discussed Chapter 2, section 2.2.4.4..

	<i>Singular-Singular congruence YES</i>	<i>Singular-Plural incongruence YES</i>	<i>Plural-Singular incongruence YES</i>	<i>Gender incongruence YES</i>
Children (n=12)	100	98.3	100	100
Controls	100	100	100	100
Broca's	98.9	95.8	96.9	97.9

The results of the experiment testing number in ECM sentences are given in Table 5.5. Children chose the correct picture in the Number congruence condition 46.7 % (chance level) significantly less often than in the Number incongruence condition 85% (chi-square = 33.654, $p < .001$). The same pattern was found in the agrammatic patients (for details, see Chapter 2, section 2.2.4.4, Table 2.4).

Table 5.5

Percentages correct picture chosen on the two experimental conditions testing number in ECM sentences in children, controls and agrammatic patients discussed in Chapter 2, section 2.2.4.4.

	<i>ECM constructions</i>	
	<i>Number congruence</i>	<i>Number incongruence</i>
Children	46.7	85.0
Controls	97.8	100
Broca's	56.7	85.6

It should be noted that the two conditions were tested with two different groups of children but using the same methodology. The congruence condition was tested in Experiment 5, discussed in section 5.2.2. The incongruence condition was tested as part of the experiment that will be discussed in section 5.5, again using the same methodology. It was impossible to test the congruence condition with this group of children because that would have increased the total number of items, which would have been impossible to test in one session. I assume that this should not be a problem since the chance level performance on ECM sentences is a robust effect found in children in many different languages (see Chapter 2, footnote 4), so there is no reason to assume that this particular group would not have problems with these constructions.

5.3.3 Discussion

The results obtained in this experiment coincide with the results obtained from the agrammatic patients and do not support the

underspecification account. Incongruence in number between the pronoun and the local antecedent improve children's performance in both simple transitive and ECM sentences (Experiment 5 and Experiment 6). Children are sensitive to the information about number and gender in both structures and use this information to correctly reject a dependency between the pronoun and the local antecedent DP.

In Chapter 2 I argued against the claim that the source of errors with pronouns in simple transitive and ECM constructions in agrammatic patients lies in their failure to implement Rule-I and the A-chain condition. I proposed that syntactic operations are not available on time in agrammatic patients because of their limited processing resources. This makes other, extra-syntactic ways of establishing referential dependencies, such as coreference interpretations, possible in environments where they are normally ruled out. I would like to propose here that the data on children's interpretation of pronouns are also better captured within the same economy-based approach as has already been claimed by Avrutin (2004a).

The Primitives of Binding model distinguishes between ECM constructions, where the pronoun and the local antecedent are not coarguments (arguments of the same predicate), and transitive constructions, where these two elements are coarguments (for details see section 2.3.3, Chapter 2). The economy hierarchy plays a role in both structures, and in transitives an additional constraint must also be considered. According to the economy hierarchy, syntactic operations are cheaper for the language processor than extra-syntactic operations (e.g. bound variable or coreference) and are applied first. Only if syntactic operations are not available can other operations be applied. The economy hierarchy is essential in accounting for both aphasic and child data with pronouns. As argued in the beginning of this chapter, syntactic operations are not the cheapest route in child's language system. Like in Broca's aphasia, I assume that children's syntactic processing is delayed. When a child encounters a pronoun in an ECM sentence, syntactic operations will not be available on time. There will thus be no way for the system to check whether a syntactic dependency would in principle be possible and which would thus block a coreferential dependency. Therefore, allowing a coreferential dependency between a pronoun and the local antecedent would in that case not be a violation of the economy hierarchy.

As is the case for agrammatic patients, pronouns in transitive sentences cause fewer problems for children because of lexical restrictions on the verb, which prohibit arity reduction. These restrictions

do not apply in ECM constructions because the pronoun and the matrix subject DP are not coarguments in these structures. Because syntax is not ready on time, an extra-syntactic referential dependency through discourse becomes possible for children as well. All featural specifications and knowledge about when syntactic dependencies can and cannot be established are part of children's syntactic knowledge, which is in principle available. However, a reduced capacity to use syntax often leads both children and agrammatic speakers to code dependencies outside (narrow) syntax.

In summary, I propose that the observed pattern in child comprehension of pronouns is similar to the pattern in agrammatic comprehension. In both populations this error pattern is not the result of a lack of knowledge, but of the lack of processing resources that are needed to carry out syntactic computations in real time. Syntactic knowledge as such is present in both populations, as is shown by their relatively good performance on the interpretation of pronouns in transitive sentences. However, whenever children or agrammatic patients fail to use syntactic operations to resolve pronominal reference, other extra-syntactic levels such as discourse take over in providing the antecedent for the pronoun in structures discussed here. In Chapter 3 I demonstrated that the problems agrammatic patients have with pronouns are not only limited to structures where Rule-I is at play. I tested coordinated structures where the only way to assign reference to the pronoun is through a discourse operation of coreference. It was found that in these structures agrammatic patients also had difficulties in establishing a pronoun-antecedent dependency. In order to check whether the same holds for children's problems in the comprehension of pronouns, I tested the same structures in children. As will become evident from the following experiment, children also exhibit problems with pronouns in coordinated constructions, which means that their problems are not limited to the instances where Rule-I is at play.

5.4 Assigning reference through discourse-operations

In the present section I discuss children's knowledge of discourse constraints, parallelism and contrastive stress, with the focus on the former, in order to compare children's data to the findings obtained from Broca's aphasic patients. As was discussed in detail in Chapter 3, agrammatic patients often fail to apply parallelism when they need to interpret a pronoun in coordinated constructions. They do so because their syntactic processing is protracted, which in turn delays the availability of thematic information necessary for a correct application of

parallelism. I argued in Chapter 3, section 3.3.3, for the parallelism of thematic roles constraint operating at the level of discourse. In the instances where Broca's patients fail to rely on parallelism, they resort to a default rule of topic preference that comes into play in ambiguous instances even in healthy adults.

In the present experiment, the issues that were addressed in Chapter 3 in relation to pronoun interpretation in agrammatic patients are studied in pre-school children. The goals of this experiment are:

- To check whether children experience problems with the interpretation of pronouns in environments where these cannot be related to a failure in the execution of Rule-I;
- To check whether children's errors with pronouns can be related to a competition between different discourse-constraints (discussed in detail in Chapter 3), which is similar to the competition between different linguistic modules (discussed in Chapters 2 and 4).

In the following section I discuss some previous findings on children's ability to use parallelism and contrastive stress in pronoun resolution, after which I present the experimental study with children.

5.4.1 Parallelism and contrastive stress in children

To my knowledge, there are only a few experimental studies that have tested children's interpretation of parallelism and contrastive stress in structures with pronouns.¹³ Most of these studies, with the exception of one (Chomsky, 1971), provide results indicating that children can implement parallelism but fail to correctly interpret contrastive stress.¹⁴ Maratsos (1973) tested children's interpretation of contrastive stress in sentences exemplified in (18) and (19), using an act out task.¹⁵

¹³A few studies have indicated that children are sensitive to contrastive stress but are unable to use it in the same way adults do in structures without parallelism (in comprehension Hornby, 1973; Tavakolian, 1974; and in production Hornby & Hass, 1970; Cutler & Swinney, 1987).

¹⁴Chomsky (1971) used an act out task to test pronouns that received contrastive stress in sentences such as (i), where the unstressed pronoun was reduced.

(i) THE HORSE pushed *the man*, and then the elephant came along and pushed 'im/HIM.

She tested 34 children of which 29 performed adult-like on stressed pronouns.

¹⁵Like in Chapter 2, italics indicate coreference and capitals indicate contrastive stress.

- (18) Ann jumped over the *old woman*, and then Harry jumped over *her/HER*.
 (19) *Ann* jumped over the old woman, and then *she/SHE* jumped over Harry.

He found that children perform at chance level with stressed pronouns in both subject and object position. Their performance on the unstressed conditions was significantly above chance (80%). In a similar study using the same paradigm and testing only pronouns in the object position of the second conjunct, McDaniel & Maxfield (1992) also found that children's performance on parallelism is above chance. They found chance performance on contrastive stress in the same children.

As was already discussed in Chapter 3 (see section 3.3.3.), Solan (1983) tested children's comprehension of parallel structures with pronouns. To summarise, he found that children apply parallelism of thematic roles, which, according to him, is unlike that of adults who use both parallelism of thematic and of grammatical roles equally often. Another study that was discussed in Chapter 3 (see section 3.2.4, p.p. 103) was conducted by Baauw, Ruigendijk & Cuetos (in preparation). They tested the comprehension of parallelism and contrastive stress by Spanish children and agrammatic aphasic patients, and used exactly the same materials (pictures) I used in Experiment 3. They found that both groups had more difficulties with stress than with parallelism. With regard to latter, the children and agrammatic patients they tested performed better on the conditions where the pronoun was in the subject position of the second conjunct. They follow Zuckerman, Vasić, Ruigendijk & Avrutin's (2002) claim that children and agrammatic patients use topic preference as a default mechanism when they run into problems with pronoun resolution in these constructions. This claim is also in line with the claim I make in Chapter 2 about the pattern of errors in agrammatism.

5.4.2 Experiment 7

5.4.2.1 *Subjects*

28 children (mean age= 5.3) were tested in this experiment, whose results are compared to a control group of 15 adults (age 35-84, mean age 56.6).

5.4.2.2 *Materials and procedure*

A picture selection task was used to test the children's interpretations of pronouns in sentences testing subject and object parallelism and

contrastive stress. The experiment testing these two types of sentences was embedded in Experiment 5, discussed in section 5.2.2.2.

The four conditions that were relevant for this study were represented by 48 sentences in total, 12 per condition (see Appendix F for all test sentences). The experimental conditions were the following: *Unstressed subject pronoun* and *Unstressed object pronoun* testing the parallelism constraint; *Stressed subject pronoun* and *Stressed object pronoun* testing the comprehension of contrastive stress.

Children were tested with the picture selection task used and described in Chapter 3. The only difference was that, in the experiment with children the characters portrayed in the pictures were *Teletubbies*. For a detailed discussion of experimental items, see section 3.2.2, Chapter 3. Examples of the experimental items are given below (*Unstressed/Stressed subject pronoun* in (20) and Figure 5.3; *Unstressed/Stressed object pronoun* in (21) and Figure 5.4).

- (20) Eerst heeft Tinky-Winky Dipsy geknepen en daarna heeft hij/HIJ Lala geknepen.
First Tinky-Winky pinched Dipsy and then he/HE pinched Lala.
- (21) Eerst heeft Lala Po geknepen en daarna heeft Tinky-Winky haar/HAAAR geknepen.
First Lala pinched Po and then Tinky-Winky pinched her/HER.

Figure 5.3
Unstressed/Stressed subject condition

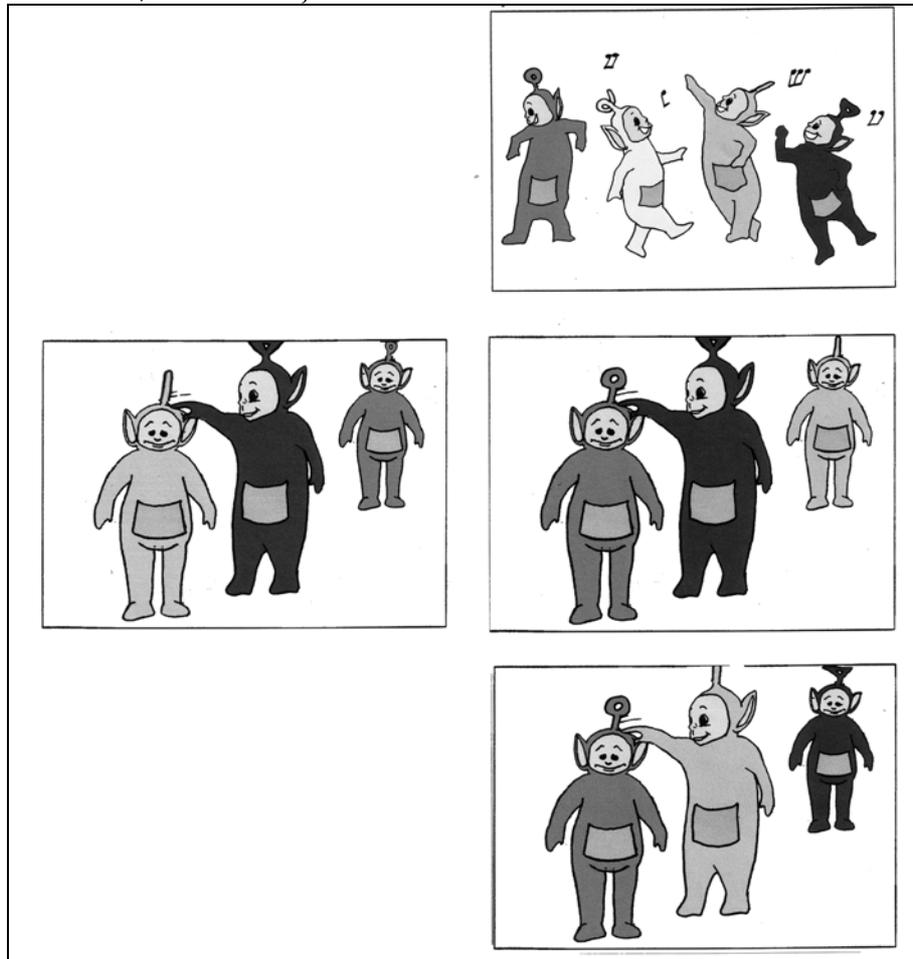
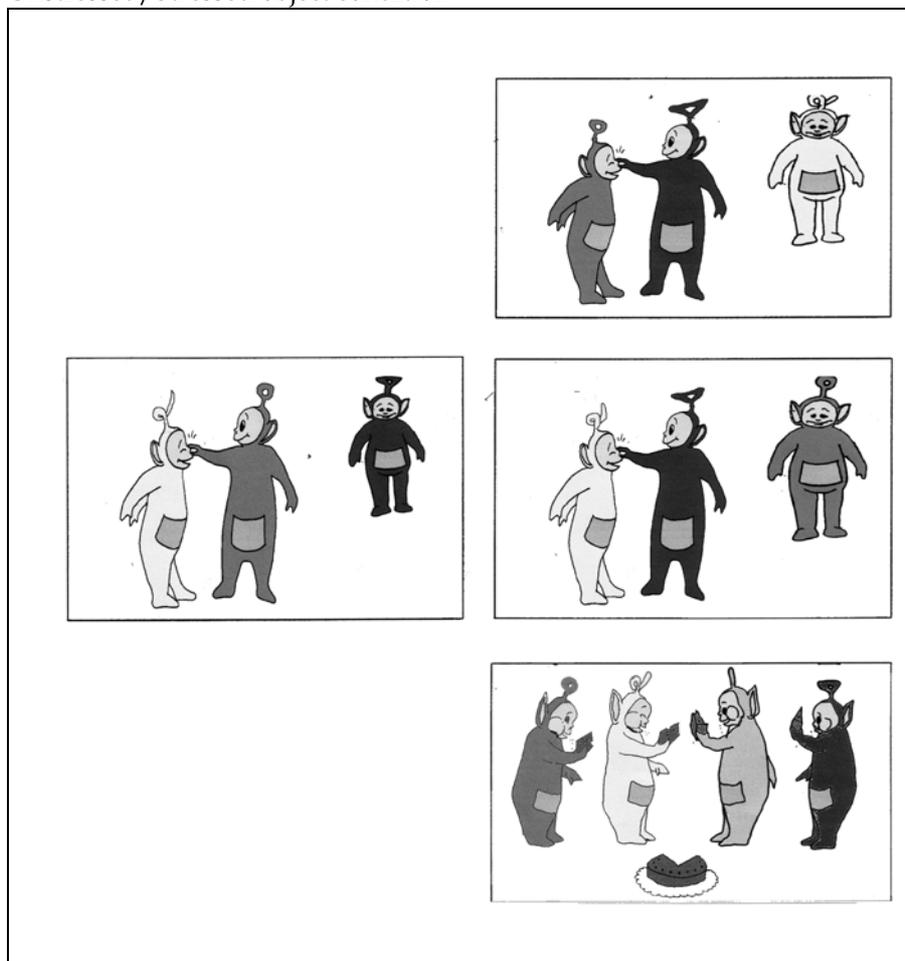


Figure 5.4
Unstressed/Stressed object condition



5.4.2.3 Results

The percentages of correct responses by children, controls and agrammatic aphasic patients (results from Experiment 3, Chapter 3, section 3.2.3) are given in Table 5.6 (for individual data, see Appendix F, Table F.3). I examined whether the whole group of 28 children that were tested in this experiment performed differently from chance-level on the four experimental conditions. Children always pointed at either the correct picture or the direct distractor. Therefore, as before, I assume that chance level performance on this task was 50%, regardless of the fact that 33% would be the real chance level when randomly chooses between

three pictures. A binomial test showed that their results on all four conditions did not differ from chance (*Unstressed subject pronoun* - $p=0.06$; *Unstressed object pronoun* - $p=0.07$; *Stressed object pronoun* - $p=0.08$; *Stressed subject pronoun* - $p=0.05$).

