Syntactic movement and comprehension deficits in Broca’s aphasia
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Contents

Acknowledgements ............................................................................................................................................. v

Introduction ...................................................................................................................................................... 1

1 Preliminary notions ...................................................................................................................................... 5
  1. Broca’s aphasia ........................................................................................................................................... 5
     1.1. The characterization of Broca’s aphasia ............................................................................................ 5
     1.2. The relation between production and comprehension in Broca’s aphasia ........................................... 7
  2. Syntactic movement ................................................................................................................................. 10
     2.1. Head movement ............................................................................................................................... 10
     2.2. XP-movement ................................................................................................................................... 12
     2.3. Covert movement ............................................................................................................................ 13
     2.4. Feature movement ........................................................................................................................... 15
  3. Summary .................................................................................................................................................... 19

2 Background .................................................................................................................................................. 21
  1. Syntactic movement and comprehension deficits .................................................................................. 21
     1.1. The data .............................................................................................................................................. 22
        1.1.1. Active and passive sentences ....................................................................................................... 22
        1.1.2. Clefts and relative clauses .......................................................................................................... 23
        1.1.3. A subject/object asymmetry ........................................................................................................ 24
        1.1.4. Data on other constructions involving movement ..................................................................... 26
           1.1.4.1. Wh-questions ......................................................................................................................... 26
           1.1.4.2. Head movement .................................................................................................................... 29
           1.1.4.3. Covert movement .................................................................................................................. 31
        1.1.5. Interim summary ........................................................................................................................ 32
     1.2. Accounts of the comprehension deficit in Broca’s aphasia .............................................................. 33
        1.2.1. Structural deficit theories: the Trace Deletion Hypothesis .......................................................... 34
           1.2.1.1. Arguments against the TDH .................................................................................................. 36
           1.2.1.2. Arguments in favor of the TDH ............................................................................................ 38
        1.2.2. Processing theories ..................................................................................................................... 39
           1.2.2.1. The Complexity Limitation Hypothesis .............................................................................. 41
           1.2.2.2. The Slowed Syntax Hypothesis ............................................................................................. 43
        1.2.3. Comparing the TDH and processing theories ............................................................................. 43
     1.3. Syntactic movement and comprehension deficits in Broca’s aphasia ................................................. 45
        1.3.1. Summary ...................................................................................................................................... 45
        1.3.2. The focus of this thesis: wh-questions ......................................................................................... 46
  2. French wh-questions ................................................................................................................................. 47
     2.1. Properties of French wh-questions .................................................................................................... 47
        2.1.1. Island effects ............................................................................................................................... 49
        2.1.2. Embedded clauses ..................................................................................................................... 51
        2.1.3. Intervention effects .................................................................................................................... 52
     2.2. Analyses of French wh-questions ..................................................................................................... 54
        2.2.1. Pollock et al. ............................................................................................................................... 55
3 Wh-questions in Broca's aphasia: experiments ........................................... 67
  1. Group studies versus single case studies ................................................. 67
     1.1. Differences between group and single case studies ............................. 67
     1.2. Group studies in aphasiology.............................................................. 68
        1.2.1. Problems with group studies on aphasic patients......................... 68
        1.2.2. Possibilities and advantages of group studies on aphasic patients .... 69
     1.3. Conclusion: a combination ................................................................. 71
  2. Subjects ....................................................................................................... 71
     2.1. Broca patients ...................................................................................... 71
        2.1.1. Patient selection ........................................................................... 71
        2.1.2. Language testing ......................................................................... 74
     2.2. Control group ...................................................................................... 75
  3. Comprehension experiments ...................................................................... 76
     3.1. Methodology: testing comprehension of wh-questions ......................... 76
     3.2. Experiment 1: subject and object who-questions .................................. 78
     3.3. Experiment 2: what-questions ............................................................... 89
     3.4. Experiment 3: adjunct questions ........................................................... 96
     3.5. Comprehension of wh-questions: summary .......................................... 107
  4. Experiment 4: repetition task .................................................................... 109
     4.1. The reason for performing experiment 4 .............................................. 109
     4.2. Methodology ....................................................................................... 110
     4.3. The repetition experiment ................................................................. 114
  5. General discussion ..................................................................................... 127
     5.1. Summary ............................................................................................ 127
     5.2. The effect of syntactic movement on patients' comprehension ............... 129
     5.3. Characterizing the comprehension deficit ........................................... 130
     5.4. Conclusion ........................................................................................ 132

4 Syntactic movement and comprehension deficits in Broca's aphasia: a new characterization ........................................................................................................ 133
  1. Introduction .............................................................................................. 133
  2. Comprehension of wh-questions .............................................................. 134
     2.1. Wh-in-situ versus wh-movement questions ........................................... 134
     2.2. Subject questions: French versus English-speaking Broca patients ...... 136
        2.2.1. Canonicity .................................................................................... 137
        2.2.2. An alternative approach: feature movement versus category movement .. 141
           2.2.2.1. English subject questions ....................................................... 141
           2.2.2.2. French subject questions ....................................................... 145
         2.2.3. Summary: subject questions in Broca's aphasia ......................... 148
     2.3. Comprehension of wh-questions: remaining observations .................. 149
        2.3.1. Subject and object questions in English-speaking Broca patients .... 149
2.1. Comprehension and production of wh-questions......................... 204
2.2. Movement and binding ................................................................. 206
3. Conclusion ..................................................................................... 207

References .......................................................................................... 209

Appendices ........................................................................................ 223
Appendix 1 ....................................................................................... 223
Appendix 2 ....................................................................................... 225
Appendix 3 ....................................................................................... 227
Appendix 4 ....................................................................................... 230

Samenvatting ...................................................................................... 233

Curriculum vitae .................................................................................. 237
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Introduction

This thesis discusses the comprehension deficit in Broca’s aphasia and the way in which this deficit is related to syntactic movement. Numerous studies in the field of neurolinguistics have shown that individuals suffering from this type of aphasia have severe difficulties comprehending sentences derived through syntactic movement. These studies have revealed an interesting pattern: Broca patients show better comprehension of sentences involving movement out of the subject position than of their object counterpart. The relation between syntactic movement and patients’ comprehension difficulties is therefore often characterized in terms of a subject/object asymmetry: intact comprehension of sentences involving subject movement, impaired comprehension of those involving object movement. In this thesis, I will argue that this characterization is too coarse and that it captures only a subset of the data on constructions derived through syntactic movement. I will propose a new characterization of the comprehension deficit in Broca’s aphasia.

The goal of this thesis is thus to provide more insight in the way in which syntactic movement affects patients’ comprehension. It focuses on one type of construction involving movement for which patients’ comprehension has as yet rarely been examined: wh-questions. The comprehension of wh-questions is examined in French-speaking Broca patients. French allows the wh-word to remain in-situ (i.e. in its base position), or to move to the beginning of the sentence. These two possible wh-questions are illustrated in (1).

(1) a. Tu as vu qui?  
    ‘Who did you see?’

    you have seen who

b. Qui tu as vu qui?  
    ‘Who did you see?’

    who you have seen

This characteristic of French makes it a suitable language for the examination of the effect of wh-movement on patients’ comprehension. The main question of the research performed for this thesis is: do French-speaking Broca patients have more difficulties comprehending questions in which the wh-word has been moved (i.e. questions of the type in (1b)) than those in which the wh-word has remained in-situ (i.e. questions of the type in (1a))? I have done four experiments examining this question for both argument and adjunct wh-questions. Further, patients’ comprehension of object wh-questions has been compared to that of subject wh-questions.

The results of these experiments differ from those obtained for other constructions involving movement. Crucially, Broca patients do not show a subject/object asymmetry in their comprehension of wh-questions. Based on these results, it will be argued that the characterization of the comprehension deficit in Broca’s aphasia commonly used in the neurolinguistic literature has to be refined. A
new and more fine-grained characterization will be put forward. I will argue that the comprehension difficulties of Broca patients are not related to the position out of which an element has been moved, but to the type of movement which has taken place. In particular, it will be argued that *Broca patients have less difficulty comprehending sentences involving head movement or feature movement than those involving XP-movement*. I will show that this characterization captures the data for wh-questions as well as those obtained for other constructions involving syntactic movement.

The research performed for this thesis is of a multidisciplinary nature, combining the fields of theoretical linguistics and neurolinguistics. This type of research has several consequences. First, the thesis now addresses researchers working in different disciplines. This means that the readers do not share the same background. Therefore many notions familiar to one group of readers have to be explained to the other group of readers. As a consequence, the discussion is often more explicit and proceeds much more slowly than would be the case if this thesis were of a purely theoretical or a strictly neurolinguistic nature.

Secondly, researchers working in each discipline have their own views on language and their own research methods. By combining both disciplines, one is forced to make choices that might not be appreciated by either group of researchers. For instance, theoretical linguistics might not like the choice of examining patients’ comprehension of only a limited set of wh-questions. They might argue that it would have been more interesting if patients’ comprehension of other wh-questions as well as several related constructions had also been examined. Although this is in principle true, it is simply not possible to set up such a study. Research on Broca patients is in a sense comparable to dialectological research or research on a language spoken by a small group of people. Both involve extensive fieldwork, entailing several constraints on the way research can be done. For one thing, it takes a lot of time to design an appropriate experiment or questionnaire and to select a group of subjects meeting the criteria for participation. Furthermore, in neurolinguistic research, patients often drop out in the course of the testing period, because of new brain damage or death. As a result, the population studied often behaves as a moving target, a rather unusual context for most theoretical or even descriptive linguists. In such circumstances, it is better to start examining a limited set of constructions thoroughly than to try to examine a large set of possibly interesting constructions which would endanger completion of the study.