Table 5.6

Percentages correct responses on all four experimental conditions.

	<i>Unstressed subject pronoun</i>	<i>Unstressed object pronoun</i>	<i>Stressed subject pronoun</i>	<i>Stressed object pronoun</i>
Children (n=28)	55.2	54.9	50.4	51.7
Children (n=18)	61.8	57.3	48.4	55.9
Controls (n=15)	96.4	79.9	45.8	56.7
Broca's (n=8)	76.6	57.5	81.3	83.5

I also compared children's performance on the two conditions testing parallelism (*Unstressed subject pronoun* and *Unstressed object pronoun* conditions). There was no significant difference between their performances on these two conditions (Wilcoxon Signed Ranks Test - $Z=-.158$, $p<0.875$). The two stressed conditions also did not differ from each other (Wilcoxon: $Z=-1.132$, $p<0.258$).

In order for children to correctly interpret contrastive stress, they must first correctly apply the parallelism constraint. I checked whether children who can apply parallelism are also able to interpret contrastive stress. I therefore isolated 18 children who showed above chance level performance on parallelism. They were treated as a separate group, whose results are also reported in Table 5.6. This group of children performed above chance on the *Unstressed subject pronoun* (binomial test - $p=0.0005$) and *Unstressed object pronoun* (binomial test - $p=0.034$) conditions and at chance on the *Stressed subject pronoun* (binomial test - $p=0.733$) and *Stressed object pronoun* conditions (binomial test - $p=0.088$). There was no difference between their responses on the *Unstressed subject pronoun* condition vs. *Unstressed object pronoun* condition (Wilcoxon: $Z=-1.045$, $p<0.296$). They performed significantly better on the *Stressed object pronoun* condition than on the *Stressed subject pronoun* condition (Wilcoxon: $Z=-1.924$, $p<0.054$).

For the 18 children that performed above chance on the parallelism constraint, I grouped the conditions together based on the expected antecedent, in order to check their error pattern. In both the *Unstressed subject pronoun* and *Stressed object pronoun* conditions, the pronoun refers to the subject in the first conjunct. In the *Unstressed object pronoun* and *Stressed subject pronoun* conditions, on the other hand, the pronoun refers to the object of the first conjunct. I compared the results of the two

conditions where the subject was the expected response to the two conditions where the object was the expected response and I found a significant difference between the two sets of results in both children ($t(18)=1.98$, $p=0.03$) and adults ($t(15)=2.23$, $p=0.02$). Both children and adult controls made significantly fewer errors on conditions where the pronoun in the second clause referred to the subject DP of the previous clause.

5.4.3 Discussion

The group of 28 children I tested in this experiment performed at chance on all experimental conditions. These children, when treated as a group, failed to apply parallelism. They also failed to shift reference when contrastive stress was applied to these structures. Their performance was equally poor on all experimental conditions. These results clearly indicate that children's problems with pronouns are not limited to structures where Rule-I is at play. In the structures tested here it is related to a failure to assign reference through discourse operations of parallelism, whose mechanics I discussed in detail in Chapter 3 (sections 3.1.2. and 3.3.3.).

The 18 children that scored above chance on the unstressed conditions (parallelism conditions) and were treated as a separate group performed at chance on the contrastive stress conditions. They failed to shift reference in the contrastive stress conditions. I further examined the pattern of errors of this group in order to compare their error pattern to the one exhibited by the agrammatic patients I tested, and the Spanish children and agrammatic patients tested by Baauw *et al.* (in prep). I found a similar pattern in children as in agrammatic patients (see Chapter 3 for details) as well as in the Spanish children and agrammatic patients reported by Baauw *et al.* (in prep); children's scores were significantly higher on conditions where the pronoun referred to the subject than on the conditions where the pronoun referred to the object of the first clause.

I would like to argue that, like Broca's aphasic patients, children have problems with the parallelism requirement. Recall that in order to apply parallelism, the syntactic and lexical-semantic information for both conjuncts needs to be retained in working memory so that it can be properly mapped onto discourse. Once this information is incorporated in the file cards representing events and individuals, the relationship between these also needs to be kept in working memory. I assume that children also have limited processing capacity and the application of the parallelism constraint goes beyond their capacity. Nevertheless, their

errors are not random. Like in agrammatic patients, in the pre-school children I tested the default mechanism of topic preference provides the antecedent for the pronoun.

5.5 Interpretation of possessive pronouns in VP-ellipsis

Children's comprehension of pronouns in elided VPs has been previously studied in a few experimental studies (Guo, Foley, Chien, Chiang & Lust, 1997; Matsuo & Duffield, 2002; Thornton & Wexler, 1999; among others). The interpretation of pronouns in these structures has mainly been examined in relation to children's knowledge of Binding principles. In the present experiment I tested Dutch children's comprehension of possessive pronouns in elided VPs. As was discussed in Chapter 4 (section 4.2.1.), the possessive pronoun in these constructions can be connected to its antecedent through either the semantic operation of variable binding or the discourse level operation of coreference. In the present study, I will compare the findings from children to the results gathered from Broca's aphasic patients in order to check whether children's error patterns reflect the same hierarchy of referential dependencies as argued for the pattern found in Broca's aphasic patients and discussed in Chapter 4. I will first discuss the previous findings on children's interpretation of possessive pronouns. Then I will discuss the experiment and its results.

5.5.1 Previous studies with children

Previous studies of children's interpretation of pronouns in elided VPs in English (e.g. Thornton & Wexler, 1999) and Dutch (Koster, 1993) have shown that children can assign both bound variable and coreference interpretations to pronouns in VP-ellipsis constructions. Contrary to the findings presented in the previous chapter, the results of these studies indicate that children obey the parallelism requirement. According to this constraint, the referential pronoun in the second elided conjunct must pick out the same referent as in the first conjunct. For example, the pronoun in the first conjunct in (22) can corefer with the DP *the boy* or with an antecedent outside the linguistic environment, such as some third person *man*.

- (22) a. The boy scratches his dog and the grandfather (does) too.
 b. Boy scratches boy's dog/*man's* and grandfather scratches boy's/*man's* dog.

If coreference is used in the first conjunct the pronoun *his* will refer to *the boy*. The pronoun, which is reconstructed in the second conjunct, must then also be assigned reference through coreference resulting in the pronoun referring also to *the boy* and not *man*. Similarly, the pronoun in the first conjunct can receive a deictic interpretation, referring to a third person not represented in the sentence, e.g. *man* in (22b). Then the pronoun in the second conjunct must also receive the same deictic referent *man*. The same applies for the bound variable interpretation; if it is used in the first conjunct to assign reference to the pronoun, it must also be used in for the pronoun in the elided conjunct.

Possessive pronouns such as the ones I tested in this experiment have not received much attention in previous experimental studies. In both Koster's and Thornton & Wexler's experiments sentences with possessive pronouns served as control sentences testing children's knowledge of the parallelism constraint. These researchers specifically focused on the question whether children possess the necessary knowledge to assign the different interpretations. The main concern in this study, however, is which interpretations children prefer when given different possible options.

5.5.2 Experiment 8

The aim of this study is to answer the following questions:

- Can children obtain semantic (bound variable), discourse (coreference) and deictic interpretations in the elided VP?
- Do children have a preference for a particular interpretation when they are given a choice?

5.5.2.1 Subjects

In this experiment I tested 19 pre-school children (mean age = 5.2) and a group of 11 adult control subjects (mean age 31).

5.5.2.2 Materials and procedure

A picture selection task was used to test children's comprehension of the experimental sentences (for examples, see Chapter 4, section 4.3.2). The same materials and procedure were used as in Experiment 4, testing the same construction in Broca's aphasic patients. However, the number of items was reduced by half (see Appendix F for all test sentences). The experiment consisted of three conditions with 5 items per condition and 30 filler sentences (total 45 items). Prior to the presentation of the target sentence, the characters represented in the pictures that were performing actions on their own pet animal or on an animal belonging to another

person were introduced in a separate picture presented on the left hand side (for examples, see Chapter 4, section 4.3.2, Figures 4.2, 4.3 and 4.4). The introduction of the characters was done extremely carefully, making sure that the children would pay close attention to the animals that the characters were associated with. Each child was presented with the target sentence orally and then asked to choose one out of three pictures that best corresponded to the sentence she heard.

Like in Experiment 4 with Broca patients, in the first half of the present experiment children were given sentences accompanied with three pictures of which only one depicted the correct interpretation, either bound variable or coreference. This was done in order to check whether subjects could obtain the two possible interpretations. The direct distractors in those instances were pictures depicting a non-parallel deictic interpretation and indirect distractors were pictures depicting a different action with the same participants involved. Leaving the indirect distractor aside, in the first half of the experiment children had to choose between either the bound variable and deictic interpretation (BV vs. DX) (Chapter 4, Figure 4.2) or the coreference and deictic interpretation (CO vs. DX) (Chapter 4, Figure 4.3). In the second half of the experiment the choice was between the two possible correct interpretations, bound variable and coreference (BV vs. CO) (Chapter 4, Figure 4.4).

5.5.2.3 Results

The overall results for the children, controls and Broca's patients are given in Table 5.7 (for individual data, see Appendix F, Table F.4). Children's performance is at chance level in the condition where they had to choose between the correct picture depicting the bound variable interpretation and the incorrect picture depicting the non-parallel deictic interpretation (BV vs. DX) (binomial test - $p=.007$).¹⁶ Their performance is below chance (binomial test - $p=.012$) where the choice is between the correct coreference (CO) interpretation and the incorrect deictic (DX) interpretation. They perform significantly worse than adults on both the BV vs. DX condition (Mann-Whitney test - $Z=-3=3.269$, $p<.000$) and the CO vs. DX condition (Mann-Whitney test - $Z=-4.023$, $p<.000$). Both children and adults prefer the BV interpretation to CO (children: $p<.0001$; adults: $p=.02$ - binomial test). Their performance on the CO vs.

¹⁶ The unrelated distractor was never chosen, therefore, chance level was 50%, being a choice between two pictures instead of 33%, a choice between three pictures.

DX condition was significantly worse than on the BV vs. DX condition (Wilcoxon Signed Ranks test - $Z=-3.289$, $p<.001$).

Table 5.7

Percentages of interpretations chosen by children, controls and Broca's speakers.

	BV vs. DX (% BV chosen)	CO vs. DX (% CO chosen)	BV vs. CO (% BV chosen)
Children	63.1 (chance)	24.2 (below chance)	72.6 (above chance)
Controls	96.3 (above chance)	90.9 (above chance)	62.5 (chance)
Broca's	80.0 (above chance)	53.3 (chance)	90.0 (above chance)

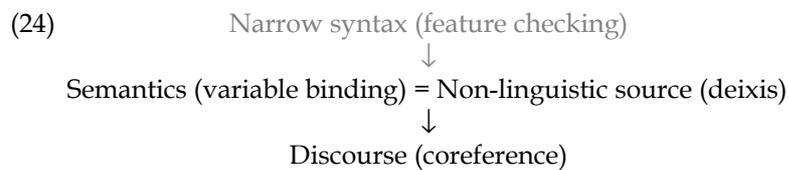
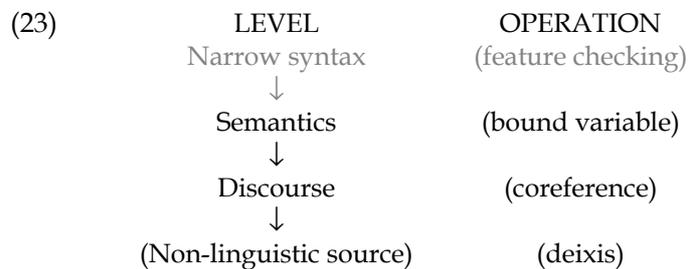
The results obtained from children are different from the ones gathered from Broca's aphasic patients. The aphasic patients perform significantly above chance on the bound variable condition, meaning that they correctly reject the incorrect non-parallel deictic interpretation. They are at chance on the coreference interpretation, unlike children who are below chance on this condition. Both children and aphasic patients prefer bound variable to coreference when they have to choose between the two correct interpretations.

5.5.3 Discussion

The results indicate that children perform at chance level when they are given a choice between a correct bound variable interpretation and an incorrect deictic interpretation, which represents a violation of the parallelism constraint. This suggests that for them bound variable and deictic interpretations are equally accessible, i.e. that there is no preference between the two. In the condition where they are given a choice between the correct coreference interpretation and, again, the incorrect deictic interpretation they prefer the deictic interpretation to coreference (discourse) interpretation. The results from both these conditions (BV vs. DX and CO vs. DX) indicate that children do not obey structural parallelism when they are given a choice between interpretations, which is surprising and in contrast to the previous results on the interpretation of pronouns in VP-ellipsis in children (Koster, 1993; Thornton & Wexler, 1999).

In the condition testing the choice between the two correct interpretations, the bound variable (semantic) interpretation is preferred to the coreference (discourse) interpretation. This is similar to what was found in agrammatic patients and adult controls. In terms of Reuland's economy hierarchy, a bound variable interpretation involves a smaller number of cross-modular steps than coreference and is, therefore, cheaper and hence the preferred interpretation in all populations.

These results suggest that, in contrast to Broca's patients, there is a stage in children's development of reference assignment at which deictic and bound variable interpretations are equally economical. The economy hierarchy proposed for adults, repeated in (23) is the same in agrammatic aphasic patients but seems to be different for children at this stage, exemplified in (24). It should be noted that in these sentences the pronoun cannot establish a syntactic dependency, therefore, the parts of the economy hierarchy that are of interest here are levels beyond syntax.



It appears that, at this stage in their language development, encoding a referential dependency through discourse is the least economical way for children. The semantic and deictic dependencies are equally economical; children have no preference for either one, regardless of the fact that the deictic interpretation in the sentences I tested is an ungrammatical option violating parallelism. The fact that the incorrect deictic interpretation is equally economical as the semantic interpretation and often used by children to assign reference to the pronoun in the elided VP is not so surprising. There are many studies reporting that young children frequently use pointing (deixis) to anchor reference. One of the first researchers to point this out was Karmiloff-Smith (1980), who found that children who were younger than 6 years of age had problems with discourse anaphora. She tested children's ability to use anaphoric devices in story telling. She found that 77% of the 4 year olds used pronouns to point (deictically) to the intended referents without introducing them in the previous discourse. Other studies have pointed to the same behaviour in children (Avrutin, 1999; Clancy, 1992;

Wagner, Kako, Amick, Carrigan & Liu, 2004; among others). Children appear to start off with non-linguistic dependencies (deictic), which seem to be the most economical option for them. They eventually achieve adult preference for language-specific (syntactic, semantic, discourse) dependencies.

As I discussed at the beginning of this chapter, children have no problems in assigning meaning to the pronoun through variable binding; sentences where the local antecedent is quantified do not pose problems for children (Chien & Wexler, 1990). Coreference, on the other hand, is problematic and this is not restricted to the cases where Rule-I applies, such as the simple transitive sentences tested in Experiment 5. In Experiment 7 I showed that children also have problems with the establishment of a pronoun-antecedent dependency in coordinated constructions where coreference is the only operation available. Therefore, I conclude that this is the least economical route for them. The claim that children have problems with discourse integration is supported by other studies examining children's knowledge and application of discourse constraints (for a different claim, see Weert, van der, 2002 and Wijnen, Roeper & Meulen, van der, 2003). Avrutin & Coopmans (2000), among others, studied children's ability to make bridging inferences (Clark & Haviland, 1977). They tested children's ability to connect a definite DP₂ with a DP₁ in a preceding clause related to it and containing a different noun – I saw [DP₁ a car]. [DP₂ The door] was red. Their claim was that children lack the computational resources needed to perform operations necessary to correctly bridge the two DPs. Krämer (2000), Philip (2003) and more recently Unsworth (2005) studied children's ability to interpret scrambled indefinite objects. The children they tested interpreted scrambled indefinites, whose interpretation depends on a form of bridging, as if they were not scrambled. They both conclude that children, up to 7-8 years of age, have problems with discourse integration through bridging.

To summarise, the results of this experiment show that children's preference for a particular interpretation of the possessive pronoun in elided VPs is different from adults' general preference. The latter prefer the bound variable interpretation to the coreference interpretation and never choose the deictic interpretation that violates the parallelism constraint. The results of the children suggest that the coreference (discourse) interpretation is less cheap than both deictic and semantic interpretations for children around five years of age and that the semantic and deictic interpretations are equally cheap and therefore equally accessible. The children's data presented here support a

maturational account of the development of the economy hierarchy in children. Following Avrutin's (2006) Weak-syntax hypothesis, I assume that children use alternative means of encoding information until their syntax, and other language-specific systems, semantic and discourse, are fully operational. This leads to a prediction that there should be a stage in children's development, earlier than the one I report in this study, which is the initial stage in their linguistic development where deictic operations used to establish reference are more or at least equally economical as syntactic operations.

5.6 General conclusion

In this chapter experimental studies testing children's interpretation of pronouns in four different constructions have been discussed. The data gathered from children were compared to the data obtained from Broca's aphasic patients testing the same constructions. In ECM, simple transitive and coordinate constructions, children's error pattern resembled the error pattern found in Broca's aphasic patients; in VP-ellipsis constructions children's error pattern was different from the pattern exhibited by agrammatic patients.

Children's performance on pronouns in ECM constructions tested in Experiment 5 was at chance level. Their performance on pronouns in simple transitives tested in the same experiment was above chance. As became evident from the results of Experiment 6, children possess the knowledge of [*gender*] and [*number*] features and use these in the process of linking the pronoun to an appropriate antecedent in both ECM and transitive structures. I argued that in children, as in agrammatic patients, the economy hierarchy of referential dependencies is different from the economy hierarchy in adult speakers. Syntactic operations are not available on time for children to be used in the process of connecting an antecedent to a pronoun. Because syntactic operations are not the most economical option, other operations, such as coreference, become available and are used by children to link an antecedent and a pronoun.

In coordinated constructions children's performance on pronouns was also at chance level. These results indicate that children's problems with pronominal elements are not limited to instances where Rule-I of the Reflexivity model applies. I argued that the discourse requirement on parallelism exceeds children's processing capacity and they often fail to apply it in coordinated constructions. In the instances where they fail to apply parallelism they resort to topic preference, which resembles the pattern found in agrammatic patients.

The difference between the two populations was found in relation to their interpretation of pronouns in elided VP constructions. Unlike Broca's aphasic patients, children rely on non-linguistic means in assigning a referent to the pronoun in these structures. They do so because the language specific modules, discourse, semantics and syntax, have not yet become fully operational in order to be used in an adult manner.

Chapter 6

Summary, general conclusion and “the bigger picture”

6.1 Introduction

In the previous chapters I have examined the comprehension of pronouns in Broca’s agrammatic aphasia. The aim of the first part of this chapter to provide a brief overview of the results emerging from the experiments presented here and to suggest issues for future research. The goal of the second part of this chapter is to place the findings on the comprehension of pronouns and the weak/delayed syntax model in the broader framework of a general language deficit in agrammatic Broca’s aphasia.

6.1.1 Summary of the experimental findings

The main objective of the experimental studies presented here was to unravel the functional organisation of the linguistic system that governs pronominal reference assignment discussed in the introductory chapter. In the experiments with Broca’s aphasic patients and children I focused on comprehension of pronouns in a number of different constructions.

In Chapter 2, two experiments testing the comprehension of pronouns in simple transitive and ECM constructions in agrammatic patients were discussed. The results of the first experiment indicated that Broca’s patients experience more difficulties interpreting pronouns in ECM environments than in the simple transitive sentences. The results of the second experiment showed that agrammatic patients could both access and use the morphosyntactic information on the pronoun in both types of constructions when linking the pronoun to its antecedent. I argued in this chapter that the Primitives of Binding model best explains the results of these experiments. In combination with the assumption that agrammatic patients have a reduced capacity for syntactic processing, I proposed that the economy hierarchy in these patients is different from the economy hierarchy in healthy non-brain-damaged adults. The most economical dependency in healthy adults is created in narrow syntax. In Broca’s patients the syntactic route is more costly, which allows other levels such as discourse to be used to assign reference without violating the economy hierarchy in these patients.

In Chapter 3 comprehension of pronouns in environments where Rule-I does not apply was assessed. Two types of conjoined constructions with the pronoun in the subject and object positions of the second conjunct were tested where the only way to connect a pronoun to its antecedent is through coreference. Agrammatic patients performed at chance level on pronouns in these sentences, which indicates that the errors they make are not limited to instances where Rule-I is at work. The error pattern Broca's patients exhibited were related to a competition between two different discourse constraints, topic preference and the constraint of parallelism of thematic roles.

In Chapter 4 interpretation of possessive pronouns in VP-ellipsis was examined. In this experiment I examined the availability of semantic and discourse dependencies in agrammatic patients. The patients I tested were able to use variable binding to assign reference to the possessive pronoun. However, they were incapable of establishing a discourse dependency between the antecedent DP and the pronoun. They also had a preference for the bound variable interpretation that is much stronger than what the controls showed. I proposed that their grammatical knowledge of these constructions is not impaired and that their errors are not a result of a lack of knowledge but a consequence of a slower-than-normal syntactic processing.

In Chapter 5 experimental data from pre-school children were presented and discussed. The four experiments conducted with agrammatic patients were also used to test children's ability to comprehend pronouns. The results of these experiments showed similarities but also differences in the patterns of errors of the two populations. The two populations exhibited a similar pattern of errors in ECM, transitive and coordinate constructions. The results of the experiments testing the interpretation of possessive pronouns in VP-ellipsis in these two populations were very different. I argued that children's syntax is weak and not fully operational at this stage in their development. Their syntactic processing is thus delayed, which is similar to the delayed syntactic processing in Broca's aphasic patients. The syntactic route is not the most economical route for children. Like in agrammatic patients, the economy hierarchy in children is different from the economy hierarchy in adults. In ECM sentences, children allow the pronoun to receive its referential value through coreference without violating the economy hierarchy. Unlike agrammatic patients and healthy adults, in elided VPs children rely on the non-linguistic way of assigning reference to the pronoun through deixis.

The results of these experimental studies provide evidence for a hierarchical organisation of the healthy, impaired and developing linguistic systems. The way in which in my view the impaired system deviates from the healthy system will be summarised below.

6.1.2 General conclusion

On the basis of the experimental results presented in the previous chapters, I argued that brain damage in Broca's aphasia reduces the capacity of such patients to process syntactic information on time. I assume that the syntactic machinery in these patients is weakened, resulting in a delayed syntactic structure building. In healthy non-brain-damaged adults syntactic operations are the fastest, most automatic operations used to establish pronoun-antecedent dependencies. As such, syntactic operations block other possible operations that can potentially be used to establish these kinds of dependencies. In agrammatic patients and pre-school children, syntactic information is not ready on time to be used in the process of connecting pronouns to their antecedents. As a consequence of this delay, other levels of information, such as discourse or the non-linguistic level, which would normally be blocked by syntax, come into play and provide information for pronoun resolution sometimes resulting in erroneous dependencies. The observed error patterns in these populations thus reveal a competition between narrow syntax and other systems.

The main issue left open for future research is related to the time course of pronoun processing in agrammatic aphasia. The data presented here have all been gathered using off-line methods, which provide no precise indication of how pronouns are processed in real time. The way to examine language processing in real time is by using online paradigms such as cross-modal lexical priming or lexical decision where this time-course is measured indirectly through a reaction time measured by a secondary task, mainly lexical decision. Another way would be to measure Event Related Potentials, which is a much more direct way of measuring brain response to a particular stimulus without the need for a secondary task.

For example, an important issue to be addressed in the case of elided VPs is whether all possible interpretations for the pronoun are activated at the point of reconstruction in the second elided conjunct. It would, of course, be necessary to establish first how healthy adults interpret pronouns in these constructions. The model I argued for predicts that in agrammatic patients only the semantic (bound variable) interpretation will be available at the point of reconstruction. For the neurologically

intact adults it could be the case that the cheaper interpretation (bound variable) is available sooner in time than the more costly option (coreference). This could possibly be examined using the cross-modal lexical priming method, where priming for different interpretation would be evaluated. The ERP technique, on the other hand, could be used to examine how Broca's patients process gender and number violations on the pronoun in different structures. The effects of these violations have been studied in healthy adults (Berkum, van, Brown & Hagoort, 1999; Brown, van, Berkum & Hagoort, 2000, Osterhout & Mobley, 1995; Barber & Carreiras, 2005), so the agrammatic data could be compared to the findings from the unimpaired population.

6.2 "The bigger picture"

The second aim of this chapter is to connect the comprehension data on pronouns with other findings obtained from agrammatic patients. The first step is to examine whether it is possible to extend the model I used to account for the error pattern of agrammatic patients in pronoun comprehension to other comprehension problems these patients have. It is of course beyond the scope of this chapter to provide a full and detailed overview of all comprehension problems. Therefore, I will give an indication of the direction further research should take in order to provide a detailed analysis of the general comprehension pattern in agrammatism. I will show that the most robust comprehension errors in this population can in principle be explained using the weak/delayed syntax model with its explanatory focus on the competition between systems, narrow syntax versus discourse or non-linguistic source (context), relevant to language processing.

A second important issue to be addressed is whether and how the error pattern observed in the comprehension is related to the well-known omission patterns in the production of agrammatic patients. It is not unnatural to assume that a person with a brain damage in or around Broca's area who exhibits agrammatic symptoms has one central underlying deficit that is expressed in the two modalities in a slightly different way. I will argue that the weak/delayed syntax model can also account for the omissions in the speech of agrammatic patients.

6.2.1 Weak/delayed syntax and other comprehension problems

The first issue to be addressed is how other comprehension problems in agrammatism can be related to the competition between narrow syntax and other linguistic levels of information. As was already discussed in detail in the introductory chapter (section 1.1.4), agrammatic patients

have problems interpreting non-canonical sentences. According to Grodzinsky (2000), agrammatic patients lack traces in their grammatical representation, which is why they fail to correctly interpret sentences such as object relatives, clefts, passives and other structures that involve syntactic movement.

In order to connect these findings to the weak/delayed syntax model and the competition between modules, the nature of the dependency that needs to be created between the trace (copy) and the moved element must be specified first. For example, in a passive structure such as (1), as in other non-canonical structures, the trace *t* in the object position is linked to the subject DP *the boy* through a syntactic chain that needs to be established between the two elements.

- (1) The boy was pushed $t_{\text{the boy}}$ by the man.



In order for agrammatic patients to correctly interpret passives and other non-canonical sentences, they need to be able to create a syntactic chain, which is a dependency created in narrow syntax. In Chapter 1, I discussed studies that have examined reactivation of moved elements in agrammatic patients. These patients do not show a priming effect at the point of the gap, which is the case in healthy adults, but at a later point (500ms) after the gap. These results indicate that agrammatic patients are in principle capable of forming a syntactic chain dependency but its establishment is delayed in time. As has been argued throughout this study, brain damage in Broca's aphasia reduces the brain's capacity to process syntactic structure in a timely fashion. Therefore, unlike for neurologically healthy adults, the syntactic system is not the most economical mechanism for Broca's aphasic patients. This is why these patients occasionally rely on discourse or context in order to establish a dependency between two elements such as a moved DP and the trace (copy) left *in-situ*.

In the case of the passive structure in (1), there is a competition between the syntactic chain whereby the first DP *the boy* will be assigned the role of *patient* and a discourse rule discussed in Chapter 3 (section 3.3.4) whereby the most prominent DP is the topic and is most likely to be marked as *agent* of the action. This competition is dynamic and it is not yet clear what the conditions are that determine which one of the two competing systems is going to win.

6.2.2 Production problems in agrammatism

In this section I will first give a short overview of the most prominent characteristics of agrammatic speech production. These characteristics will then be explained using the Weak syntax model proposed by Avrutin (2004a), who argues that the errors in production are also a result of a competition between narrow syntax, discourse and context. His account of production errors forms the basis of the model I use in this study to account for the comprehension data on pronouns.

The most characteristic feature of Broca's aphasic patients' speech is its *telegraphic* nature, which manifests itself in the omission of functional categories, such as determiners (2) and tense (3) (patient AN) (see also Roo, de, 1999; Friedmann, 1998; Kolk, 2001a, Avrutin, 2004a).^{1, 2}

- (2) [...] ja, _ baas, administratief, he?
yes, boss, administrative, right?
- (3) [...] tweeveertig dertig jaar geleden ongeveer eventjes in Arnhem gezeten.
forty-two thirty years ago approximately a while in Arnhem spent-participle.

The rate of omission varies in each individual agrammatic patient; in one conversation each patient sometimes omits and sometimes produces these functional categories. The rate of omission is also related to the degree of impairment and amount of therapy received. As indicated by Kolk (2001b), the rate of omission of functional categories in Dutch agrammatic patients ranges from 7% to 93. Following Avrutin (2004a), I argue that the model of their impairment should account for not only the pattern of omission but also for the optional nature of these omissions within a patient and across patients.

¹ It is interesting to note that children also omit functional categories in their speech (Pierce, 1989; Weverink, 1989; Radford, 1990; Rizzi, 1994; Phillips, 1995; Wexler, 1994; among others). The pattern of omissions resembles the pattern exhibited by agrammatic patients. Avrutin (2004a) explains the omissions pattern in children with the same model where syntax has not fully matured as a channel for transmission of information. Therefore, children also use alternative ways of introducing a frame for individual and event file cards at the level of linguistic discourse.

² In languages like English or Dutch, where bare stems can be used as independent lexical items, agrammatic speakers frequently omit bound morphemes. In languages like Russian, Italian and Hebrew, which disallow bare stems, Broca's aphasics do not produce bare stems but may produce an incorrect inflection and thereby make substitution errors with agreement (for details, see Grodzinsky, 2000).