Neurolinguists, on the other hand, might not agree with the way in which both disciplines are combined in this thesis. In their view, theoretical linguists, and especially syntacticians, make matters extremely complex. They might argue that this complexity might be interesting from a purely theoretical point of view, but that it is of no use to the research in the field of neurolinguistics. Moreover, the frameworks and notions used in theoretical linguistics are constantly changing. In the past decades, several theoretical frameworks have been put forward and subsequently abandoned. Similarly, notions that were once popular have now been removed from the theory. Neurolinguists might therefore argue that theoretical linguistics should be used in a less detailed way than it is done in this thesis. Suppose that a new framework makes no longer use of notions such as features and
feature movement. Under such a framework, the characterization of the comprehension deficit of Broca patients proposed in this thesis might be argued to become meaningless.

Such a reasoning does, however, not hold. Of course, it is very well possible that theoretical devices such as features and feature movement will no longer be used in newer theoretical frameworks. Crucially, however, the phenomenon nowadays described as resulting from feature movement will always have to be accounted for, since it is a phenomenon occurring in natural languages. As will be shown in this thesis, the phenomenon described by feature movement has a set of characteristics that can be shown to be substantially different from that of phenomena described by other types of syntactic movement. So, in any framework, this phenomenon will receive its own analysis. By consequence, the characterization of the comprehension deficit can easily be restated in new terms, whatever they will be.

Note further that a less detailed use of theoretical linguistics is not a possible alternative. On such a view, one could claim that Broca patients have difficulties with intra-sentential dependency relations. However, as will be shown in this thesis, such a claim is too coarse. Broca patients do not have difficulties with all dependency relations. Instead, their comprehension deficit is related to the type of dependency relation in that some movement operations have more effect on patients’ comprehension than others do. The data obtained on Broca patients show a very intricate pattern that can only be described if different types of syntactic movement are distinguished.

I hope that researchers in both disciplines will abstract away somewhat from their views on language and research methodology. By the end of this book, I hope to have convinced the reader that a multidisciplinary study is fruitful for the research in both fields. Theoretical linguistics provides well-defined tools useful in analyzing the data of Broca patients. At the same time, these data lead to new analyses of several syntactic constructions. Thus, research combining theoretical and neurolinguistics offers interesting new insights as well as questions for further research in both disciplines.

The outline of the thesis is as follows. Chapter 1 offers a brief introduction to the three main notions of the thesis, namely Broca’s aphasia, comprehension deficits, and syntactic movement. In chapter 2, the necessary neurolinguistic and theoretical linguistic background for the research performed for this thesis is given. The chapter presents an overview of the literature concerning syntactic movement and comprehension deficits in Broca’s aphasia. Since I have examined comprehension of wh-questions in French-speaking Broca patients, this chapter also discusses the syntactic analyses of the wh-questions under scrutiny. Chapter 3 deals with the experimental part of this study. It discusses the methodology of examining comprehension in Broca patients and presents the four experiments done for this thesis, as well as the obtained results. In chapter 4, these results are analyzed and the new characterization of the comprehension deficit in Broca’s aphasia is put forward. Finally, chapter 5 discusses some of the possible consequences of the present study as well as questions for further research.
1 Preliminary notions

This chapter introduces three of the main notions of this thesis: *Broca’s aphasia*, *comprehension deficits*, and *syntactic movement*. Section 1 gives a brief characterization of Broca’s aphasia. This type of aphasia is traditionally viewed as an output disorder, since the production of speech in individuals with Broca’s aphasia is severely impaired. However, in the past decades it has become clear that Broca patients also suffer from comprehension deficits. This thesis focuses on this aspect of Broca’s aphasia. Section 1 therefore also discusses the question whether it is legitimate to concentrate on only one of the two language disorders of Broca patients.

As will be shown in more detail in the following chapter, the comprehension deficit in Broca’s aphasia is highly restricted: patients are able to understand many different sentences, except those derived through certain types of syntactic movement. Because of this relation between syntactic movement and the comprehension deficit in Broca’s aphasia, section 2 briefly introduces the notion of syntactic movement, and describes several types of movement.

1. Broca’s aphasia

1.1. The characterization of Broca’s aphasia

Aphasia literally means ‘without speech’ and refers to the disruption of language abilities following brain damage. There are many types of aphasia, such as Broca’s aphasia, Wernicke’s aphasia, transcortical aphasia, conduction aphasia, global aphasia and so forth. I will not discuss all these types here (see for instance Goodglass & Kaplan (1972) and Obler & Gjerlow (1999) for a description of these and other types of aphasia), but focus on the main distinction between *fluent* and *non-fluent* aphasia.

Broca’s aphasia is a type of non-fluent aphasia. The name *Broca* stems from the French neurologist Paul Broca. In 1861, he described a patient with severe production difficulties, but whose comprehension was seemingly unimpaired. The brain of this patient showed large damage to the left frontal lobe. This area (Brodmann’s area 44 and 45) has later been called *Broca’s area*. Figure 1 illustrates the part of the brain where Broca’s area is located. Nowadays, it is well-known that the brain area involved in Broca’s aphasia is not limited to Broca’s area. Adjacent and deeper areas also seem to be implicated.
Traditionally, Broca’s aphasia is characterized by its slow and effortful speech, but relatively intact comprehension (cf. Goodglass 1976). An example of the speech of a Broca patient is given in (1). In this example (from Goodglass 1976) a patient is trying to explain why he went to the hospital.

(1) Ah… Monday…ah, Dad and X (referring to himself by his full name) and Dad… hospital. Two…ah, doctors…, and eh…thirty minutes…and yes… a… hospital. And, er, Wednesday… nine o’clock. And er Thursday, ten o’clock… doctors. Two doctors…and ah… teeth. Yeah,… fine.

As can be seen in this example, the speech of Broca patients only contains content words. Function words or morphemes as well as syntactic structure are virtually absent. The speech of these patients has therefore been dubbed telegraphic or agrammatic. Broca patients are also often referred to as agrammatic patients.

Note, however, that agrammatism refers to a more specific phenomenon than the traditional description of Broca’s aphasia. Agrammatic patients show a production deficit as the one illustrated in (1). Their comprehension however, is severely impaired. These patients show a very specific comprehension deficit: they have difficulties comprehending semantically reversible passive sentences, object clefts and object relative clauses, but are able to understand the subject counterparts of these sentence types (a detailed overview of the comprehension difficulties of agrammatic patients will be given in the next chapter). There has been a discussion in the neurolinguistic literature concerning the question whether agrammatism exists as a syndrome (see Badecker & Caramazza 1985; Grodzinsky 1991 and references therein). Following Grodzinsky (1991), Grodzinsky, Piñango, Zurif and Drai (1999), Zurif and Piñango (1999), and many others, I will here adopt the position that agrammatism is a phenomenon tied to Broca’s aphasia and clearly distinct from the language disorder associated with Wernicke’s aphasia.1 In the neurolinguistic literature, these patients are referred to as either Broca patients, agrammatic Broca patients, or agrammatic patients. In this thesis, I will use the term Broca patients. By Broca patients I thus mean agrammatic Broca patients producing the non-fluent

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1 See also chapter 3, section 2 for more discussion concerning the characterization of Broca’s aphasia.
speech exemplified in (1) and suffering from a comprehension deficit to be discussed in more detail in the next chapter.

Broca’s aphasia is usually contrasted with Wernicke’s aphasia.² Wernicke patients suffer from a lesion in the left anterior brain regions. This type of aphasia is characterized by fluent and effortless speech, with complex syntactic structures. However, the speech of Wernicke patients is often semantically empty, marked by words such as thing, and full of paraphasias (word and phoneme substitutions) and neologisms. Wernicke’s aphasia is also referred to as paragrammatism. The example in (2) illustrates the speech of Wernicke patients. In this example (from Obler & Gjerlow 1999), a Wernicke patient explains what brought him to the hospital.

(2) From when wine I’m here. What’s wrong with me because I ... was myself until the taenz took something about the time between me and my regular time in that time and they took the time in that time here and that’s when the time took around here and saw me around in it it’s started with me no time and then I bekan work of nothing else that’s the way the doctor find me that way ...

Apart from production difficulties, Wernicke patients suffer from severe comprehension difficulties.

In this thesis, I will focus on Broca’s aphasia. As was said above, according to the classical definition of this syndrome patients’ production is impaired, while their comprehension is relatively intact. However, since the 1980s it has become clear that this definition is too broad and that Broca patients also have a comprehension deficit. This gave rise to the question whether the production and comprehension difficulties in Broca’s aphasia might result from one underlying deficit and if so, what this deficit might be. This question will be discussed in the next section.

1.2. The relation between production and comprehension in Broca’s aphasia

The first indication that comprehension in Broca’s aphasia was impaired came from a study performed by Caramazza and Zurif (1976). They compared patients’ comprehension of semantically reversible (3a) and semantically irreversible (3b) object relative clauses.³

(3) a. The cat that the dog is chasing is brown.
   b. The apple that the boy is eating is red.

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² The function of the part of the brain now known as Wernicke’s area was first discovered and described by the German neurologist Carl Wernicke in 1874.
³ The notion ‘semantically reversible’ is used in the psycholinguistic literature to indicate sentences in which both arguments have the same animacy features. In (3a), both arguments are animate. Hence, both arguments could in principle bear the Agent role. The syntactic structure of the sentence in (3a) is the only reason why the dog is the agent and the cat the theme of the verb chase. Crucially however, if these arguments would change their position in the syntactic structure, the thematic roles would be reversed and this would still give a possible situation, namely that of a cat chasing a dog. By contrast, it is not possible to reverse the thematic roles of the arguments in sentences such as (3b). Reversion of the thematic roles would here lead to an anomalous sentence, namely an apple eating a boy.
For each sentence, patients were asked to select the picture representing the situation described in the sentence. Patients had to choose between two pictures: the correct picture and a picture in which either a lexical or a syntactic change had been made. The set of incorrect alternatives contained three lexical foils, and one syntactic foil. So, for the sentence in (3a), patients had to choose between a picture representing the correct situation (4a) and one of the incorrect alternatives given in (4b) through (4e).

(4) a. A dog chasing a brown cat. \textit{Correct response}
    b. A dog chasing a \textit{black} cat. \textit{Lexical change} \textit{(adjective)}
    c. A dog \textit{bitten} a brown cat. \textit{Lexical change} \textit{(verb)}
    d. A dog \textit{biting} a \textit{black} cat. \textit{Lexical change} \textit{(verb & adjective)}
    e. A cat chasing a brown dog. \textit{Syntactic change} \textit{(subject-object reversal)}

The results were clear: Broca patients never made a lexical error. Thus, they never selected pictures of the type in (4b) through (4d). However, when they had to choose between (4a) and (4e) their performance dropped dramatically. Crucially, patients made this syntactic reversal order only for semantically reversible sentences, such as (3a) and not for those in (3b). Caramazza and Zurif (1976) argued that this result suggested that Broca patients suffer from a comprehension deficit that is clearly linked to syntax. Indeed, in understanding a sentence of the type in (3b), patients can rely on their knowledge of the world. They know that apples do not eat boys. Hence, they correctly select the picture in which a boy is eating an apple. However, in a sentence of the type in (3a) such a strategy does not help. In order to understand this sentence, and to know who is doing what to whom, access to its syntactic structure is necessary. The observation that Broca patients are unable to understand these types of sentences suggests that in these patients syntax is impaired.

As was noted by Grodzinsky (2000a,b), this and other studies by Zurif and colleagues (amongst others Zurif, Caramazza & Myerson 1972; Zurif, Caramazza, Myerson & Galvin 1974) have had two important consequences. First of all, it brought new insight into the brain-language relation. Until then, it was commonly assumed that the brain contained several language areas which were all specified for a certain modality (speaking, hearing, writing etc.). Roughly speaking, Broca’s area was thought to house the production of speech, and Wernicke’s area the comprehension. However, studies as the one described above showed that Broca’s area also involved comprehension. Zurif and colleagues thus redefined the language areas (cf. Zurif 1980). Speaking very roughly again (see Grodzinsky 2000a,b for more details), it was now claimed that syntax resided in Broca’s area, and semantics in Wernicke’s area.

Secondly, this view led to the so-called \textit{overarching agrammatism} hypothesis (Zurif 1980). According to this hypothesis, Broca patients suffered from a central deficit disrupting both production and comprehension. This central deficit was claimed to be syntactic in nature. In other words, brain damage in Broca’s area was said to result in ‘asynaptic’ production and comprehension (Caramazza & Zurif 1976; Zurif & Caramazza 1976). This view led to several experiments comparing patients’ production and comprehension difficulties (see for instance Saffran,
Schwartz & Marin 1980; Schwartz, Saffran & Marin 1980; Friederici 1981). These studies revealed interesting parallels. Therefore, several proposals were put forward for a unified analysis of the production and comprehension deficit in Broca’s aphasia (cf. Bradley, Garret & Zurif 1980; Grodzinsky 1984).

However, the observation of counterexamples soon challenged this view. Several cases have been documented of patients showing agrammatic production, but intact comprehension (cf. Miceli, Mazzucchi, Menn & Goodglass 1983; Kolk, van Grunsven & Keyser 1985; Nespoulous, Dordain, Perron, Ska, Caplan, Mehler & Lecours 1988). The reverse pattern has also been observed. Thus, some fluent aphasics showed the comprehension difficulties typically associated with Broca’s aphasia (cf. Caplan, Baker & Dehaut 1985; Caramazza & Miceli 1991). These cases led several neurolinguists to the conclusion that there is no correlation between patients’ production and comprehension and that both systems should be examined separately (see for instance Martin, Wetzel, Blossom-Stach & Fehler 1989; Shankweiler, Crain, Gorrel & Tuller 1989).

As new evidence accumulated in the past decade, the question whether Broca patients suffer from a central deficit frequently reappeared in the literature. Some maintain the claim that comprehension and production are two different systems that can be damaged separately. For instance, Grodzinsky (2000a) argues that the hypothesis of a central deficit presumes similar patterns of loss and sparing across modalities. He shows that these patterns do not occur. Production of Broca patients can be characterized as a selective loss of some functional projections. By contrast, with respect to comprehension, Grodzinsky argues that patients have lost the traces of some but not all movement operations. Grodzinsky (2000a,b) notes that it is unclear in what way the loss of certain functional projections in patients’ production and the loss of certain traces in their comprehension can be related. Crucially, there is no correlation between the class of lost and spared functional projections on the one hand and that of intact and impaired movement operations on the other. Thus, patients show intact comprehension of sentences involving movement to functional projections that are claimed to be absent in their production (see Grodzinsky 2000b for details). In similar vein, Friedmann and Gil (2001) note several differences between the comprehension and production difficulties of Broca patients. Both Grodzinsky and Friedmann conclude that Broca patients have different deficits in production and in comprehension. Although this conclusion is not shared by everyone, it is noted more often that it is as yet unclear whether there exists a relation between production and comprehension in aphasia (cf. Parisi 1987; Caplan 1995; Thompson, Shapiro, Ballard, Jacobs, Schneider & Tait 1997).

Others argue, however, that it is still possible to assume that Broca patients suffer from a central deficit. For instance, Bastiaanse, Koekkoek and van Zonneveld (2003) argue that what is disrupted in both production and comprehension is the mechanism of *syntactic movement*. In production, Broca patients therefore avoid movement. This explains why Dutch-speaking Broca patients have more difficulties with the production of finite verbs in main clauses than with those in embedded clauses, as was observed by Bastiaanse and van Zonneveld (1998). In Dutch embedded clauses, the finite verb remains in its base position. In main clauses, by

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4 See also Bastiaanse (2002).
contrast, the finite verb has to move to a higher position in the syntactic tree (see section 2.1 below). Verbs in main clauses are therefore more difficult to produce than in embedded clauses. Other experiments also show that Broca patients prefer to produce sentences without overt movement (see Bastiaanse et al. 2003). Bastiaanse (2002) further claims that the disruption of syntactic movement yields difficulties in comprehending sentences in which movement results in a non-canonical order of the arguments. Similarly, Avrutin (2004) has proposed a model accounting for both the production and the comprehension difficulties in Broca’s aphasia. I will return to this model in the next chapter (see section 1.2.2.2). Other proposals reconciling patients’ comprehension and production deficits have been made by Kempen (2000), Nicol and Love (2000) amongst others.

In sum, the relation between production and comprehension in Broca’s aphasia is unclear. Patients show different error patterns in both modalities. Some neurolinguists therefore argue that comprehension and production are two independent systems that can be selectively damaged. Others claim that the difficulties of Broca patients in both modalities might be due to one underlying deficit. In this thesis, I will not go into this discussion. Instead, I will restrict myself to a detailed investigation of the comprehension deficit in Broca’s aphasia. As will be shown in the next chapter, there are still many open questions concerning the precise characterization of this deficit in Broca’s aphasia. These questions first have to be answered before any insightful comparison with patients’ production difficulties can be made.

In discussing the comprehension difficulties of Broca patients, syntactic movement will play a crucial role. The next section therefore offers a brief introduction to several types of movement distinguished in theoretical linguistics.

2. Syntactic movement

This section briefly describes the mechanism of syntactic movement. In theoretical linguistics, movement refers to a phenomenon in which an element is pronounced in a different position than the one in which it is generated. There are several types of movement. In this section, I will discuss five of them, which will be shown to be relevant in the rest of the thesis.

2.1. Head movement

Theoretical linguists distinguish between heads (also called Xs) and larger constituents, called XPs. Heads form the head of the constituent. XPs are larger constituents containing a head and one or more complements. The notion head refers to its function in the constituent. In (5) *buy* is the head of the constituent. It is this verb that selects the complement a book. This constituent is therefore called VP.
It is assumed that both heads and XPs can move. In this section, I will present an example of head movement. The next section discusses XP-movement.

Consider the sentences below.

(6) a. John is reading a nice book.
   b. Is John reading a nice book?

As can be seen in (6), the auxiliary *is* occupies different positions depending on the type of sentence in which it occurs. In declaratives as in (6a) it follows the subject. By contrast, in yes/no questions as in (6b) it occupies a position before the subject. It is generally assumed that in these types of sentences, *is* has been moved from its base position to a higher position in the syntactic tree. This results in the subject-auxiliary inversion in (6b). The underlying structure of (6b) is given below.