As argued by Avrutin (2006), it is important to note that the omissions observed in agrammatic patients are not necessarily *ungrammatical* but *uninterpretable*. According to him, an utterance can be uninterpretable for a variety of reasons, only some of which are syntactic in nature and when particular contextual conditions are satisfied this utterance becomes acceptable; these conditions will be discussed in the following paragraphs. Such utterances are therefore grammatically well formed but uninterpretable. On the other hand, an utterance is ungrammatical only if it violates the principles of narrow syntax. An example of an ungrammatical utterance is given in (4). Interestingly, such utterances are not observed in agrammatic patients.

- (4) *The house are on fire.

As was already pointed out, omission of functional categories in healthy adults is allowed in special registers (see also Kolk & Heeschen, 1992; Blom 2003; Tesak & Dittman, 1991). Special registers refer to a particular context that, for example, facilitates omission of determiners (5) and (6) (taken from Baauw, Roo, de & Avrutin, 2002) or for tense (7) and (8) (taken from Avrutin (2006)).

- (5) Q: Wie heeft jou gisteren gebeld? [Dutch]
 'Who called you yesterday?'
 A: Oh, *meisje* van school.
 Oh, girl from school.
- (6) Leuk *huisje* heb je.
 Nice house have you.
- (7) Ded Moroz prinjos podarki. Deti prygat' ot radosti. [Russian]
 Santa Clause has brought gifts. Children to-jump-[INF] of joy.
- (8) Maria vertelde Peter een mop. Hij *lachen*. [Dutch]
 Mary told Peter a joke. He to-laugh-[INF].

According to Avrutin (2004b), in Russian and Dutch, non-finite clauses are allowed only when they follow a completed event, as in examples (7) and (8). In Dutch and in other languages, determiners can be omitted only in contexts where there is a sufficient presupposition with regard to the referent of the NP. He argues that the function of a functional category can occasionally be taken over by the non-linguistic source (context). Such instances are only allowed under very strict conditions

and if these conditions are not satisfied, functional elements must be produced in order to make an utterance interpretable. In the next section I outline the model proposed by Avrutin (2004a, 2004b, 2006).

6.2.3 Weak/delayed syntax and production problems

One of the first attempts to describe agrammatism as a syndrome with one central underlying deficit that disrupts both comprehension and production in these patients was made by Zurif (1980) and is also known as the *overarching agrammatism* hypothesis (see also Caramazza & Zurif, 1976; Saffran, Schwartz & Marin, 1980; Grodzinsky, 1984). According to Zurif, syntax is impaired in agrammatic patients, which results in both *asyntactic* production and comprehension in these patients.³ A more recent attempt to unify production and comprehension problems was made by Bastiaanse, Koekkoek & Zonneveld, van (2003). According to Bastiaanse *et al.* (2003), in both production and comprehension the mechanism of syntactic movement is disturbed. In production these patients avoid movement. In embedded clauses in Dutch, finite verbs remain *in-situ* and in main clauses they move to the second position higher up in the tree structure. Bastiaanse *et al.* (2003) show that agrammatic patients produce fewer finite verbs in main clauses than in embedded clauses; they avoid syntactic movement and produce non-finite verbs in main clauses.⁴ In comprehension they have problems with non-canonical sentences that involve syntactic movement (discussed in detail in section 1.1.4, Chapter 1).

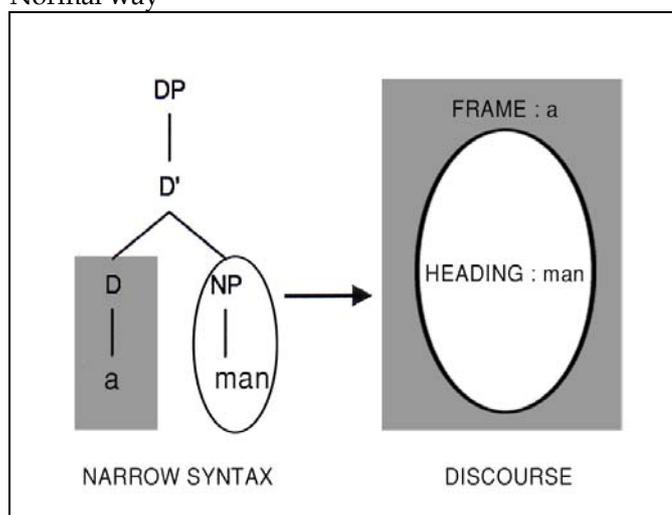
As discussed in Chapter 3 (section 3.3.1.), Avrutin (2002, 2004a, 2006) proposes that his model of linguistic discourse depends on the input from narrow syntax. The units of linguistic discourse, the event and individual file cards, are constructed on the basis of information provided by narrow syntax. As we saw in Chapter 3, the linguistic discourse is a computational system that operates on information units, and an information unit consists of *a frame*, which separates the units, and *a heading*, which provides the information necessary for

³ Soon after Zurif's proposal researchers came with evidence they claimed provided evidence against the overarching agrammatism hypothesis. Broca's patients were discovered with an intact comprehension and agrammatic production (Miceli, Mazzucchi, Menn & Goodglass, 1983; Kolk, Grunsvan, van & Keyser, 1985; among others) and the other way around; patients with spared production and impairment in comprehension (Caplan, Baker & Dehaut, 1985; Caramazza & Miceli, 1991).

⁴ For criticism on the hypothesis that verb second is impaired in Broca's patients see Kok, Kolk & Haverkort (2006), who failed to replicate Bastiaanse *et al.*'s (2003) findings.

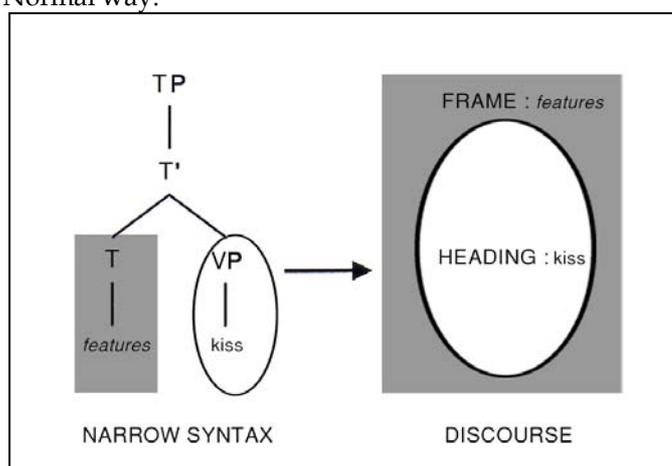
interpretation. The diagram (9) illustrates the relationship between narrow syntax and linguistic discourse. According to Avrutin, this is the normal way a frame is introduced, through narrow syntax; the determiner *a* supplies the frame of the file card and the noun *man* supplies the heading.

(9) Normal way



The diagram in (10) illustrates the normal way of introducing an event card: Tense (T) features provide the event heading, and the verb *kiss* provides the heading.

(10) Normal way:



An important distinction that Avrutin makes in his model is between the notions of linguistic discourse and *context*. According to him, the linguistic discourse is a level of linguistic representation responsible for resolving some of the anaphoric dependencies, for identifying topic and focus, for determining an appropriate antecedent for a logophoric element as well as for other operations usually referred to as *discourse operations*. This is a system that is constructed dynamically in the course of a given conversation and that operates by rules that go beyond sentence level. He defines *context* as a non-linguistic system that can be modified by different means, e.g. presupposition based on general knowledge, and he remains agnostic with regard to the type of symbols and the structure of context as a cognitive system. The reason he gives for the distinction between context and discourse is to avoid confusion in terminology because the term *discourse* is often used in the literature as referring to both purely linguistic discourse as well as the context (in Avrutin's terminology).

There are two conditions on well formedness of linguistic discourse repeated below:

- File cards (event & individual) must be interpretable.
- To be fully interpretable, a file card must contain a frame and a heading.

The main characteristic of the special register examples in (5) - (8) is that in all these utterances functional categories are missing, meaning that the frames of file cards at the level of linguistic discourse are not introduced by syntactic means. Nevertheless, these utterances are acceptable in particular contexts, which implies that the frames of the file cards in these examples must be introduced by the context, what Avrutin (2004a, 2004b) also calls presupposition.

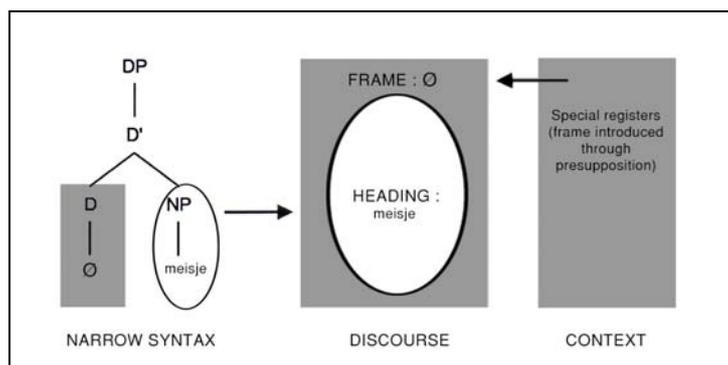
Special registers are examples of the non-syntactic way of introducing frames of an event or individual file card. An example of a determinerless utterance is repeated in (11).

- (11) Q: Wie heeft jou gisteren gebeld? [Dutch]
 'Who called you yesterday?'
 A: Oh, *meisje* van school.
 Oh, girl from school.

The response lacks a determiner *het* (the), which indicates that the narrow syntax fails to provide D-features that introduce a frame of an individual file card at the level of linguistic discourse. However, the question-answer pair with a strong presupposition by the speaker allows

the listener to make this utterance interpretable by introducing the frame for this file card by alternative means, namely by inference about the speaker's presupposition (context), as in (12).

(12)

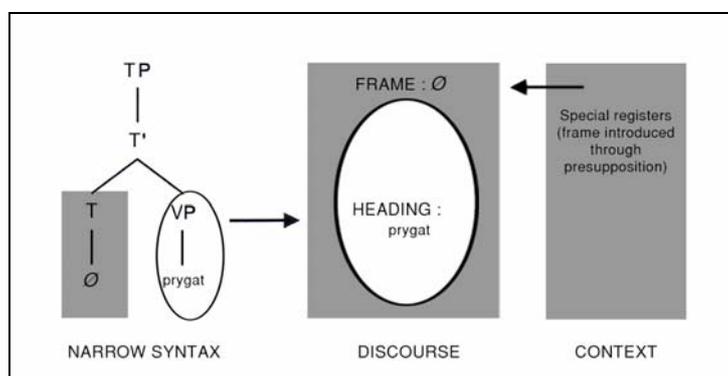


An example of a non-syntactic way of introducing a frame of an event file card is provided by the Russian utterances repeated in (13) and represented in (14), where tense is missing.

- (13) Ded Moroz prinjos podarki. Deti prygat' ot radosti.
Santa Clause has brought gifts. Children to-jump-[INF] of joy.

According to Avrutin, the speaker must provide a specific temporal point introduced in the prior linguistic discourse to which the new event can be anchored. The new event will become part of the context and the listener will be able to infer the temporal information about the tenseless clause.

(14)



Avrutin further argues that, regardless of the fact that an event or an individual file card frame can be introduced by non-syntactic means in natural languages, we rely on syntactic means (functional categories) much more often because of economy. In healthy adult speakers narrow syntax is the cheapest, most economical way of introducing individual and event file card frames. The reason why special registers have a special status in the speech of non-brain-damaged adults is again related to economy considerations. Healthy adult speakers encode information syntactically because this is for them the cheapest option and only in very specific contextual conditions is the alternative way cheaper than encoding it through narrow syntax.⁵

The speech of agrammatic patients exhibits a competition between the narrow syntax and the non-linguistic source for introducing the frame of a file card in the linguistic discourse. This competition occasionally results in the victory for the narrow syntax route and the functional category is produced. The non-linguistic route sometimes also wins sometimes and the functional category is omitted. This competition is also observable on an individual level. It is a well-known fact that an aphasic patient can sometimes produce a finite verb, and sometimes not. The same is true for determiners that are sometimes produced and at other moments they are omitted in the speech of a single agrammatic patient. Depending on their level of severity more severe agrammatic patients are expected to omit more than the less severe ones.⁶

⁵ It should also be noted that a difference has been found in various languages between tense, which was omitted more often than agreement by agrammatic patients (Hebrew: Friedmann, 1998; Dutch: Kolk, 2000b and German: Wenzlaff & Clahsen, (2004), among others). The model presented here can explain this difference; agreement is a morphosyntactic feature that is required by narrow syntax, consequently, there is no register that allows omission of agreement (e.g. no register in Russian would allow a sentence like **deti prygnul* - children [PL] jumped [SING] - taken from Avrutin (2004a)). Tense, on the other hand, is more related to the linguistic discourse and, as argued by Avrutin (2004) and following (Enç, 1991), is used to anchor an utterance to the linguistic discourse.

⁶ In his Adaptation theory, Kolk (1995) provides a slightly different account for the pattern of omissions in agrammatism. According to him, agrammatic patients omit elements that are less informative than other linguistic elements and their behaviour represents an adaptation to the impairment. Kolk characterises agrammatic behaviour as a semi-conscious strategy applied in order to save resources. However, besides speech monitoring, speech production is an unconscious process.

6.2.4 Production of pronouns in agrammatism

In this study I have focused on the comprehension of pronouns in agrammatism and in this section I turn briefly to the scarce data on the production of pronominal elements in these patients. As shown in Chapter 3, structurally pronouns are DPs without a complement and can be treated as a type of functional element. At the level of linguistic discourse they introduce a file card with a frame but without a heading, as was illustrated in Chapter 3, section 3.3.2, example (19).

Like other functional categories, pronouns can also be omitted in special registers (for an overview, see Roo, de, 1999). In Dutch and other Germanic verb second languages, a pronoun can be omitted from the first position where it functions as topic that refers to a person or an object already mentioned in the discourse, such as in (15).⁷

- (15) ***Ik kon gisteren na school niet meteen uitgaan.***
 I could not go out immediately after school yesterday.
(Ik) moest eerst naar huis om een paar klusjes te doen.
 (I) had to go home first to complete a few chores.

The same holds for pronouns in English, as discussed by Haegeman (1990) who refers to this type of omission as a *diary drop* and the register that allows these kinds of omissions as *diary style*. The reason why pronouns functioning as topics can be omitted is because they are salient in the discourse. For example, in any discourse where the first person pronoun *I* is used there must always be a speaker who this pronoun refers to; the speaker is presupposed in the context. Like the omission of other functional categories, the omission of pronouns represents an instance where the frame of a file card is supplied by the non-linguistic source through presupposition.

The few studies that have examined pronoun production in Dutch (Roo, de, 1999, Ruigendijk, 2002) show that agrammatic patients produce a relatively low number of pronouns in comparison with neurologically healthy speakers. Ruigendijk (2002) examined the production of pronouns in relation to the production of verbs and the inflection on verbs. Pronouns are DPs that must be assigned a case by the finite verb. As was already discussed in the previous section, agrammatic patients frequently omit tense, which means that their utterances are left without a case assigner. Ruigendijk's data on Dutch and German show that when

⁷ For the main properties of Germanic topic drop see, for German: Cardinaletti (1990); for Germanic V2 languages: Sigurðsson (1993) and for English: Rizzi (1994).

a patient produced a finite verb (case assigner), (s)he also produced a pronoun. When the realised verb was non-finite the pronoun was either omitted or produced and assigned a nominative case as a default case.

Roo, de (1999) found significantly more omissions in the first position in comparison with all other positions. This pattern resembles determiner omission and can be explained in the same way as the data on determiner and tense omission; as a consequence of the weakening of the syntactic channel, agrammatic patients occasionally introduce a frame through presupposition and not through the syntactic route. I need to point out, however, that more detailed research needs to be done in order to precisely examine the pattern of production/omission of pronominal elements. At this point only tentative conclusions can be made on the basis of the limited data gathered up until now.