(7) CP
    \[ C^* \]
    \[ C \]
    \[ IP \]
    \[ is \]
    \[ John \]
    \[ I' \]
    \[ I \]
    \[ t_a \]
    \[ VP \]
    \[ reading a nice book \]

In the structure in (7), the auxiliary *is* is a head, generated in the I-position and subsequently moved to the C-position. This movement is indicated by an arrow, called *chain*, connecting the two positions of the verb. The original position of the verb is indicated by a *t*, meaning *trace*. This trace can be seen as a sort of footprint left behind by the moved item.

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5 I and C refer to respectively Inflection and Complementizer. Traditionally, the I-position is seen as the position where the inflectional morphemes of the verb, such as the third person singular –s in English, are generated. It is assumed that auxiliaries are also generated in this position. Complementizers, such as *that*, are assumed to be located in the C-position.

6 I will not discuss the question why the verb has to move, but only describe that it moves and how this movement is represented in the syntactic structure.

7 Recently, traces have been replaced by *copies* (Chomsky 1993). According to this copy-theory of movement, moved items do not leave a trace but a copy of themselves behind. It has further been argued that phonology determines whether the moved item or its copy is pronounced (see for instance Bobaljik...
Syntactic movement thus results in a situation in which a certain element occupies two positions in the sentence: the position in which it is generated (i.e. the base position) and the position towards which it has been moved. Interestingly, these two positions are sometimes both phonologically realized. Consider for instance the examples in (8).8

(8)  
  a. Marie denkt dass wir jetzt das Licht anmachen.  
      Marie thinks that we now the light on-make  
      ‘Mary thinks that we are now turning on the light.’
  b. Wir machen jetzt das Licht an.  
      We make now the light on  
      ‘We are now turning the light on.’

In (8b), the German verb *anmachen* (‘turn on’) has been separated into two parts. It is as if its pronunciation is spread out over two positions. The verbal part (*machen*) is pronounced in the moved position, while the prepositional part (*an-*) is pronounced in the base position of the verb. Examples of this kind are a strong argument in favor of the idea that the verb in German main clauses moves to an earlier position in the sentence.

### 2.2. XP-movement

As was said above, every head can project a larger structure, called XP. These constituents, just as heads, can move to a higher position in the syntactic structure. Here, I briefly discuss two types of XP-movement, namely NP-movement and wh-movement.

In NP-movement, an entire NP9 (i.e. a noun and its complements) moves out of his base position to a new position. A passive sentence forms a typical construction in which this type of movement takes place.

(9)  
  a. The girl kisses the tall boy.  
  b. The tall boy is kissed by the girl.

In English, the verb attributes the thematic role Theme to objects to its right. Thus, the NP *the tall boy* is generated at the right of the verb in both (9a) and (9b). However, in (9b), this NP has been moved out of its object position towards the first position in the sentence. The derivation of the sentence in (9b) is illustrated below.

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8 I owe this example to Pesetsky (1997).
9 In theoretical linguistics the notion NP has been replaced by DP, since it has been argued that the determiner and not the noun is the head of the clause. For convenience, I will however continue to speak of NPs instead of DPs.
Again, I will not discuss the reason why this movement takes place. The only thing that is important here, is that there are constructions in which elements appear in a different position than the one in which they have been generated and that this is called movement.

The second type of XP-movement relevant in this thesis is wh-movement. Wh-movement is a type of movement in which a \textit{wh-element} moves. Typical examples of wh-elements are wh-words, such as \textit{who}, \textit{what}, \textit{when} etc. In (11b) the object \textit{what} is generated in the object position at the right of the verb and has subsequently been moved to the first position in the sentence.

\begin{enumerate}[label=(\arabic*)]
\item John buys a book.
\item \textbf{What} does John buy \textit{what}?
\end{enumerate}

Wh-movement is one of the types of movement that will be discussed extensively in this thesis. The types of movement described in 2.1 and 2.2 are all \textit{visible} types of movement. In all these cases, the moved element is pronounced in a different position than the one in which it has been generated. These visible types of movement are called \textit{overt movement}. Apart from overt movement, linguists also distinguish an invisible type of movement, dubbed \textit{covert movement}. This type of movement is invisible to the extent that it does not affect the pronunciation of the sentence. In other words, it is claimed that there are elements that have been moved, but that are still pronounced in their base position. The next section discusses an example of this type of movement.

\section*{2.3. Covert movement}

The example in (12) illustrates a construction for which covert movement has been argued.

\begin{enumerate}[label=(\arabic*)]
\item Every boy kisses a girl.
\end{enumerate}

This sentence is ambiguous between a reading in which each boy is kissing a different girl and a reading in which all of the boys are kissing one and the same girl. These two readings are exemplified below.

\begin{enumerate}[label=(\arabic*)]
\item John kisses Mary, Bill kisses Sue, Peter kisses Jane. \textit{reading 1}
\item John, Bill, and Peter kiss Mary. \textit{reading 2}
\end{enumerate}

Since May (1985), it is assumed that quantifiers move to a higher position in the syntactic structure. It is further claimed that the reading in (13b) results from covert movement of the existential quantifier phrase \textit{a girl} to a position before the universal
quantifier phrase \textit{every boy}. Thus, the underlying structure of (13b) is as given in (14).

(14) \underline{a girl} every boy kisses \underline{t_{a girl}}

The structure in (14) is derived through covert movement. The NP \textit{a girl} has been moved to a position before the NP \textit{every boy}, but is still pronounced in its base position.

It has been assumed for a long time that the difference between overt and covert movement lies in the syntactic level at which movement takes place. To see this, consider figure 2, which illustrates the architecture of the grammar as proposed by Chomsky (1993).\footnote{PF and LF refer to phonological form and logical form respectively.}

![Fig.2. The 'inverted Y-model' (Chomsky 1993)](image)

According to this model, elements from the lexicon are merged into the syntactic structure. These elements can be moved in overt syntax. When these movement operations are completed, the sentence arrives at the point called spell out. At this point, the sentence is ‘sent’ to both the phonological component where it is pronounced and the semantic component where its semantic structure is determined. Crucially, it is still possible to move elements in a sentence that is on its way to LF (the semantic component). This part of syntax is called covert syntax. All movement operations that take place here do not affect the word order of the sentence, since the sentence has already been sent off to the phonological component. Hence, the pronunciation of the sentence is fixed. In other words, all movement operations that take place after spell-out do only have a semantic and not a phonological effect.

The sentence in (12) has two different readings, i.e. two different LF structures. These two LF structures are illustrated below. The structure in (15a) corresponds to the reading in (13a), and the structure in (15b) to that in (13b).

(15) a. \([cp \textbf{Every boy a girl} [sp \underline{t_{every boy}} \text{ kisses } \underline{t_{a girl}}]]\)

b. \([cp \textbf{A girl every boy} [sp \underline{t_{every boy}} \text{ kisses } \underline{t_{a girl}}]]\)
As can be seen in (15), both quantifiers move to a higher position in the syntactic structure. For convenience, the movement of the different quantifiers has been indicated by different types of arrows. The precise position to which the quantifiers move is not important here. The only issue relevant here is that the difference between the two readings in (13) lies in the different LF-positions of the quantifiers relative to each other. In (15b), the existential quantifier has been moved to a position before the universal quantifier and as a consequence has wide scope of this quantifier. The movements of the quantifiers take place after spell-out and are thus instances of covert movement.

Recently, the model in figure 2 has come under attack. Some linguists claim that covert movement does not exist and propose alternative explanations for the phenomena traditionally explained by covert movement (cf. Kayne 1998; Simpson 2000). Others argue that the difference between so-called overt and covert movement is not a syntactic difference, but a matter of phonology (cf. Bobaljik 1995, 2002; Pesetsky 1997, 1998). In these models, phonology ‘chooses’ whether the moved element is pronounced in its new position or in its base position (see also footnote 6). The first case results in what was traditionally called overt movement, the second in so-called covert movement. Further, Chomsky (1995) has changed the model in figure 2 and argued that all movement operations take place overtly. There is only one type of covert movement remaining: feature movement. This type of movement plays a crucial role in the analysis of French wh-questions as well as in the remainder of this thesis. The next section therefore presents a detailed overview of the assumptions behind feature movement.

2.4. Feature movement

Many of the analyses to be discussed in chapter 2 are based on the Minimalist Program (Chomsky 1995). In this theoretical framework, the notions of features and feature movement play an important role. Movement is seen as essentially consisting of feature movement. The assumption is that movement is triggered by the need for feature checking. A head whose features have to be checked ‘looks’ into the sentence to find another element bearing the same features. If such an element is found, the features of this element are attracted to the head so that the features of the head can be checked against the newly attracted features.

I will use the derivation of English wh-questions as an example to illustrate the notions of feature checking and feature movement. In (16) the underlying base structure of the wh-question *who did you see?* is given. This is the structure before any movement operations have taken place. In theoretical linguistics, it is assumed that every sentence is a CP. Every sentence thus contains the C-position, even though this position is not always filled by a lexical item.

(16) \[
\begin{array}{c}
\text{CP} \\
\text{C} \\
\text{IP} \\
\text{wh} \\
\text{IP} \\
\text{wh}
\end{array}
\]
The notion of features refers to the properties of lexical elements. One of the properties of the item *who* is that it is a wh-word. It is therefore assumed that *who* contains wh-features. It is further assumed that C in wh-questions also has wh-features, marking the clause as a wh-question. Finally, it is assumed that these features of C have to be checked. In essence, this means that the wh-features in C have to be related to other wh-features in the clause. Simplifying somewhat, the idea behind this assumption is as follows. As mentioned above, the wh-features of C mark the clause as a wh-question. If this is true, the clause should contain a wh-word. Indeed, wh-questions differ from yes/no questions in that the former and not the latter contain a wh-word. A wh-question is only a wh-question if it contains a wh-word. Thus, if the clause is marked as [wh], it has to contain a wh-word. In other words, in wh-questions there is a dependency relation between C and the presence of a wh-word. This relation is formally expressed by feature checking: C and the wh-word must contain the same features. Only if this is the case, the sentence is licensed by the grammar as a wh-question. It is further assumed that feature checking proceeds through feature movement: the features of the wh-word move to C. As a consequence, C ‘knows’ that the clause does contain another element bearing wh-features (i.e. a wh-word) and that the sentence can be interpreted as a wh-question. This feature movement is illustrated below. The double strike-through indicates that the features are checked.

(17) \[
\text{CP} \quad \text{C} \quad \text{[IP you see who]} \\
\text{[wh]} \quad \text{[wh]} \\
\text{t wh}
\]

Chomsky (1995) further argued that the structure in (17) is problematic for the phonological system. This system is unable to pronounce a lexical item that lacks some of its features. On this view, *who* in (17) cannot be pronounced, since it lacks its wh-features. Therefore, the grammar resorts to a ‘repair strategy’: the wh-word moves to a position where it can be recombined with its wh-features. This secondary movement step is called category movement. The resulting configuration is illustrated in (18). For convenience, the syntactic structure is represented here in the form of a tree.

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11 In chapter 2, section 2.2.3 this assumption will be discussed in more detail.
12 The insertion of the dummy auxiliary *do* is not important here and has therefore been omitted.
13 There is no difference between this way of representing syntactic structure and the way used in (16) and (17). I use a tree in (18) because in this representation positions such as Spec,CP are easier to illustrate. Whenever there is no need for illustrating these positions, I will use the more compact way of representing syntactic structure (i.e. the bracketed representation used in (16) and (17)).
As can be seen in (18), the wh-word has moved to a position before C, called the specifier of CP (Spec,CP). In this position, it can be recombined with its features. As a consequence, the phonological component is now able to pronounce the sentence. In the Minimalist Program it is thus assumed that movement consists of two steps: feature movement followed by category movement. Feature movement is covert movement, since it has no effect on the order in which the words in the sentence are pronounced. Category movement (cf. (18)), is overt movement.

These new ideas on movement have given rise to many questions. For instance, what is the nature of feature movement? Is it similar to any of the types of movement already known, such as head movement or XP-movement? Secondly, what exactly is the trigger for category movement? Is it only phonology? And if so, does this predict that this type of movement has no syntactic consequences? Further, it is unclear under what conditions a lexical element and its moved features can be recombined. Why is this possible in (18) and not (17)? Is this because in (17) the wh-word and its features are not located in the same syntactic projection, while both are in the CP domain in (18)? Or is the recombination of who and its wh-features in (17) blocked by the presence of other lexical items, namely the words you and see? The examples in (19) below illustrate the need for a clear definition of the conditions determining recombination of an element and its moved features.

(19) a. [Mit wem] glaubt Hans [CP dass Jakob jetzt t[mit wem] spricht]? with whom thinks Hans that Jacob now talks ‘With whom does Hans think that Jacob is now talking?’

b. Was glaubt Hans [CP [mit wem] Jakob jetzt t[mit wem] spricht]? WH thinks Hans with whom Jacob now talks ‘With whom does Hans think that Jakob is now talking?’

14 In this thesis, I abstract away from the various functional projections out of which IP is claimed to exist, such as TP and AgrP. These projections are not relevant for the types of syntactic movement discussed in this thesis. I will only use the projections CP, IP, and VP.

15 Obviously, in an introduction chapter such as the present one, the minimalist ideas on movement have been presented in a very brief and sketchy way. For more details, as well as a discussion on open questions, the reader is referred to Takahashi (1997), Aghayani (1998), Ochi (1999) and Pesetsky (2000).

16 In 1995, Chomsky thus slightly changes his ideas on overt and covert movement. Covert movement is now reduced to feature movement and covert syntax (see figure 2) does no longer exist.

17 See Ochi (1999) for a discussion of the trigger and the effects of this second movement step.
The contrast in (19) shows that German allows a wh-element to move to the first position of the matrix clause (19a) or to move halfway, to the specifier of the embedded CP (19b). In the second case, the matrix clause contains the scope marker *was* (glossed as WH). Cheng (2000) has argued that (20b) involves feature movement. The wh-features of *mit wem* ('with whom') move out of the embedded CP to the matrix C (i.e. the beginning of the sentence) and are there spelled out as *was*. Her analysis of (19b) is given in (20).

(20) \[ \begin{array}{c}
\text{CP} \text{ was glaubt } [_{IP} \text{ Hans } [_{CP} \text{ [mit wem]} C^0 _{IP} \text{ Jakob jetzt } t_{[mit wem]} \text{ spricht}]]]?
\end{array} \]

In (20) the wh-item *mit wem* moves to the specifier of the embedded CP. The wh-features of this wh-element move further to the matrix C in order to check the wh-features of C. C is then spelled out as the scope marker *was*. If Cheng is correct, moved features and their originating lexical element do not have to be located in the same syntactic projection. Moreover, this example shows that the presence of other lexical items does not block the recombination of the wh-item *mit wem* and its moved wh-features. Examples such as (19b) thus suggest that a more sophisticated description of the conditions on recombination is needed. Several conditions have been proposed. One of them will be discussed in chapter 4, section 2.2.2.

In light of these questions and problems, it is important to note that feature movement has also been claimed to be a phenomenon in its own right and not the first step of a secondary overt movement of the lexical item. This claim has been put forward by Pesetsky (2000). He argued that feature movement does exist, but that it differs from the way proposed by Chomsky (1995). In particular, Pesetsky argues that apart from overt and covert *phrasal* (i.e. head or XP) movement, there is a kind of movement in which less than the entire element is moved. This type of movement is feature movement, since only the formal features of the element move. In chapter 2, section 2.2.3, I will discuss his views on feature movement.

To conclude, it has recently been argued that there exists a type of movement called *feature movement*. This process involves movement of the formal characteristics (features) out of a lexical element, while the element itself remains in its base position. Many aspects of this type of movement are still unknown. The only thing that is clear for now is that there is a dependency relation between two positions in the sentence that is formally expressed as feature movement. In the remainder of this thesis, I will show that this kind of movement provides a new and better characterization of the data of Broca patients. This is done in chapter 4. Conversely, as will be shown in chapter 5, these data shed new light on the nature of feature movement.

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18 See Van Riemsdijk (1982) and McDaniel (1989) for a discussion of this phenomenon, called *partial movement*. 
3. Summary

In this chapter, I have introduced the notions of Broca’s aphasia and syntactic movement. I have further presented an overview of the discussion concerning the relation between the production and comprehension difficulties of Broca patients. This led to the conclusion that it is unclear whether these systems are related and whether there is one underlying deficit for the language disorders observed in Broca’s aphasia. In the remainder of this thesis, I will concentrate on patients’ comprehension difficulties.
2 Background

The purpose of this thesis is to provide more insight in the way in which syntactic movement affects comprehension in Broca’s aphasia. In order to do so, I will examine the comprehension of wh-questions by French-speaking Broca patients.

This chapter gives the neurolinguistic and theoretical linguistic background of the experiments performed for this thesis. Section 1 discusses the comprehension deficit in Broca’s aphasia. It presents an overview of the data concerning patients’ comprehension of constructions involving syntactic movement. It will be argued that many aspects of the relation between syntactic movement and patients’ comprehension difficulties are still unclear. The amount of data obtained on several constructions derived through movement is still insufficient to determine whether the types of movement underlying these constructions affect patients’ comprehension. In this thesis, I will therefore examine one of these types of syntactic movement: wh-movement in wh-questions. The study focuses on French wh-questions. Section 2 therefore discusses the syntactic properties and analyses of French wh-questions.

1. Syntactic movement and comprehension deficits

As mentioned in the previous chapter, the study by Caramazza and Zurif (1976) revealed that Broca patients do not only suffer from production, but also from comprehension difficulties. This observation led to the hypothesis that patients’ language difficulties in both modules arise from a complete loss of syntax (cf. Caramazza & Zurif 1976; Caplan & Futter 1986). However, numerous studies revealed that Broca patients were able to understand many syntactic constructions and that many syntactic aspects were still intact. These patients were shown to have retained knowledge of the theta-criterion (cf. Lapointe 1985), argument structure (cf. Shapiro & Levine 1990; Shapiro, Brookins, Gordon & Nagel 1991; Shapiro, Gordon, Hack & Killackey 1993; Grodzinsky & Finkel 1998), and subcategorization rules (cf. Linebarger, Schwarz & Safran 1983a). In other words, syntax in Broca’s aphasia seemed to be largely intact. The only exception is syntactic movement. Broca patients are unable to detect violations of syntactic movement (cf. Schwartz, Linebarger, Safran & Pate 1987; Grodzinsky & Finkel 1998). Further, these patients have severe difficulties comprehending sentences derived through syntactic movement. It is therefore often stated that syntactic movement forms the key factor underlying the comprehension deficit of Broca patients. In this section, I will present an overview of the results obtained in studies examining patients’ comprehension of sentences involving syntactic movement. This will be done in section 1.1. In section 1.2, I will discuss several explanations of the comprehension deficit in Broca’s aphasia.