6.2.5 Conclusion

In this chapter an attempt was made at providing a unified explanation for the language impairment in Broca's aphasia. As a consequence of brain damage these patients process syntactic information in a slower-than normal manner, which results in other levels of information taking over and providing the necessary information for language processing, be it comprehension or production. The aim of this chapter was not to give a full overview of all comprehension and production problems but merely to point out a way of addressing these issues using one common denominator, the weaker and therefore slower-than-normal syntactic processing. The consequence of the weakening of the syntactic channel is a change in the economy hierarchy not only in pronoun resolution but also in the establishment of other types of dependencies. The most economical option for neurologically intact adults, the syntactic channel, is not the most economical in agrammatic aphasic patients, which is why they occasionally rely on other channels to encode or decode the message.

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Appendix A

Table A.1.1
Individual patient data

Subject	Sex	Age	Tpo	Diagnosis	Cause
AD	Female	52	3y4m	Non-classifiable aphasia	CVA-l, ACM
AN	Male	73	20y	Agrammatic Broca's aphasia	CVA-l, ACM
MJG	Male	51	7m	Agrammatic Broca's aphasia	CVA-l
GK	Male	60	3m	Agrammatic Broca's aphasia	CVA-l, ACM
AK	Male	82	2y	Agrammatic Broca's aphasia	CVA-l
JW	Male	41	2y6m	Agrammatic Broca's aphasia	CVA-l
AL	Female	38	7m	Agrammatic Broca's aphasia	CVA-l ACM
IH	Female	57	5m	Agrammatic Broca's aphasia	CVA-l

Tpo= time post onset, y=year, m=months; CVA=cerebral vascular accident, l=left, ACM=artery cerebri media.

Table A.1.2
Individual Aachen Aphasia Battery scores¹

Subject	Spontaneous		Token		Written		Compre- hension	Diagnosis
	speech	Test	Repeating	language	Naming			
AD	3/5/5/4/4/2	17	115	73	110	112	non-classifiable	
AN	3/3/2/4/4/1	17	122	97	104	82	Broca	
MJG	3/5/5/4/4/2	35	38	22	50	57	Broca	
GK	3/2/4/3/2/2	39	82	7	90	83	Broca	
AK	2/3/3/3/4/2	29	116	81	95	70	Broca	
JW	3/5/3/4/4/2	18	112	82	99	107	Broca	
AL	2/4/5/3/1/1	18	90	34	67	96	Broca	
IH	3/3/5/3/4/2	26	113	67	95	60	Broca	

¹ The numbers under spontaneous speech refer to: communicational behaviour, articulation & prosody, automatic language, semantic structure, phonological structure, and syntactic structure respectively. Scores go from 0 to 5, 0 referring to maximum disorder, 5 minimal problems, except for syntactic structure, where 1 or 2 refer to short and syntactic incomplete utterances. Under Token Test the number of errors is given (max 50). The maximum score for repeating is 150, for written language 90, for naming 120, and for comprehension also 120. Patients AL, GK, IH and MJG have been tested with a shorter version of the AAT that has been developed by Heesbeen & van Loon-Vervoorn (2002). Their scores here are derived from their earlier scores on the shorter version using the Heesbeen & van Loon-Vervoorn method.

Appendix B

Test sentences Experiment 1

Anaphors in transitive sentences:

1. Eerst hebben de vrouw en het meisje gedanst en daarna heeft de vrouw zichzelf gekieteld.
First the woman and the girl danced and then the woman tickled herself.
2. Eerst hebben de man en de jongen gegeten en daarna heeft de man zichzelf geslagen.
First the man and the boy ate and then the man hit himself.
3. Eerst hebben de man en de jongen iets gedronken en daarna heeft de jongen zichzelf gestreeld.
First the man and the boy drank something and then the boy caressed himself.
4. Eerst hebben de vrouw en het meisje gezongen en daarna heeft het meisje zichzelf geschminkt.
First the woman and the girl sang and then the girl made herself up.
5. Eerst hebben de vrouw en het meisje geapplaudisseerd en daarna heeft de vrouw zichzelf gefotografeerd.
First the woman and the girl applauded and then the woman took a picture of herself.
6. Eerst hebben de man en de jongen geschaatst en daarna heeft de man zichzelf gefilmd.
First the man and the boy skated and then the man filmed himself.
7. Eerst hebben de vrouw en het meisje gelezen en daarna heeft het meisje zichzelf geknepen.
First the woman and the girl read and then the girl pinched herself.
8. Eerst hebben de vrouw en het meisje gelopen en daarna heeft de vrouw zichzelf gewassen.
First the woman and the girl walked and then the woman washed herself.
9. Eerst hebben de man en de jongen gezwaaid en daarna heeft de jongen zichzelf gekrabd.
First the man and the boy waved and then the boy scratched himself.
10. Eerst hebben de vrouw en het meisje geschrobd en daarna heeft het meisje zichzelf gebeten.
First the woman and the girl scoured and then the girl bit herself.
11. Eerst hebben de vrouw en het meisje gelachen en daarna heeft de vrouw zichzelf aangeraakt.
First the woman and the girl laughed and then the woman touched herself.
12. Eerst hebben de man en de jongen gevoetbald en daarna heeft de man zichzelf opgenomen.
First the man and the boy played soccer and then the man recorded himself.
13. Eerst hebben de man en de jongen gefietst en daarna heeft de jongen zichzelf ingesmeerd.
First the man and the boy cycled and then the boy put some oil on himself.
14. Eerst hebben de man en de jongen gehuild en daarna heeft de man zichzelf omarmd.
First the man and the boy cried and then the man embraced himself.
15. Eerst hebben de man en de jongen gekropen en daarna heeft de man zichzelf aangekleed.
First the man and the boy crawled and then the man dressed himself.

Pronouns in transitive sentences:

1. Eerst hebben de vrouw en het meisje gedanst en daarna heeft de vrouw haar gekieteld.
First the woman and the girl danced and then the woman tickled her.
2. Eerst hebben de man en de jongen gegeten en daarna heeft de man hem geslagen.
First the man and the boy ate and then the man hit him.
3. Eerst hebben de man en de jongen iets gedronken en daarna heeft de jongen hem gestreeld.
First the man and the boy drank something and then the boy caressed him.
4. Eerst hebben de vrouw en het meisje gezongen en daarna heeft het meisje haar geschminkt.
First the woman and the girl sang and then the girl made her up.
5. Eerst hebben de vrouw en het meisje geapplaudisseerd en daarna heeft de vrouw haar gefotografeerd.
First the woman and the girl applauded and then the woman took a picture of her.
6. Eerst hebben de man en de jongen geschaatst en daarna heeft de man hem gefilmd.
First the man and the boy skated and then the man filmed him.
7. Eerst hebben de vrouw en het meisje gelezen en daarna heeft het meisje haar geknepen.
First the woman and the girl read and then the girl pinched her.

8. Eerst hebben de vrouw en het meisje gelopen en daarna heeft de vrouw haar gewassen.
First the woman and the girl walked and then the woman washed her.
9. Eerst hebben de man en de jongen gezwaaid en daarna heeft de jongen hem gekrabd.
First the man and the boy waved and then the boy scratched him.
10. Eerst hebben de vrouw en het meisje geschrobd en daarna heeft het meisje haar gebeten.
First the woman and the girl scoured and then the girl bit her.
11. Eerst hebben de vrouw en het meisje gelachen en daarna heeft de vrouw haar aangeraakt.
First the woman and the girl laughed and then the woman touched her.
12. Eerst hebben de man en de jongen gevoetbald en daarna heeft de man hem opgenomen.
First the man and the boy played soccer and then the man recorded him.
13. Eerst hebben de man en de jongen gefietst en daarna heeft de jongen hem ingesmeerd.
First the man and the boy cycled and then the boy put some oil on him.
14. Eerst hebben de man en de jongen gehuild en daarna heeft de man hem omarmd.
First the man and the boy cried and then the man embraced him.
15. Eerst hebben de man en de jongen gekropen en daarna heeft de man hem aangekleed.
First the man and the boy crawled and then the man dressed him.

ECM sentences (pronoun/anaphor):

1. Eerst hebben de vrouw en het meisje gelachen en daarna zag de vrouw haar/zichzelf dansen.
First the woman and the girl laughed and then the woman saw her/herself dancing.
2. Eerst hebben de man en de jongen geschaatst en daarna zag de man hem/zichzelf eten.
First the man and the boy skated and then the man saw him/himself eating.
3. Eerst hebben de man en de jongen gehuild en daarna zag de jongen hem/zichzelf drinken.
First the man and the boy cried and then the boy saw him/himself drinking.
4. Eerst hebben de vrouw en het meisje geschrobd en daarna zag het meisje haar/zichzelf zingen.
First the woman and the girl scoured and then the girl saw her/herself singing.
5. Eerst hebben de vrouw en het meisje gelopen en daarna zag de vrouw haar/zichzelf applaudiseren.
First the woman and the girl walked and then the woman saw her/herself applauding.
6. Eerst hebben de man en de jongen gekropen en daarna zag de man hem/zichzelf schaatsen.
First the man and the boy crawled and then the man saw him/himself skating.
7. Eerst hebben de vrouw en het meisje gezongen en daarna zag het meisje haar/zichzelf lezen.
First the woman and the girl sang and then the girl saw her/herself reading.
8. Eerst hebben de vrouw en het meisje gelezen en daarna zag de vrouw haar/zichzelf lopen.
First the woman and the girl read and then the girl saw her/herself walking.
9. Eerst hebben de man en de jongen gefietst en daarna zag de jongen hem/zichzelf zwaaien.
First the man and the boy cycled and then the boy saw him/himself waving.
10. Eerst hebben de man en de jongen gezwaaid en daarna zag de man hem/zichzelf voetballen.
First the man and the boy waved and then the man saw him/himself playing soccer.
11. Eerst hebben de vrouw en het meisje geapplaudisseerd en daarna zag het meisje haar/zichzelf schrobben.
First the woman and the girl applauded and then the girl saw her/herself scouring.
12. Eerst hebben de vrouw en het meisje gedanst en daarna zag de vrouw haar/zichzelf lachen.
First the woman and the girl danced and then the woman saw her/herself laughing.
13. Eerst hebben de man en de jongen gegeten en daarna zag de jongen hem/zichzelf huilen.
First the man and the boy ate and then the boy saw him/himself crying.
14. Eerst hebben de man en de jongen gevoetbald en daarna zag de man hem/zichzelf kruipen.
First the man and the boy played soccer and then the man saw him/himself crawling.
15. Eerst hebben de man en de jongen gedronken en daarna zag de jongen hem/zichzelf fietsen.
First the man and the boy drank and then the boy saw him/himself cycling.

Appendix C

Test sentences Experiment 2

Version A

Singular-Singular congruence YES

1. De kabouter knijpt hem.
The goblin pinches him.
2. De indiaan bindt hem vast.
The Indian ties him up.
3. De jongen beschiet hem.
The boy shoots at him.
4. De oma aait haar.
The granny caresses her.
5. De vrouw omhelst haar.
The woman embraces her.
6. De vrouw slaat haar.
The woman hits her.
7. Het meisje fotografeert haar.
The girl photographs her.
8. De oma streelt haar.
The granny caresses her.

Singular-Singular congruence NO

1. De politieman wijst hem aan.
The police officer points at him.
2. De tovenaar raakt hem aan.
The magician touches him.
3. De jongen spuit hem nat.
The boy squirts him.
4. De opa kietelt hem.
The grandpa tickles him.
5. De vrouw kleedt haar aan.
The woman dresses her.
6. Het meisje bijt haar.
The girl bites her.
7. De verpleegster prikt haar.
The nurse pricks him.
8. De vrouw filmt haar.
The woman films her.

Singular-Plural incongruence YES

1. De heks raakt hun aan.
The witch touches them.
2. Het meisje wijst hun aan.
The girl points at them.
3. Het meisje kietelt hun.
The girl tickles them.
4. De oma kleedt hun aan.
The granny dresses them.
5. De man spuit hun nat.
The man squirts them.
6. De jongen bijt hun.
The boy bites them.

Version B

Singular-Singular congruence YES

1. De politieman wijst hem aan.
The police officer points at him.
2. De tovenaar raakt hem aan.
The magician touches him.
3. De jongen spuit hem nat.
The boy squirts him.
4. De opa kietelt hem.
The grandpa tickles him.
5. De vrouw kleedt haar aan.
The woman dresses her.
6. Het meisje bijt haar.
The girl bites her.
7. De verpleegster prikt haar.
The nurse pricks her.
8. De oma filmt haar.
The granny films her.

Singular-Singular congruence NO

1. De kabouter knijpt hem.
The goblin pinches him.
2. De indiaan bindt hem vast.
The Indian ties him up.
3. De jongen beschiet hem.
The boy shoots at him.
4. De oma aait haar.
The granny caresses her.
5. Het meisje omhelst haar.
The girl embraces her.
6. De vrouw slaat haar.
The woman hits her.
7. De oma fotografeert haar.
The granny photographs her.
8. De opa streelt hem.
The grandpa caresses him.

Singular-Plural incongruence YES

1. De jongen beschiet hun.
The boy shoots at them.
2. De oma omhelst hun.
The granny embraces them.
3. De indiaan bindt hun vast.
The Indian ties them up.
4. De vrouw knijpt hun.
The woman pinches them.
5. De oma aait hun.
The granny caresses them.
6. De man slaat hun.
The man hits them.

- De dokter prikt hun.
The doctor pricks them.
7. De man filmt hun.
The man films them.

Singular-Plural incongruence NO

1. De jongen beschiet hun.
The boy shoots at them.
2. De oma omhelst hun.
The granny embraces them.
3. De indiaan bindt hun vast.
The Indian ties them up.
4. De vrouw knijpt hun.
The woman pinches them.
5. De oma aait hun.
The granny caresses them.
6. De man slaat hun.
The man hits them.
7. Het meisje fotografeert hun.
The girl photographs them.
8. De opa streelt hun.
The grandpa caresses them.

Plural-Singular incongruence YES

1. De jongens beschieten hem.
The boys shoot at him.
2. De indianen binden hem vast.
The Indians tie him up.
3. De meisjes omhelzen haar.
The girls embrace her.
4. De kabouters knijpen hem.
The goblins pinch him.
5. De vrouwen aaien haar.
The women caress her.
6. De boeven slaan hem.
The thieves hit him.
7. De meisjes fotograferen haar.
The girls photograph her.
8. De oma's strelen haar.
The grannies caress her.

Plural-Singular incongruence NO

1. De brandweermannen spuiten hem nat.
The firemen squirt him.
2. De boeven wijzen hem aan.
The thieves point at him.
3. De meisjes kietelen haar.
The girls tickle her.
4. De oma's omhelzen haar.
The grannies embrace her.
5. De tovenaars raken hem aan.
The magicians touch him.
6. De meisjes bijten haar.
The girls bite her.

- De oma fotografeert hun.
The grandma photographs them.
7. De man streelt hun.
The man caresses them.

Singular-Plural incongruence NO

1. De heks raakt hun aan.
The witch touches them.
2. Het meisje wijst haar aan.
The girl points at her.
3. Het meisje kietelt hun.
The girl tickles them.
4. De oma kleedt hun aan.
The granny dresses them.
5. De man spuit hun nat.
The man squirts them.
6. De jongen bijt hun.
The boy bites them.
7. De dokter prikt hun.
The doctor pricks them.
8. De opa filmt hun.
The grandpa films them.