19 See Grodzinsky (1995a, 2000b) for a more detailed overview.
1.1. The data

Studies investigating patients’ comprehension of constructions involving syntactic movement have focused on their comprehension of active sentences, passive sentences, clefts, and relative clauses. The data obtained in these studies are summarized and discussed in the sections 1.1.1 through 1.1.3. However, apart from these constructions, there are many other constructions involving syntactic movement. Patients’ comprehension of these constructions has either rarely been examined or has revealed contradictory results. The data obtained on these constructions are therefore discussed separately, in section 1.1.4.

1.1.1. Active and passive sentences

The study by Caramazza and Zurif (1976) revealed that Broca patients had difficulties comprehending passive sentences. Since then, numerous studies observed the same contrast in patients’ comprehension of active and passive sentences. Broca patients correctly understand active sentences, but have severe difficulties with the comprehension of passive sentences (cf. Ansell & Flowers 1982; Caplan et al. 1985; Caplan & Futter 1986; Schwartz et al. 1980, 1987; Ostrin & Schwartz 1986; Sherman & Schweikert 1989). Patients’ comprehension of these kinds of sentences is usually examined by means of a sentence-picture matching task. In this task, the experimenter shows two pictures, one depicting correctly the situation described in the sentence, and one depicting the reversed situation. Thus, for the sentences in (1), patients are shown a picture of a girl pushing a boy and a picture of a boy pushing a girl.20

(1) a. The girl pushes the boy.
   b. The boy is pushed by the girl.

The experimenter reads out a sentence aloud and patients are asked to point to the picture corresponding to the sentence. It has been observed that for active sentences, Broca patients select the correct picture. However, their performance drops to chance-level in passive sentences. This indicates that for the sentence in (1b), Broca patients do not know who is doing what to whom. Hence, in a forced-choice task, they resort to guessing and score at chance-level.21

This difference between patients’ comprehension of active and passive sentences suggests that the comprehension deficit of Broca patients is related to syntactic movement. As was explained in the previous chapter, passive sentences are derived through NP-movement of the underlying object.

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20 In some experiments lexical foils are also included. Thus, apart from the picture depicting correctly the situation and one in which the thematic roles are reversed, two other pictures are included showing an event that is lexically related to the event of the sentence.

21 It is commonly assumed that this chance-level performance indicates that patients are not using a strategy based on the linear order of the arguments. If they would use such a strategy, they would consistently reverse the thematic roles of the arguments in sentences of the type in (1b). Hence, they would always point to the picture in which a boy is hitting a girl. Crucially, this results in below chance-level performance. The observed chance-level performance indicates that patients are guessing. I will return to chance-level and its interpretation in chapter 3.
Evidence for the fact that the difficulties understanding passives follow from syntactic movement and not from passive morphology, comes from two different studies. First, Hagiwara (1993) observed that Japanese-speaking Broca patients have difficulties with the comprehension of direct passives as in (3a), but crucially not with that of indirect passives (3b).

(3) a. Taro-ga Hanako-ni nagu-rare-ta.  
    Taro-NOM Hanako-by hit-PASS-PAST  
    ‘Taro was hit by Hanako.’  
    
    b. Okaasan-ga musuko-ni kaze-o hik-are-ta  
    Mother-NOM a son-by a cold-ACC catch-PASS-PAST  
    ‘Mother has (her) son catch a cold on her.’

Indirect passives, in contrast to direct passives, do not involve movement. Both types of sentences in (3) contain passive morphology. The observation that Broca patients interpret (3a) worse than (3b) thus has to be related to syntactic movement. Secondly, Grodzinsky, Pierce and Marakovitz (1991) compared patients’ comprehension of verbal passives (4a) with that of adjectival passives (4b).

(4) a. The man was hit by the woman.  
    verbal passive  
    b. The man was interested in the woman.  
    adjectival passive

The results revealed a clear contrast: patients had no difficulties comprehending sentences of the type in (4b), while they had severe difficulties comprehending sentences of the type in (4a). Again, this difference can only be explained if patients’ difficulties with (4a) are related to syntactic movement. The sentences in (4) both contain the passive morpheme –ed. However, their syntactic derivation differs. The sentence in (4b), in contrast to that in (4a), does not involve NP-movement. These data thus show that NP-movement yields impaired comprehension.22

1.1.2. Clefts and relative clauses

Numerous studies have revealed that patients’ comprehension of object relative clauses (5a) and object clefts (5b) is impaired (cf. Ansell & Flowers 1982; Caplan et al. 1985; Caplan & Futter 1986; Grodzinsky 1989; Sherman & Schweikert 1989; 22 Other types of NP-movement, such as raising, also yield comprehension difficulties. Raising is illustrated in (ib) below. The verb seem does not select an Agent. Hence, either a dummy subject it is inserted at the subject position (ia), or the subject of the embedded verb is ‘raised’ to the subject position of seem (ib).  

(i) a. It seems that John is ill.  
    b. John seems to be ill.  

Although the data concerning patients’ comprehension of raising constructions are not as abundant as those on passive sentences, there is some evidence suggesting that patients’ comprehension of sentences of the type in (ib) is impaired (cf. Hildebrandt, Caplan & Evans 1987; Caplan & Hildebrandt 1988ab; Grodzinsky & Finkel 1998).
Hickok, Zurif & Canseco-Gonzalez 1993; Hickok & Avrutin 1995). In these constructions too, patients score at chance-level.

(5)  
a. I see the boy who the girl pushes.
   b. It is the boy who the girl pushes.

In theoretical linguistics, it is commonly assumed that these constructions do not involve NP-movement. Instead, they are derived through wh-movement. The structure of (5a) is illustrated below.

(6)  
I see the boy [CP who [IP the girl pushes twho]]

As can be seen in (6), relative clauses contain a wh-operator (who). This operator is moved from its base position to the Spec,CP of the embedded clause. Further, the head noun the boy is related to this wh-operator through some sort of predication relation, indicated here by the dotted line. The precise formulation of this predication relation is not important here. What is important is that the result of this relation is that the boy is interpreted both as the object of the main verb see and as the object of the embedded verb push. The derivation of clefts (5b) is similar to that of relative clauses. In chapter 4, section 3, I will discuss the derivation of relative clauses and clefts in more detail. For now, it is sufficient to conclude that patients’ difficulties understanding passive sentences, object clefts, and object relative clauses show that syntactic movement is a key factor underlying the comprehension deficit in Broca’s aphasia.

1.1.3. A subject/object asymmetry

In the previous sections, I have summarized the findings obtained on Broca patients. These findings show that patients’ comprehension of sentences derived through NP- or wh-movement is impaired. However, NP-movement and wh-movement do not always result in comprehension difficulties. As is illustrated below, the subject variants of the sentences in (5) are also derived through wh-movement.

(7)  
a. I see the girl [CP who [IP twho pushes the boy]]
   b. It is the girl [CP who [IP twho pushes the boy]]

Similarly, it is assumed in theoretical linguistics that in active sentences, the subject also moves (cf. Kitagawa 1986; Koopman & Sportiche 1988). It is generated within the VP and moves into the Spec,IP position. Thus, the derivation of (1a) is as in (8).

(8)  
[IP The girl [VP tgirl pushes the boy]]
Crucially, patients’ comprehension of these constructions has been shown to be relatively intact (cf. Caramazza & Zurif 1976; Ansell & Flowers 1982; Caplan et al. 1985; Grodzinsky 1989; Sherman & Schweikert 1989; Hickok et al. 1993). In contrast to the chance-level score obtained on passive sentences, object clefts and object relative clauses, Broca patients score above chance-level on active sentences, subject clefts, and subject relative clauses. Thus, patients’ comprehension shows the following pattern.

(9) a. The girl pushes the boy. active
    b. I see the girl who pushes the boy. subject rel.
    c. It is the girl who pushes the boy. subject cleft
    d. The boy is pushed by the girl. passive
    e. I see the boy who the girl pushes. object rel.
    f. It is the boy who the girl pushes. object cleft

This pattern has not only been observed in English-speaking Broca patients. Instead, numerous crosslinguistic studies has revealed the similar pattern in the comprehension of Broca patients (see among others Caplan et al. (1985) for French; Lukatela, Shankweiler & Crain (1995) for Serbo-Croatian; Beretta, Piñango, Patterson & Harford (1999) for Spanish; Luzzatti, Toraldo, Guasti, Ghirardi, Lorenzi & Guarnaschelli (2001) for Italian; Friedmann & Gvion (2003) and Friedmann & Shapiro (2003) for Hebrew; Burchert, de Bleser & Sonntag (2003) for German; Bastiaanse & Edwards (2004) for Dutch23). In the neurolinguistic literature, the pattern in (9) is therefore referred to as the ‘standard pattern’ or the ‘core data’.25 It is assumed to be the pattern typically found in Broca patients and the dissociation illustrated in (9) is nowadays used in some neurolinguistic tests as an indication for Broca’s aphasia. Based on these data, the comprehension deficit in Broca’s aphasia is often characterized as follows: intact comprehension of sentences involving movement out of the subject position (e.g. 9a-c), impaired comprehension of sentences involving movement out of the object position (e.g. 9d-f) (cf. Grodzinsky et al. 1991; Hickok et al. 1993; Saddy 1995; Zurif 1995; Hickok & Avrutin 1996; 23 But see Kolk & van Grunsven (1985) for contradictory results.