Plural-Singular incongruence YES

1. De brandweermannen spuiten hem nat.
The firemen squirt him.
2. De boeven wijzen hem aan.
The thieves point at him.
3. De meisjes kietelen haar.
The girls tickle her.
4. De oma's omhelzen haar.
The grannies embrace her.
5. De tovenaars raken hem aan.
The magicians touch him.
6. De jongens bijten hem.
The boys bite him.
7. De verpleegsters prikken haar.
The nurses prick her.
8. De vrouwen filmen haar.
The women film her.

Plural-Singular incongruence NO

1. De jongens beschieten hem.
The boys shoot at him.
2. De indianen binden hem vast.
The Indians tie him up.
3. De meisjes omhelzen haar.
The girls embrace her.
4. De kabouters knijpen hem.
The goblins pinch him.
5. De vrouwen aaien haar.
The women caress her.
6. De vrouwen slaan haar.
The women hit her.

7. De verpleegsters prikken haar.
The nurses prick her.
8. De jongens filmen hem.
The boys film him.

Gender incongruence YES

1. De oma aait hem.
The granny caresses him.
2. Het indianenmeisje bindt hem vast.
The Indian girl ties him up.
3. De oma omhelst hem.
The granny embraces him.
4. De kabouter knijpt haar.
The goblin pinches her.
5. De jongen beschiet haar.
The boy shoots at her.
6. Het meisje slaat hem.
The girl hits him.
7. De vrouw fotografeert hem.
The woman photographs her.
8. De opa streelt haar.
The grandpa caresses her.

Gender incongruence NO

1. De oma kleedt hem aan.
The granny dresses him.
2. Het meisje spuit hem nat.
The girl squirts him.
3. De vrouw kietelt hem.
The woman tickles him.
4. De prinses wijst hem aan.
The princess points at him.
5. De tovenaar raakt haar aan.
The magician touches her.
6. De jongen bijt haar.
The boy bites her.
7. De dokter prikt haar.
The doctor pricks her.
8. De man filmt haar.
The man films her.

7. De opa's fotograferen hem.
The grandpas photograph him.
8. De oma's strelen haar.
The grannies caress her.

Gender incongruence YES

1. De oma kleedt hem aan.
The granny dresses him.
2. Het meisje spuit hem nat.
The girl squirts him.
3. De vrouw kietelt hem.
The woman tickles him.
4. De prinses wijst hem aan.
The princess points at him.
5. De tovenaar raakt haar aan.
The magician touches her.
6. De jongen bijt het meisje.
The boy bites the girl.
7. De dokter prikt haar.
The doctor pricks her.
8. De opa filmt het meisje.
The grandpa films the girl.

Gender incongruence NO

1. De oma aait hem.
The granny caresses him.
2. Het indianenmeisje bindt hem vast.
The Indian girl ties him up.
3. De oma omhelst hem.
The granny embraces him.
4. De kabouter knijpt haar.
The goblin pinches her.
5. De jongen beschiet haar.
The boy shoots at her.
6. De man slaat haar.
The man hits her.
7. De opa fotografeert haar.
The grandpa photographs her.
8. Het meisje streelt hem.
The girl caresses him.

Appendix D

Test sentences Experiment 3

Subject unstressed condition:

1. Eerst heeft de dochter de moeder gekieteld en daarna heeft zij de vader gekieteld.
First the daughter tickled the mother and then she tickled the father.
2. Eerst heeft de vader de zoon geslagen en daarna heeft hij de dochter geslagen.
First the father hit the son and then he hit the daughter.
3. Eerst heeft de moeder de dochter gekust en daarna heeft zij de zoon gekust.
First the mother kissed the daughter and then she kissed the son.
4. Eerst heeft de vader de zoon gestreeld en daarna heeft hij de dochter gestreeld.
First the father caressed the son and then he caressed the daughter.
5. Eerst heeft de moeder de dochter geschminkt en daarna heeft zij de zoon geschminkt.
First the mother made up the daughter and then she made up the son.
6. Eerst heeft de zoon de vader getekend en daarna heeft hij de moeder getekend.
First the son drew the father and then he drew the mother.
7. Eerst heeft de moeder de dochter gefotografeerd en daarna heeft zij de vader gefotografeerd.
First the mother photographed the daughter and then she photographed the father.
8. Eerst heeft de vader de zoon gefilmd en daarna heeft hij de moeder gefilmd.
First the father filmed the son and then he filmed the mother.
9. Eerst heeft de dochter de moeder geknepen en daarna heeft zij de vader geknepen.
First the daughter pinched the mother and then she pinched the father.
10. Eerst heeft de zoon de vader gegroet en daarna heeft hij de moeder gegroet.
First the son greeted the father and then he greeted the mother.
11. Eerst heeft de moeder de dochter geduwd en daarna heeft zij de zoon geduwd.
First the mother pushed the daughter and then she pushed the son.
12. Eerst heeft de vader de zoon gedragen en daarna heeft hij de dochter gedragen.
First the father carried the son and then he carried the daughter.
13. Eerst heeft de moeder de dochter gewassen en daarna heeft zij de zoon gewassen.
First the mother washed the daughter and then she washed the son.
14. Eerst heeft de zoon de vader gekrabd en daarna heeft hij de moeder gekrabd.
First the son scratched the father and then he scratched the mother.
15. Eerst heeft de moeder de dochter gebeten en daarna heeft zij de zoon gebeten.
First the mother bit the daughter and then she bit the son.

Subject stressed condition:

1. Eerst heeft de dochter de moeder gekieteld en daarna heeft ZIJ de vader gekieteld.
First the daughter tickled the mother and then SHE tickled the father.
2. Eerst heeft de vader de zoon geslagen en daarna heeft HIJ de dochter geslagen.
First the father hit the son and then HE hit the daughter.
3. Eerst heeft de moeder de dochter gekust en daarna heeft ZIJ de zoon gekust.
First the mother kissed the daughter and then SHE kissed the son.
4. Eerst heeft de vader de zoon gestreeld en daarna heeft HIJ de dochter gestreeld.
First the father caressed the son and then HE caressed the daughter.
5. Eerst heeft de moeder de dochter geschminkt en daarna heeft ZIJ de zoon geschminkt.
First the mother made up the daughter and then SHE made up the son.
6. Eerst heeft de zoon de vader getekend en daarna heeft HIJ de moeder getekend.
First the son drew the father and then HE drew the mother.
7. Eerst heeft de moeder de dochter gefotografeerd en daarna heeft ZIJ de vader gefotografeerd.
First the mother photographed the daughter and then SHE photographed the father.
8. Eerst heeft de vader de zoon gefilmd en daarna heeft HIJ de moeder gefilmd.
First the father filmed the son and then HE filmed the mother.

9. Eerst heeft de dochter de moeder geknepen en daarna heeft ZIJ de vader geknepen.
First the daughter pinched the mother and then SHE pinched the father.
10. Eerst heeft de zoon de vader gegroet en daarna heeft HIJ de moeder gegroet.
First the son greeted the father and then HE greeted the mother.
11. Eerst heeft de moeder de dochter geduwd en daarna heeft ZIJ de zoon geduwd.
First the mother pushed the daughter and then SHE pushed the son.
12. Eerst heeft de vader de zoon gedragen en daarna heeft HIJ de dochter gedragen.
First the father carried the son and then HE carried the daughter.
13. Eerst heeft de moeder de dochter gewassen en daarna heeft ZIJ de zoon gewassen.
First the mother washed the daughter and then SHE washed the son.
14. Eerst heeft de zoon de vader gekrabd en daarna heeft HIJ de moeder gekrabd.
First the son scratched the father and then HE scratched the mother.
15. Eerst heeft de moeder de dochter gebeten en daarna heeft ZIJ de zoon gebeten.
First the mother bit the daughter and then SHE bit the son.

Object unstressed condition:

1. Eerst heeft de dochter de moeder gekieteld en daarna heeft de vader haar gekieteld.
First the daughter tickled the mother and then the father tickled her.
2. Eerst heeft de vader de zoon geslagen en daarna heeft de dochter hem geslagen.
First the father hit the son and the daughter hit him.
3. Eerst heeft de moeder de dochter gekust en daarna heeft de zoon haar gekust.
First the mother kissed the daughter and then the son kissed her.
4. Eerst heeft de vader de zoon gestreeld en daarna heeft de dochter hem gestreeld.
First the father caressed the son and the daughter caressed him.
5. Eerst heeft de moeder de dochter geschminkt en daarna heeft de zoon haar geschminkt.
First the mother made up the daughter and then the son made her up.
6. Eerst heeft de zoon de vader getekend en daarna heeft de moeder hem getekend.
First the son drew the father and then the mother drew him.
7. Eerst heeft de moeder de dochter gefotografeerd en daarna heeft de vader haar gefotografeerd.
First the mother photographed the daughter and then the father photographed her.
8. Eerst heeft de vader de zoon gefilmd en daarna heeft de moeder hem gefilmd.
First the father filmed the son and then the mother filmed him.
9. Eerst heeft de dochter de moeder geknepen en daarna heeft de vader haar geknepen.
First the daughter pinched the mother and then the father pinched her.
10. Eerst heeft de zoon de vader gegroet en daarna heeft de moeder hem gegroet.
First the son greeted the father and then the mother greeted him.
11. Eerst heeft de moeder de dochter geduwd en daarna heeft de zoon haar geduwd.
First the mother pushed the daughter and then the son pushed her.
12. Eerst heeft de vader de zoon gedragen en daarna heeft de dochter hem gedragen.
First the father carried the son and then the daughter carried him.
13. Eerst heeft de moeder de dochter gewassen en daarna heeft de zoon haar gewassen.
First the mother washed the daughter and then the son washed her.
14. Eerst heeft de zoon de vader gekrabd en daarna heeft de moeder hem gekrabd.
First the son scratched the father and then the mother scratched him.
15. Eerst heeft de moeder de dochter gebeten en daarna heeft de zoon haar gebeten.
First the mother bit the daughter and then the son bit her.

Object stressed condition:

1. Eerst heeft de dochter de moeder gekieteld en daarna heeft de vader HAAR gekieteld.
First the daughter tickled the mother and then the father tickled HER.
2. Eerst heeft de vader de zoon geslagen en daarna heeft de dochter HEM geslagen.
First the father hit the son and then the daughter hit HIM.
3. Eerst heeft de moeder de dochter gekust en daarna heeft de zoon HAAR gekust.
First the mother kissed the daughter and then the son kissed HER.

4. Eerst heeft de vader de zoon gestreeld en daarna heeft de dochter HEM gestreeld.
First the father caressed the son and then the daughter caressed HIM.
5. Eerst heeft de moeder de dochter geschminkt en daarna heeft de zoon HAAR geschminkt.
First the mother made up the daughter and then the son made up HER.
6. Eerst heeft de zoon de vader getekend en daarna heeft de moeder HEM getekend.
First the son drew the father and then the mother drew HIM.
7. Eerst heeft de moeder de dochter gefotografeerd en daarna heeft de vader HAAR gefotografeerd.
First the mother photographed the daughter and then the father photographed HER.
8. Eerst heeft de vader de zoon gefilmd en daarna heeft de moeder HEM gefilmd.
First the father filmed the son and then the mother filmed HIM .
9. Eerst heeft de dochter de moeder geknepen en daarna heeft de vader HAAR geknepen.
First the daughter pinched the mother and then the father pinched HER.
10. Eerst heeft de zoon de vader gegroet en daarna heeft de moeder HEM gegroet.
First the son greeted the father and then the mother greeted HIM.
11. Eerst heeft de moeder de dochter geduwd en daarna heeft de zoon HAAR geduwd.
First the mother pushed the daughter and then the son pushed HER.
12. Eerst heeft de vader de zoon gedragen en daarna heeft de dochter HEM gedragen.
First the father carried the son and then the daughter carried HIM.
13. Eerst heeft de moeder de dochter gewassen en daarna heeft de zoon HAAR gewassen.
First the mother washed the daughter and then the son washed HER.
14. Eerst heeft de zoon de vader gekrabd en daarna heeft de moeder HEM gekrabd.
First the son scratched the father and then the mother scratched HIM.
15. Eerst heeft de moeder de dochter gebeten en daarna heeft de zoon HAAR gebeten.
First the mother bit the daughter and then the son bit HER.

Appendix E

Test sentences Experiment 4

Bound Variable Only condition:

1. De man aait zijn hond en de jongen doet dat ook.
The man pats his dog and the boy does that too.
2. De boerin voert haar kat en de heks doet dat ook.
The female farmer feeds her cat the witch does that too.
3. De clown borstelt zijn schaap en de tovenaar doet dat ook.
The clown combs his sheep and the magician does that too.
4. De vrouw wast haar paard en het meisje doet dat ook.
The woman washes her horse and the girl does that too.
5. De man raakt zijn hond aan en de jongen doet dat ook.
The man touches his dog and the boy does that too.
6. De heks fotografeert haar kat en de fee doet dat ook.
The witch photographs her cat and the fairy does that too.
7. De tovenaar schopt zijn schaap en de clown doet dat ook.
The magician kicks his sheep and the clown does that too.
8. De opa knipt zijn hond en de man doet dat ook.
The grandfather cuts hair of his dog and the man does that too.
9. De fee duwt haar kat en de boerin doet dat ook.
The fairy pushes her cat and the female farmer does that too.
10. De vrouw trekt haar paard en het meisje doet dat ook.
The woman pulls her horse and the girl does that too.

Coreference Only Condition:

1. De heks aait haar kat en de fee doet dat ook.
The witch pats her cat and the fairy does that too.
2. De jongen voert zijn hond en de opa doet dat ook.
The boy feeds his dog and the grandfather does that too.
3. De oma borstelt haar paard en de vrouw doet dat ook.
The grandmother combs her horse and the women does that too.
4. De tovenaar wast zijn schaap en de boer doet dat ook.
The magician washes his sheep and the farmer does that too.
5. Het meisje raakt haar paard aan en de oma doet dat ook.
The girl touches her horse and the grandmother does that too.
6. De jongen fotografeert zijn hond en de opa doet dat ook.
The boy photographs his dog and the grandfather does that too.
7. De boerin schopt haar kat en de heks doet dat ook.
The female farmer kicks her cat and the witch does that too.
8. Het meisje knipt haar paard en de oma doet dat ook.
The girl cuts the hair of her horse and the grandmother does that too.
9. De clown duwt zijn schaap en de boer doet dat ook.
The clown pushes his sheep and the farmer does that too.
10. De man trekt zijn hond en de jongen doet dat ook.
The man pulls his dog and the boy does that too.

Bound Variable vs. Coreference Condition:

1. De boer aait zijn schaap en de clown doet dat ook.
The farmer pats his sheep and the clown does that too.
2. Het meisje voert haar paard en de oma doet dat ook.
The girl feeds her horse and the grandmother does that too.
3. De opa borstelt zijn hond en de man doet dat ook.
The grandfather combs his dog and the man does that too.

4. De fee wast haar kat en de boerin doet dat ook.
The fairy washes her cat and the female farmer does that too.
5. De boer raakt zijn schaap aan en de clown doet dat ook.
The farmer touches his sheep and the clown does that too.
6. De oma fotografeert haar paard en de vrouw doet dat ook.
The grandmother photographs her horse and the woman does that too.
7. De man schopt zijn hond en de jongen doet dat ook.
The man kicks his dog and the boy does that too.
8. De boer knipt zijn schaap en de tovenaer doet dat ook.
The farmer cut the hair of his sheep and the magician does that too.
9. De oma duwt haar paard en de vrouw doet dat ook.
The grandmother pushes her horse and the woman does that too.
10. De boerin trekt haar kat en de heks doet dat ook.
The female farmer pulls her cat the witch does that too.

Appendix F

Test sentences Experiment 5

Pronouns in transitive sentences

1. Eerst hebben Dipsy en Tinky-Winky gedanst en daarna heeft Tinky-Winky hem geknuffeld.
First Dipsy and Tinky-Winky danced and then Tinky-Winky cuddled him.
2. Eerst hebben Lala en Po taart gegeten en daarna heeft Lala haar gekieteld.
First Lala and Po ate cake and then Lala tickled her.
3. Eerst hebben Po en Lala aan de bloemen geroken en daarna heeft Po haar geaaïd.
First Po and Lala smelled the flowers and then Po caressed her.
4. Eerst hebben Tinky-Winky en Dipsy geslapen en daarna heeft Dipsy hem geknepen.
First Tinky-Winky and Dipsy slept and then Dipsy pinched him.
5. Eerst hebben Po en Lala op de grond gelegen en daarna heeft Lala haar gefotografeerd.
First Po and Lala lay on the ground and then Lala photographed her.
6. Eerst hebben Tinky-Winky en Dipsy gespeeld en daarna heeft Tinky-Winky hem aangeraakt.
First Tinky-Winky and Dipsy played and then Tinky-Winky touched him.

Anaphor in transitive sentences

1. Eerst hebben Dipsy en Tinky-Winky gedanst en daarna heeft Tinky-Winky zichzelf geknuffeld.
First Dipsy and Tinky-Winky danced and then Tinky-Winky cuddled himself.
2. Eerst hebben Lala en Po taart gegeten en daarna heeft Lala zichzelf gekieteld.
First Lala and Po ate cake and then Lala tickled herself.
3. Eerst hebben Po en Lala aan de bloemen geroken en daarna heeft Po zichzelf geaaïd.
First Po and Lala smelled the flowers and then Po caressed herself.
4. Eerst hebben Tinky-Winky en Dipsy geslapen en daarna heeft Dipsy zichzelf geknepen.
First Tinky-Winky and Dipsy slept and then Dipsy pinched herself.
5. Eerst hebben Po en Lala op de grond gelegen en daarna heeft Lala zichzelf gefotografeerd.
First Po and Lala lay on the ground and then Lala photographed herself.
6. Eerst hebben Tinky-Winky en Dipsy gespeeld en daarna heeft Tinky-Winky zichzelf aangeraakt.
First Tinky-Winky and Dipsy played and then Tinky-Winky touched herself.

ECM sentences pronoun

1. Eerst hebben Dipsy en Tinky-Winky gedanst en daarna zag Tinky-Winky hem touwtjespringen.
First Dipsy and Tinky-Winky danced and then Tinky-Winky saw him skipping.
2. Eerst hebben Lala en Po taart gegeten en daarna zag Lala haar dansen.
First Lala and Po ate cake and then Lala saw her dancing.
3. Eerst hebben Po en Lala aan de bloemen geroken en daarna zag Po haar eten.
First Po and Lala smelled the flowers and then Po saw her eating.
4. Eerst hebben Tinky-Winky en Dipsy geslapen en daarna zag Dipsy hem dansen.
First Tinky-Winky and Dipsy slept and then Dipsy saw him dancing.
5. Eerst hebben Po en Lala op de grond gelegen daarna zag Lala haar touwtjespringen.
First Po and Lala lay on the ground and then Lala saw her skipping.
6. Eerst hebben Tinky-Winky en Dipsy gespeeld en daarna zag Tinky-Winky hem eten.
First Tinky-Winky played and then Tinky-Winky saw him eating.

Test sentences Experiment 6
Version A

Singular-Singular congruence YES

1. De kabouter knijpt hem.
The goblin pinches him.
2. De indiaan bindt hem vast.
3. The Indian ties him up.
4. De jongen beschiet hem.
The boy shoots at him
5. De oma aait haar.
The granny caresses her.
6. De vrouw omhelst haar.
The woman embraces her.

Singular-Singular congruence NO

1. De politiemans wijst hem aan.
The police officer points at him.
2. De tovenaars raakt hem aan.
The magician touches him.
3. De jongen spuit hem nat.
The boy squirts him.
4. De opa kietelt hem.
The grandpa tickles him.
5. De vrouw kleedt haar aan.
The woman dresses her.

Singular-Plural incongruence YES

1. De heks raakt hun aan.
The witch touches them.
2. Het meisje wijst hun aan.
The girl points at them.
3. Het meisje kietelt hun.
The girl tickles them.
4. De oma kleedt hun aan.
The granny dresses them.
5. De man spuit hun nat.
The man squirts them.

Singular-Plural incongruence NO

1. De jongen beschiet hun.
The boy shoots at them.
2. De oma omhelst hun.
The granny embraces them.
3. De indiaan bindt hun vast.
The Indian ties them up.
4. De vrouw knijpt hun.
The woman pinches them.
5. De oma aait hun.
The granny caresses her.

Plural-Singular incongruence YES

1. De jongens beschieten hem.
The boys shoot at him.

Version B

Singular-Singular congruence YES

1. De politiemans wijst hem aan.
2. The police officer points at him
3. De tovenaars raakt hem aan.
The magician touches him
4. De jongen spuit hem nat.
The boy squirts him.
5. De opa kietelt hem.
The grandpa tickles him.
6. De vrouw kleedt haar aan.
The woman dresses her.

Singular-Singular congruence NO

1. De vrouw knijpt haar.
The woman pinches her.
2. De indiaan bindt hem vast.
The Indian ties him up
3. De jongen beschiet hem.
The boy shoots at him
4. De oma aait haar.
The granny caresses her.
5. Het meisje omhelst haar.
The girl embraces her.

Singular-Plural incongruence YES

1. De jongen beschiet hun.
The boy shoots at them.
2. De oma omhelst hun.
The granny embraces them.
3. De indiaan bindt hun vast.
The Indian ties them up.
4. De vrouw knijpt hun.
The woman pinches them.
5. De oma aait hun.
The granny caresses them.

Singular-Plural incongruence NO

1. De heks raakt hun aan.
The witch touches them.
2. Het meisje wijst hun aan.
The girl points at them.
3. Het meisje kietelt hun.
The girl tickles them.
4. De oma kleedt hun aan.
The granny dresses them.
5. De man spuit hun nat.
The man squirts them.

Plural-Singular incongruence YES

1. De brandweermannen spuit hem nat.
The firemen squirt him.

2. De indianen binden hem vast.
The Indians tie him up.
3. De meisjes omhelzen haar.
The girls embrace her.
4. De kabouters knijpen hem.
The goblins pinch him.
5. De vrouwen aaien haar.
The women caress her.

Plural-Singular incongruence NO

1. De brandweermannen spuiten hem nat.
The firemen squirt him.
2. De boeven wijzen hem aan.
The thieves point at him.
3. De meisjes kietelen haar.
The girls tickle her.
4. De oma's omhelzen haar.
The grannies embrace her.
5. De tovenaars raken hem aan.
The magicians touch him.

Gender incongruence YES

1. De oma aait hem.
The granny caresses him.
2. Het indianenmeisje bindt hem vast.
The Indian girl ties him up.
3. De oma omhelst hem.
The granny caresses him.
4. De kabouter knijpt haar.
The goblin pinches her.
5. De jongen beschiet haar.
The boy shoots at her.

Gender incongruence NO

1. De oma kleedt hem aan.
The granny dresses him.
2. Het meisje spuit hem nat.
The girl squirts him.
3. De vrouw kietelt hem.
The woman tickles him.
4. De prinses wijst hem aan.
The princess points at him.
5. De tovenaars raken haar aan.
The magicians touch her.

2. De boeven wijzen hem aan.
The thieves point at him.
3. De meisjes kietelen haar.
The girls tickle her.
4. De oma's omhelzen haar.
The grannies embrace her.
5. De tovenaars raken hem aan.
The magicians touch him.

Plural-Singular incongruence NO

1. De jongens beschieten hem.
The boys shoot at him.
2. De indianen binden hem vast.
The Indians tie him up.
3. De meisjes omhelzen haar.
The girls embrace her.
4. De kabouters knijpen hem.
The goblins pinch him.
5. De vrouwen aaien haar.
The women caress her.

Gender incongruence YES

1. De oma kleedt hem aan.
The granny dresses him.
2. Het meisje spuit hem nat.
The girl squirts him.
3. De vrouw kietelt hem.
The woman tickles him.
4. De prinses wijst hem aan.
The princess points at him.
5. De tovenaars raken haar aan.
The magicians touch her.

Gender incongruence NO

1. De oma aait hem.
The granny touches him.
2. Het indianenmeisje bindt hem vast.
The Indian girl ties him up.
3. De oma omhelst hem.
The granny embraces him.
4. De kabouter knijpt haar.
The goblin pinches her.
5. De jongen beschiet haar.
The boy shoots at her.

Test sentences Experiment 7

Subject unstressed

1. Eerst heeft Lala Po aangeraakt en daarna heeft zij Dipsy aangeraakt.
First Lala touched Po and then she touched Dipsy.
2. Eerst heeft Dipsy Tinky-Winky geknuffeld en daarna heeft hij Po geknuffeld.
First Dipsy cuddled Tinky-Winky and then he cuddled Po.
3. Eerst heeft Tinky-Winky Dipsy gekieteld en daarna heeft hij Lala gekieteld.
First Tinky-Winky tickled Dipsy and then he tickled Lala.
4. Eerst heeft Po Lala geknepen en daarna heeft ze Tinky-Winky geknepen.
First Po pinched Lala and then she pinched Tinky-Winky.
5. Eerst heeft Tinky-Winky Dipsy geaaid en daarna heeft hij Po geaaid.
First Tinky-Winky caressed Dipsy and then he caressed Po.
6. Eerst heeft Lala Po gefotografeerd en daarna heeft zij Dipsy gefotografeerd.
First Lala photographed Po and then she photographed Dipsy.

Subject stressed

1. Eerst heeft Lala Po aangeraakt en daarna heeft ZIJ Dipsy aangeraakt.
First Lala touched Po and then SHE touched Dipsy.
2. Eerst heeft Dipsy Tinky-Winky geknuffeld en daarna heeft HIJ Po geknuffeld.
First Dipsy cuddled Tinky-Winky and then HE cuddled Po.
3. Eerst heeft Tinky-Winky Dipsy gekieteld en daarna heeft HIJ Lala gekieteld.
First Tinky-Winky tickled Dipsy and then HE tickled Lala.
4. Eerst heeft Po Lala geknepen en daarna heeft ZIJ Tinky-Winky geknepen.
First Po pinched Lala and then SHE pinched Tinky-Winky.
5. Eerst heeft Tinky-Winky Dipsy geaaid en daarna heeft HIJ Po geaaid.
First Tinky-Winky caressed Dipsy and then HE caressed Po.
6. Eerst heeft Lala Po gefotografeerd en daarna heeft ZIJ Dipsy gefotografeerd.
First Lala Photographed Po and then SHE photographed Dipsy.

Object unstressed

1. Eerst heeft Lala Po aangeraakt en daarna heeft Dipsy haar aangeraakt.
First Lala touched Po and then Dipsy touched her.
2. Eerst heeft Dipsy Tinky-Winky geknuffeld en daarna heeft Po hem geknuffeld.
First Dipsy cuddled Tinky-Winky and then Po cuddled him.
3. Eerst heeft Tinky-Winky Dipsy gekieteld en daarna heeft Lala hem gekieteld.
First Tinky-Winky tickled Dipsy and then Lala tickled him.
4. Eerst heeft Po Lala geknepen en daarna heeft Tinky-Winky haar geknepen.
First Po pinched Lala and then Tinky-Winky pinched her.
5. Eerst heeft Tinky-Winky Dipsy geaaid en daarna heeft Po hem geaaid.
First Tinky-Winky caressed Dipsy and then Po caressed him.
6. Eerst heeft Lala Po gefotografeerd en daarna heeft Dipsy haar gefotografeerd.
First Lala photographed Po and then Dipsy photographed her.

Object stressed

1. Eerst heeft Lala Po aangeraakt en daarna heeft Dipsy HAAR aangeraakt.
First Lala touched Po and then Dipsy touched HER.
2. Eerst heeft Dipsy Tinky-Winky geknuffeld en daarna heeft Po HEM geknuffeld.
First Dipsy cuddled Tinky-Winky and then Po cuddled HIM.
3. Eerst heeft Tinky-Winky Dipsy gekieteld en daarna heeft Lala HEM gekieteld.
First Tinky-Winky tickled Dipsy and then Lala tickled HIM.
4. Eerst heeft Po Lala geknepen en daarna heeft Tinky-Winky HAAR geknepen.
First Po pinched Lala and then Tinky-Winky pinched HER.
5. Eerst heeft Tinky-Winky Dipsy geaaid en daarna heeft Po HEM geaaid.
First Tinky-Winky caressed Dipsy and then Po caressed HIM.
6. Eerst heeft Lala Po gefotografeerd en daarna heeft Dipsy HAAR gefotografeerd.
First Lala photographed Po and then Dipsy photographed HER.

Test sentences Experiment 8

Bound Variable Only

1. De clown borstelt zijn schaap en de tovenaar doet dat ook.
The clown brushes his sheep and the magician does that too.
2. De vrouw wast haar paard en het meisje doet dat ook.
The woman washes her horse and the girls does that too.
3. De heks fotografeert haar kat en de fee doet dat ook.
The witch photographs her cat and the fairy does that too.
4. De opa knipt zijn hond en de man doet dat ook.
The grandpa cuts his dog and the man does that too.
5. De fee duwt haar kat en de boerin doet dat ook.
The fairy pushes her cat and the farmer's wife does that too.

Coreference Only

1. De oma borstelt haar paard en de vrouw doet dat ook.
The granny brushes her horse and the woman does that too.
2. De tovenaar wast zijn schaap en de boer doet dat ook.
The magician washes his sheep and the farmer does that too.
3. De jongen fotografeert zijn hond en de opa doet dat ook.
The boy photographs his dog and the grandpa does that too.
4. Het meisje knipt haar paard en de oma doet dat ook.
The girl cuts her horse and the granny does that too.
5. De clown duwt zijn schaap en de boer doet dat ook.
The clown pushes his sheep and the farmer does that too.

Bound Variable vs. Coreference

1. De opa borstelt zijn hond en de man doet dat ook.
The grandpa brushes his dog and the man does that too.
2. De fee wast haar kat en de boerin doet dat ook.
The fairy washes her cat and the farmer's wife does that too.
3. De oma fotografeert haar paard en de vrouw doet dat ook.
The granny photographs her horse and the woman does that too.
4. De boer knipt zijn schaap en de tovenaar doet dat ook.
The farmer cuts his sheep and the magician does that too.
5. De oma duwt haar paard en de vrouw doet dat ook.
The granny pushes her horse and the woman does that too.