24 Note that the subject/object asymmetry illustrated in (9) has been observed both in languages with and languages without visible case marking. In case marking languages such as German, Hebrew and Serbo-Croatian, the case marker indicates the function of the NP. Apparently, patients do not profit from case morphology when interpreting a sentence. See Smith & Mimica (1984), Lukatela et al. (1995), Burchert et al. (2003), and Friedmann & Shapiro (2003) for a discussion of this observation.

25 Note however, that the pattern in (9) and especially the data concerning passives are subject to a large amount of variation. Several cases of intact comprehension of passives have been documented (cf. Berndt, Mitchun & Haendiges 1996; Caramazza, Capitani, Rey & Berndt 2001; Luzzatti et al. 2001; Burchert et al. 2003). This has led to a discussion revolving around the question whether Broca’s aphasia is associated with a single pattern of comprehension performance. Some underscore the individual variation in the data and claim that there is no comprehension deficit characterizing Broca’s aphasia (cf. Berndt et al. 1996; Berndt & Caramazza 1999; Caramazza et al. 2001). Others advocate the opposite position, by stressing the general pattern emerging from all these studies (cf. Drai & Grodzinsky 1999; Grodzinsky et al. 1999; Zurif & Piñango 1999; Drai, Grodzinsky & Zurif 2001). I will adopt the latter position. See Hickok et al. (1993), Grodzinsky et al. (1999), and Grodzinsky (2000b) for a discussion concerning variation in patients’ performance.
In section 1.2, I will discuss several explanations for the comprehension deficit in Broca’s aphasia. Crucially, all these explanations are based on the characterization of the comprehension deficit given above. They all propose an account for the subject/object asymmetry illustrated in (9). In the remainder of this section, I will show, however, that the above-mentioned characterization has to be refined. First, patients’ comprehension of wh-questions suggests that object movement does not always yield impaired comprehension. Secondly, apart from NP and wh-movement, other types of movement can be distinguished. It has to be examined whether these types of movement also affect patients’ comprehension and if so in what way.

1.1.4. Data on other constructions involving movement

1.1.4.1. Wh-questions

In sharp contrast to the large amount of crosslinguistic data obtained on the constructions exemplified in (9), patients’ comprehension of wh-questions has rarely been examined. The neurolinguistic literature contains only two studies investigating comprehension of wh-questions by Broca patients: a study by Hickok and Avrutin (1996) and one by Thompson, Tait, Ballard and Fix (1999). Both studies have been done on English-speaking Broca patients. The data obtained in these studies suggest that patients’ comprehension of wh-questions differs from that of other constructions involving syntactic movement. Patients’ comprehension of wh-questions does not show the same subject/object asymmetry as illustrated in (9). I will therefore discuss these studies in more detail.

Hickok and Avrutin (1996) examined comprehension of subject and object wh-questions in two English-speaking Broca patients. This study revealed two remarkable findings concerning patients’ comprehension of wh-questions. First of all, Hickok and Avrutin observed no difference between patients’ comprehension of subject and object wh-questions. Patients scored above chance on both types of sentences, exemplified in (10).

(10) a. Who t_who chased the tiger?  above chance-level performance
    b. Who did the tiger chase t_wh?  above chance-level performance

The above chance-level performance on object wh-questions in (10b) is striking in light of patients’ deficit comprehending constructions involving movement out of the object position (cf. the examples in (9d) through (9f)). Similar to object clefts and relative clauses, these constructions are derived through wh-movement out of the object position (see the examples in (7) for the derivation of clefts and relative clauses). If the comprehension deficit in Broca’s aphasia is characterized as described above, these patients are expected to score at chance-level on questions of the type in (10b).

Secondly, Hickok and Avrutin observed that patients’ comprehension of D-linked questions (11) differed from that of non D-linked questions (10). Patients scored above chance on D-linked subject wh-questions (11a), but at chance on D-linked object wh-questions (11b).
(11) a. Which lion \text{which lion} chased the tiger?  \textit{above chance-level performance}  
b. Which lion did the tiger chase \text{which lion}? \textit{chance level performance}  

In contrast to non D-linked questions (10), patients’ comprehension of D-linked questions (11) thus patterns with the data typically observed in Broca’s aphasia (i.e. the pattern in (9)).

These data give rise to two questions. First, how can the above chance-level score on non D-linked object questions (10b) be explained? Secondly, how can the difference between patients’ comprehension of D-linked and non D-linked wh-questions be explained?

In the literature following the experiment of Hickok and Avrutin, the focus has been on the second question. Hickok and Avrutin proposed and explanation for the difference between D-linked and non D-linked questions (and see also Grodzinsky (1995a) and Avrutin (2000)). Further, Thompson et al. (1999) replicated the study by Hickok and Avrutin, focusing on the difference between D-linked and non D-linked wh-questions. The results of their study showed a lot of individual variation. Thompson and colleagues therefore claim that the sensitivity to D-linking is not a characteristic of Broca’s aphasia, but of a subset of Broca patients.26

This thesis discusses the effect of syntactic movement on patients’ comprehension. I will therefore not go into the issue of D-linking. Instead, I will focus on the results obtained on non D-linked wh-questions. As mentioned above, these results are interesting, because they differ from the results obtained on other constructions involving syntactic movement. Table 1 gives the individual results of the patients examined by Hickok and Avrutin and those examined by Thompson and colleagues.

Table 1

\textit{Comprehension of who-questions in English-speaking Broca patients (percentage correct)}

<table>
<thead>
<tr>
<th>Patient</th>
<th>subject who-question</th>
<th>object who-question</th>
</tr>
</thead>
<tbody>
<tr>
<td>RD(^a)</td>
<td>80*</td>
<td>87*</td>
</tr>
<tr>
<td>FC(^a)</td>
<td>93*</td>
<td>87*</td>
</tr>
<tr>
<td>MD(^b)</td>
<td>70*</td>
<td>80*</td>
</tr>
<tr>
<td>CH(^b)</td>
<td>55</td>
<td>75*</td>
</tr>
<tr>
<td>DL(^b)</td>
<td>95*</td>
<td>90*</td>
</tr>
<tr>
<td>FP(^b)</td>
<td>90*</td>
<td>60</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>80.0</strong></td>
<td><strong>79.1</strong></td>
</tr>
</tbody>
</table>

\(^a\) data from Hickok & Avrutin (1996)  
\(^b\) data from Thompson et al. (1999)  
* indicates above chance-level score27

26 However, Avrutin (2000) showed that if the results obtained by Hickok and Avrutin and those obtained by Thompson et al. are combined and the results of the group of patients rather than individual scores are examined, the contrast between D-linked and non D-linked constructions remains.

27 See Hickok & Avrutin (1996) and Thompson et al. (1999) for details concerning the statistics.
Based on these data, it can be concluded that English-speaking Broca patients understand both subject and object who-questions equally well (around 80% correct).28

As mentioned above, this is a striking observation in light of patients’ comprehension of other constructions involving syntactic movement. Broca patients typically show better comprehension of sentences involving movement out of the subject position than of their object counterparts. Crucially, the Broca patients participating in the experiments of Hickok and Avrutin and of Thompson and colleagues also showed this subject/object asymmetry in their comprehension of active sentences, passive sentences, clefts, and relative clauses. The results on these constructions are given in table 2.

Table 2
Comprehension of constructions involving syntactic movement (percentage correct)

<table>
<thead>
<tr>
<th>Patient</th>
<th>actives</th>
<th>passives</th>
<th>subject clefts and relative clauses</th>
<th>object clefts and relative clauses</th>
</tr>
</thead>
<tbody>
<tr>
<td>RD</td>
<td>100</td>
<td>58</td>
<td>93</td>
<td>36</td>
</tr>
<tr>
<td>FC</td>
<td>90</td>
<td>57</td>
<td>90</td>
<td>40</td>
</tr>
<tr>
<td>MD</td>
<td>90</td>
<td>65</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>CH</td>
<td>80</td>
<td>50</td>
<td>90</td>
<td>30</td>
</tr>
<tr>
<td>DL</td>
<td>90</td>
<td>65</td>
<td>90</td>
<td>40</td>
</tr>
<tr>
<td>FP</td>
<td>80</td>
<td>50</td>
<td>70</td>
<td>30</td>
</tr>
<tr>
<td>Mean</td>
<td>88.3</td>
<td>57.5</td>
<td>85.5</td>
<td>39.3</td>
</tr>
</tbody>
</table>

28 Notice that the data in table 1 show some individual variation. Patients MD and DL pattern with the patients examined by Hickok and Avrutin (patients RD and FC) in that they score above chance-level on both subject and object who-questions. However, patient FP shows better comprehension of subject than of object questions, whereas the reversed pattern is observed in the scores of patient CH. These individual differences will not be discussed here. As mentioned in footnote 24, in investigating the comprehension deficit in Broca’s aphasia, I will concentrate on the general pattern rather than on the individual results.
Table 1 shows that patients’ comprehension of who-questions differs from that of other constructions involving syntactic movement. This suggests that the relation between syntactic movement and the comprehension deficit in Broca’s aphasia might have to be characterized in a different way than assumed until now. In the following sections, I will discuss the effect of several other types of syntactic movement on patients’ comprehension.