Table F.1

Individual child data Experiment 5 - number of correct responses

	<i>Age</i>	<i>Anaphor in transitives</i>	<i>Pronoun in transitives</i>	<i>Pronoun in ECM</i>
Br	5,11	12/12	5/12	1/12
Ch	5,09	11/12	5/12	3/12
Jo	6,01	12/12	6/12	8/12
Ne	5,02	12/12	6/12	1/12
Be	4,06	11/12	7/12	0/12
Jy	5,07	12/12	7/12	5/12
Sa	6,03	11/12	7/12	5/12
Da	6,06	12/12	8/12	3/12
Kr	6	12/12	8/12	2/12
Ja	5,07	8/12	8/12	6/12
Je	6,09	9/12	8/12	8/12
Se	5,05	12/12	9/12	5/12
Jm	5	12/12	9/12	8/12
Mi	6,04	11/12	9/12	9/12
El	4,1	8/12	9/12	7/12
Ky	6,02	12/12	9/12	9/12
To	5,08	10/12	9/12	4/12
Ze	6,06	10/12	9/12	7/12
Ee	6,07	11/12	10/12	6/12
Ro	5,04	12/12	11/12	4/12
Bo	5,04	11/12	11/12	4/12
Sh	6,06	12/12	11/12	7/12
Te	5,1	12/12	11/12	8/12
Gi	5,04	10/12	12/12	5/12
Ke	5,05	12/12	12/12	7/12
Ki	6,03	11/12	12/12	5/12
No	5,01	12/12	12/12	12/12
Jr	4,05	10/12	12/12	8/12
Total		310	252	157

Table F.2

Individual child data Experiment 6 - number of correct responses

	<i>Singular-Singular congr. YES</i>	<i>Singular-Singular congr. NO</i>	<i>Singular-Plural incongr. YES</i>	<i>Singular-Plural incongr. NO</i>	<i>Plural-Singular incongr. YES</i>	<i>Plural-Singular incongr. NO</i>	<i>Gender incongr. YES</i>	<i>Gender incongr. NO</i>
Te	10/10	8/10	10/10	8/10	10/10	6/10	10/10	10/10
Ev	10/10	8/10	8/10	8/10	10/10	10/10	10/10	8/10
Se	10/10	4/10	10/10	10/10	10/10	6/10	10/10	8/10
Si	10/10	8/10	10/10	10/10	10/10	0/10	10/10	8/10
Gr	10/10	6/10	10/10	10/10	10/10	6/10	10/10	10/10
S	10/10	2/10	10/10	10/10	10/10	10/10	10/10	8/10
Sh	10/10	2/10	10/10	6/10	10/10	6/10	10/10	8/10
L	10/10	8/10	10/10	10/10	10/10	10/10	10/10	10/10
Le	10/10	8/10	10/10	8/10	10/10	10/10	10/10	10/10
Ja	10/10	8/10	10/10	8/10	10/10	4/10	10/10	10/10
F	10/10	6/10	10/10	10/10	10/10	6/10	10/10	8/10
M	10/10	4/10	10/10	8/10	10/10	8/10	10/10	6/10

Table F.3

Individual child data Experiment 7 – number of correct responses.

	<i>Age</i>	<i>Subject unstressed</i>	<i>Object unstressed</i>	<i>Subject stressed</i>	<i>Object stressed</i>
Br	5,11	8/12	10/12	2/12	3/12
Ch	5,09	6/12	7/12	4/12	6/12
Jo	6,01	6/12	6/12	4/12	5/12
Ne	5,02	7/12	5/12	6/12	6/12
Be	4,06	7/12	6/12	4/12	7/12
Jy	5,07	9/12	7/12	4/12	6/12
Sa	6,03	7/12	6/12	8/12	6/12
Da	6,06	8/12	9/12	4/12	7/12
Kr	6	8/12	5/12	4/12	6/12
Ja	5,07	4/12	9/12	6/12	7/12
Je	6,09	7/12	6/12	8/12	5/12
Se	5,05	9/12	6/12	4/12	6/12
Jm	5	5/12	7/12	5/12	5/12
Mi	6,04	9/12	5/12	5/12	9/12
El	4,1	5/12	8/12	6/12	7/12
Ky	6,02	10/12	7/12	7/12	5/12
To	5,08	4/12	7/12	7/12	6/12
Ze	6,06	8/12	6/12	8/12	8/12
Ee	6,07	5/12	4/12	7/12	6/12
Ro	5,04	7/12	6/12	6/12	6/12
Bo	5,04	5/12	6/12	8/12	6/12
Sh	6,06	7/12	7/12	9/12	8/12
Te	5,1	9/12	6/12	9/12	10/12
Gi	5,04	6/12	6/12	6/12	3/12
Ke	5,05	6/12	8/12	7/12	9/12
Ki	6,03	3/12	7/12	7/12	6/12
No	5,01	5/12	7/12	7/12	7/12
Jr	4,05	6/12	6/12	8/12	3/12
Total		186	185	170	174

Table F.4

Individual child data Experiment 8 - number of correct responses.

	<i>Bv-Only</i>	<i>Co-Only</i>	<i>BVCO</i>	<i>ECM mismatch</i>
No.	3/5	0/5	5/5	14/15
Te	3/5	4/5	1/5	10/15
Sa	3/5	2/5	3/5	14/15
Ev	2/5	1/5	3/5	11/15
Sh	4/5	0/5	4/5	13/15
Si	3/5	1/5	4/5	12/15
Ge	2/5	3/5	3/5	10/15
El	4/5	1/5	2/5	14/15
Jo	4/5	0/5	5/5	15/15
My	4/5	2/5	5/5	14/15
Se	1/5	2/5	4/5	14/15
Ch	3/5	1/5	5/5	11/15
An	4/5	1/5	5/5	15/15
Ol	4/5	0/5	4/5	15/15
An	1/5	1/5	2/5	13/15
Ma	5/5	0/5	5/5	8/15
De	4/5	2/5	2/5	9/15
Fe	4/5	1/5	5/5	15/15
Ni	2/5	1/5	2/5	15/15
Total	60/95	23/95	69/95	242/285

Samenvatting in het Nederlands

In dit proefschrift onderzoek ik de totstandkoming van afhankelijkheidsrelaties tussen pronominale elementen en hun antecedenten. Ik focus daarbij op de interpretatie van persoonlijke voornaamwoorden door patiënten met een afasie van Broca. Dit proefschrift heeft als primair doel de data van deze patiënten te gebruiken in het onderzoek naar de organisatie van linguïstische kennis. De achterliggende gedachte daarbij is dat het patroon van fouten van patiënten met een afasie van Broca een reflectie is van de functionele organisatie van het systeem dat deze patiënten gebruiken om voornaamwoorden te interpreteren.

Het theoretische Primitives of Binding-model (Reuland, 2001), dat ik gebruik, gaat uit van een functionele scheiding van de verschillende linguïstische representatieniveaus waardoor de interpretatie van voornaamwoorden wordt gereguleerd. Deze niveaus zijn 'narrow syntax', semantiek en 'discourse'. Operaties die plaatsvinden op deze niveaus resulteren in verschillende soorten pronominale afhankelijkheidsrelaties. De zogenaamde economie-hiërarchie van pronominale afhankelijkheden vormt de essentie van dit theoretische model. De goedkoopste manier om voornaamwoorden te verbinden aan het juiste antecedent vindt volgens deze hiërarchie plaats door middel van een syntactische operatie. Een semantische operatie is een iets duurere optie en de 'discourse' operatie is de meest kostbare manier van een afhankelijkheidsrelatie leggen. Voornaamwoorden zijn een goed onderzoeksmiddel om verschillende linguïstische niveaus van representatie en hun interacties te bestuderen. Dit proefschrift laat zien hoe de vakgebieden van afasiologie en linguïstiek elkaar ontmoeten en helpt om de kennis te verbreden van een specifiek linguïstisch fenomeen en zijn verstoring in afasie van Broca.

Naast data van een gestoord taalsysteem draag ik ook data aan van een zich ontwikkelend taalsysteem, namelijk dat van kleuters. Alle experimenten die ik met patiënten met een afasie van Broca heb uitgevoerd, heb ik ook uitgevoerd met kinderen om hun gedrag te kunnen vergelijken. De belangrijkste redenen om data van taalverwerving toe te voegen zijn: (1) dat er wordt aangenomen dat in beide populaties de verwerkingscapaciteit is verminderd; en (2) dat er wordt aangenomen dat als gevolg van dit tekort aan verwerkingscapaciteit beide taalsystemen niet in staat zijn syntactische kennis toe te passen. Een vergelijking van de manier waarop kinderen en afasiepatiënten pronominale afhankelijkheidsrelaties interpreteren, kan inzicht geven in de wijze waarop onze kennis van deze afhankelijkheidsrelaties is gestructureerd.

Het eerste hoofdstuk is een inleiding waarin het theoretische kader van dit proefschrift wordt geschetst en de belangrijkste termen worden geïntroduceerd. In de experimenten met de afasie patiënten en kinderen heb

ik me gericht op de interpretatie van voornaamwoorden in een aantal verschillende constructies.

In hoofdstuk 2 worden twee experimenten behandeld naar de interpretatie van voornaamwoorden door afasiepatiënten in simpele transitieve zinnen zoals in (1) en in Exceptional Case Marking (ECM) constructies in (2).

- (1) De jongen kietelt *hem*.
- (2) De jongen zag *hem* dansen.

In het eerste experiment onderzoek ik de interpretatie van voornaamwoorden in deze twee soorten constructies. De resultaten van dit experiment wijzen erop dat afasiepatiënten meer problemen hebben met de interpretatie van voornaamwoorden in ECM-constructies dan in de simpele transitieve zinnen.

In het tweede experiment test ik het vermogen van patiënten om de morfosyntactische kenmerken getal en geslacht te gebruiken tijdens de interpretatie van voornaamwoorden. De resultaten van dit experiment tonen aan dat deze patiënten toegang hebben tot de morfosyntactische informatie van getal en geslacht van het voornaamwoord en deze ook kunnen gebruiken tijdens de interpretatie. Ik beargumenteer dat de resultaten van beide experimenten het best verklaard kunnen worden door het Primitives of Binding-model. Gecombineerd met de aanname dat afasiepatiënten een beperkte capaciteit hebben voor syntactische verwerking veronderstel ik dat de economie-hiërarchie in deze patiënten met een hersenbeschadiging anders is dan de economie-hiërarchie in gezonde volwassenen. Door gezonde volwassenen wordt de meest economische afhankelijkheid gerealiseerd in 'narrow syntax'. Voor patiënten met een afasie van Broca is de syntactische route niet meer de meest economische waardoor andere niveaus zoals 'discourse' worden gebruikt voor de interpretatie zonder dat daardoor de economie-hiërarchie wordt geschonden.

In hoofdstuk 3 wordt de interpretatie van voornaamwoorden met twee typen van samengestelde constructies getest. Dat zijn zinnen met het voornaamwoord als onderwerp van het tweede samenstellende deel zoals in (3), of met het voornaamwoord als lijdend voorwerp van het tweede samenstellende deel zoals in (4).

- (3) Eerst heeft *het meisje* de vrouw geknepen en daarna heeft *zij* de man geknepen.
- (4) Eerst heeft het meisje *de vrouw* geknepen en daarna heeft de man *haar* geknepen.

In dit soort constructies is een 'discourse'-operatie de enige manier om het voornaamwoord met het antecedent uit het eerste zinsdeel te verbinden. Bij de interpretatie van voornaamwoorden in deze zinnen presteren de patiënten met een afasie van Broca op kansniveau. Het foutenpatroon dat zij vertonen is het resultaat van een competitie tussen twee verschillende 'discourse'-beperkingen. De eerste beperking bestaat uit de voorkeur om de 'topic' van de zin (in beide zinnen *het meisje*) als antecedent van het voornaamwoord te nemen. De tweede beperking heet 'parallelisme' van thematische rollen, dat wil zeggen dat het voornaamwoord met een thematische rol van 'agent' refereert naar een antecedent met eenzelfde thematische rol (eveneens 'agent'). Een voornaamwoord met een thematische rol van 'patient' refereert op zijn beurt naar een antecedent met de thematische rol van 'patient'. De data van sommige patiënten wijzen op een sterke 'topic'voorkeursinterpretatie en andere patiënten lijken vooral de 'parallelisme'-beperking te hanteren.

In hoofdstuk 4 wordt de interpretatie onderzocht van bezittelijke voornaamwoorden in VP-ellipsis (5).

- (5) De oma fotografeert *haar* paard en de vrouw doet dat ook.

Dit type zinnen is ambigu. Er kan een semantische of een 'discourse' relatie gevormd worden, die beide tot verschillende interpretaties leiden. Een semantische afhankelijkheidsrelatie leidt tot de interpretatie dat de vrouw haar eigen paard fotografeert en de 'discourse' relatie geeft de betekenis dat de vrouw het paard van oma fotografeert. In dit experiment bestudeer ik de beschikbaarheid van semantische en 'discourse'-afhankelijkheden bij afasiepatiënten. De door mij geteste patiënten zijn in staat een semantische operatie te gebruiken voor de interpretatie van de bezittelijke voornaamwoorden. Maar zij zijn niet in staat een 'discourse'-afhankelijkheidsrelatie tot stand te brengen tussen het antecedent en het voornaamwoord. Zij hebben tevens een voorkeur voor een semantische interpretatie die veel sterker is dan bij de controlegroep. Ik veronderstel dat hun syntactische kennis van deze constructies niet verstoord is en dat hun fouten derhalve niet het resultaat zijn van een gebrek aan kennis, maar het gevolg zijn van een tragere syntactische verwerking.

In hoofdstuk 5 worden de data van de kleuters gepresenteerd en besproken. De vier experimenten die met de afasiepatiënten zijn uitgevoerd zijn eveneens met kinderen uitgevoerd om hun begripsvermogen van voornaamwoorden te testen. De resultaten van deze experimenten vertonen zowel gelijkenissen als verschillen in de foutenpatronen van beide populaties. Beide populaties vertonen een vergelijkbaar foutenpatroon in ECM, transitieve en samengestelde constructies. Het foutenpatroon voor de

interpretatie van bezittelijke voornaamwoorden in VP-ellipsis is echter zeer verschillend voor beide populaties. Ik beweer dat de syntaxis van kinderen zwak is en nog niet volledig operationeel is in deze fase van hun ontwikkeling. Hun syntactische verwerking is daardoor vertraagd, wat vergelijkbaar is met de trage syntactische verwerking van patiënten met een afasie van Broca. De syntactische route is niet de meest economische route voor kinderen. Zoals bij afasiepatiënten is de economie-hiërarchie in kinderen anders dan die in volwassenen. In ECM-zinnen staan kinderen het voornaamwoord toe zijn referentiële waarde te ontvangen door een discourseoperatie zonder dat daarmee de economie-hiërarchie wordt geschonden. In tegenstelling tot afasiepatiënten en gezonde volwassenen vertrouwen kinderen in VP-ellipsis constructies op de niet-linguïstische manier van interpretatie van voornaamwoorden door 'deixis'.

Op basis van deze resultaten stel ik dat bij patiënten met een afasie van Broca de hersenbeschadiging het vermogen van deze patiënten vermindert. Ik veronderstel dat het syntactische systeem van deze patiënten is verzwakt, hetgeen resulteert in een vertraagde opbouw van syntactische structuren. Bij gezonde volwassenen zijn syntactische processen de snelste processen; de meest automatische processen vormen bijvoorbeeld voornaamwoord-antecedent-relaties. Hierdoor blokkeren syntactische processen andere minder economische operaties die potentieel gebruikt kunnen worden om dergelijke afhankelijkheden vast te stellen. Bij afasiepatiënten en kleuters is syntactische informatie niet tijdig gereed om gebruikt te worden in het proces van het verbinden van voornaamwoorden met hun antecedenten. Een gevolg van deze vertraging is dat andere informatieniveaus, zoals 'discourse' of het niet-linguïstische niveau, die normaal gesproken geblokkeerd worden door syntaxis, in het spel komen en informatie leveren voor de interpretatie van voornaamwoorden. Dat kan soms leiden tot een verkeerde afhankelijkheidsrelatie en dus een verkeerde interpretatie. De waargenomen foutenpatronen bij deze populaties reflecteren daarom een competitie tussen 'narrow syntax' en andere systemen.

Curriculum vitae

Nada Vasić was born on the 16th of July 1974 in Dobož, Bosnia and Herzegovina, former Yugoslavia. She attended International School Beverweerd and obtained an International Baccalaureate (IB) diploma in 1994. She started her study of English language and literature at Utrecht University in 1995 and obtained her MA degree with distinction (Cum Laude) in 1999. In 1998 she also spent two semesters at the University of Ottawa attending psycholinguistic courses.

In 1999 Nada worked for a year as a junior researcher studying speech monitoring of stuttering individuals at the Utrecht Institute of Linguistics OTS.

Nada joined the *Comparative Psycholinguistic Project* in 2001 as an AIO (Assistent in Opleiding) and started her PhD research. This dissertation contains the results of her research.