1.1.4.2. Head movement
As explained in chapter 1, linguists distinguish between XP-movement and X-movement (head movement). The types of movement discussed in the previous sections, NP-movement and wh-movement, are both instances of XP-movement. The question thus arises whether head movement also affects patients’ comprehension, or whether their comprehension deficit is restricted to XP-movement. This question is a topic of debate in the neurolinguistic literature. Some (e.g. Grodzinsky 1995a, 2000b; Friedmann & Gil 2001) claim that patients’ comprehension of constructions involving head movement is intact. Others, such as Bastiaanse et al. (2003) advocate a general movement deficit and argue that both XP-movement and X-movement are impaired in Broca’s aphasia.

The claim that head movement does not affect patients’ comprehension is based on the results obtained on several studies. For instance, Grodzinsky and Finkel (1998) compared patients’ ability to detect (un)grammaticality in constructions involving NP-movement, such as (12bc), versus constructions involving head movement, such as (13bc).

(12) a. It seems likely that John will win.
   b. John seems likely t_{Obama} to win.
   c. *John seems that it is likely t_{Obama} to win.

(13) a. They could have left town.
   b. Could they t_{Obama} have left town?
   c. *Have they could t_{Obama} have left town?

The sentence in (13c) involves violation of the Head Movement Constraint, according to which heads are not allowed to move over other heads (cf. Chomsky 1986; Rizzi 1990). In (13c) the head have has been moved over the head could, yielding an ungrammatical sentence. The sentence in (13b) also involves head movement, but here the head could does not cross another head. This sentence thus does not violate the Head Movement Constraint. Grodzinsky and Finkel (1998) observed that Broca patients were unable to detect the (un)grammaticality of constructions of the type in (12b) and (12c). By contrast, they correctly judged the (un)grammaticality of sentences of the type in (13b) and (13c). Grodzinsky and Finkel (1998) take this to mean that head movement, in contrast to NP-movement, does not affect patients’ comprehension.

Similarly, Friedmann and Gil (2001) examined the effect of head movement in Hebrew-speaking Broca patients in a sentence picture matching task. The construction in (14b) is called triggered inversion and involves movement of the verb to the C position (cf. Shlonsky 1997).
(14) a. Ha-yom ha-savta mecayeret et ha-nexda.
   ‘Today, grandmother draws her grandchild.’

b. Ha-yom mecayeret ha-savta t mecayeret et ha-nexda.
   ‘Today, grandmother draws her grandchild.’

For each of the sentences in (14), patients were shown two pictures, one of a grandmother drawing a child and one depicting the reversed situation. Patients were asked to point to the picture corresponding to the sentence. The results revealed no difference between patients’ score on both types of questions. Friedmann and Gil therefore conclude that head movement does not affect comprehension in Broca’s aphasia (see also Friedmann & Shapiro (2003) for similar results). Other results suggesting intact comprehension of constructions derived through head movement were obtained by Linebarger et al. (1983a) and by Lonzi & Luzzatti (1993).

However, Bastiaanse et al. (2003) argued that the evidence in favor of intact head-movement is not as clear-cut as it is sometimes presented. They argued that patients’ comprehension of sentences involving head movement cannot be tested, since head movement does not lead to a possible different interpretation. In contrast to XP-movement, head movement does not change the order of the arguments. Hence, in a sentence-picture matching task, such as the one done by Friedmann and Gil, there is no reason to expect patients to select the wrong picture. Bastiaanse and colleagues concluded that it is impossible to examine patients’ comprehension of sentences involving verb movement. Grammaticality judgment tasks only examine patients’ parsing of constructions. It is, however, unclear whether success on a grammaticality judgment task implies intact comprehension (cf. Zurif & Grodzinsky 1983; Caplan 1995, Friedmann, Biran, Gvion & Novogrodsky (to appear)).

Recently, Friedmann and colleagues developed a new task to examine the effect of head movement on patients’ comprehension (cf. Friedmann et al. to appear). They compared patients’ comprehension of the triggered inversion construction (15b) to that of sentences in which the verb has remained in its base position (15a). Crucially, in this experiment, these sentences contained verb noun homophones. An example is given below. The word xacav can either be a noun and mean ‘squill’ (a type of plant) or it can be a verb and mean ‘quarry’.

(15) a. etmol ha-ish ra’ah xacav ba-har
   ‘Yesterday the man saw a squill in the mountain.’

b. etmol ra’ah ha-ish t ra’ah xacav ba-har
   ‘Yesterday saw the man squill the-mountain’

The sentences in (15) mean the same. In both xacav is a noun and the object of the verb ra’ah (‘see’). Patients were required to paraphrase the target sentence. The results showed a difference between patients’ performance on these two sentences. Patients correctly paraphrased sentences of the type in (15a). However, (15b) was
often paraphrased as ‘the man quarried in the mountain’. Friedmann et al. argue that this indicates that patients fail to link the moved verb ra‘ah to its trace position. As a result, they interpret the word following the subject as a verb. Hence, they analyze xacav as a verb.

The observations of Friedmann et al. thus suggest that verb movement does affect comprehension in Broca’s aphasia. This is an important finding, since it shows again that the characterization of the comprehension deficit in Broca’s aphasia needs to be refined. The way it is formulated now, it only captures the findings on XP-movement (and not even all the findings, as was shown in the previous section). The above-mentioned results show, however, that not only XP-movement, but also X-movement affects the comprehension of Broca patients. Obviously, additional research is required before such a conclusion can be drawn, but these results are a clear counterexample against the claim that patients’ comprehension of constructions involving head-movement is intact.

1.1.4.3. Covert movement
In chapter 1, it was explained that apart from overt movement, theoretical linguists distinguish cases of covert movement. Covert movement is covert in that it does not change the order of the items in the linear string. The relevant item is still pronounced in the position in which it was generated. If syntactic movement yields comprehension difficulties in Broca’s aphasia, the question now arising is whether this also holds for covert movement.

The effect of covert movement on patients’ comprehension has not been examined. There is one study which might be relevant to this issue. This is the study performed by Saddy (1995). He investigated comprehension of sentences such as (16) in English-speaking Broca patients.

(16) Every man photographs a child.

As explained in chapter 1, section 2.3, this sentence is ambiguous between a reading in which every man photographs a different child and a reading in which one child is photographed by a group of men. Moreover, it is assumed that these two readings result from covert movement of the quantifier. At LF, quantifiers raise to Spec,CP. Thus, the sentence in (16) has two different LF structures, illustrated below.29

(17) a. \([\text{CP} \text{every man} [\text{IP} \text{every man photographs a child}]\]

b. \([\text{CP} \text{a child} [\text{IP} \text{every man photographs a child}]\]

The structure in (17a) corresponds to the reading in which each man is photographing a different child. The structure in (17b) corresponds to the reading in which there is only one child, photographed by a group of men. The reading in (17a) is called the narrow scope reading of the existential quantifier a child. The reading in (17b) is called the wide scope reading of the existential quantifier. It has moved to

29 In this structures, only the movement of the quantifier obtaining wide scope is illustrated.
a position before the universal quantifier every man and as such has wide scope over this quantifier.

Saddy (1995) observed that Broca patients have retained both readings for sentences of the type in (16). In a sentence-picture verification task, patients correctly accepted both pictures belonging to this sentence (i.e. a picture representing the reading in (16a) and a picture representing the reading in (16b)). Further, they correctly rejected pictures that did not correspond to either of the possible readings (e.g. a picture showing a group of men photographing a child but there is also another man standing aside who is not taken pictures). Thus, patients accepted both the narrow scope reading and the wide scope reading of the existential quantifier. Since this last reading results from covert movement of a child, this observation might be taken to indicate that covert movement does not affect patients’ comprehension. Despite the movement of the object in (17b), patients still correctly comprehend this sentence.31

Importantly, however, the movement analysis in (17b) is not commonly accepted. Heim (1982) proposed that indefinites are variables which can be bound by different quantifiers. These different quantifiers yield the two different readings in (17). A discussion concerning the differences between this analysis and the quantifier raising analysis proposed by May (1985) is outside the scope of this thesis. The only point relevant here is that it is unclear whether elements such as a child in (16) undergo covert movement. Hence, it is unclear whether patients’ comprehension of these type of sentences reveals anything about the effect of covert movement in Broca’s aphasia.

### 1.1.5. Interim summary

In the sections 1.1.1 through 1.1.3, it was shown that the comprehension deficit in Broca’s aphasia is related to syntactic movement. Broca patients have difficulties understanding passive sentences, object clefts, and object relative clauses because these constructions involve NP or wh-movement of the object. This led to the pattern illustrated in (9) and repeated below.32

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30 Patients’ results also showed nonstandard entailments for universal quantifiers. The sentence in (15) was understood as entailing that every photographer had to be a man. Thus, patients rejected a picture in which a group of men is photographing a child and a woman is photographing a building. Still, this picture corresponds to the sentence. Similar observations were made by Philip & Avrutin (1998). See Saddy (1995) and Philip & Avrutin (1998) for an explanation.

31 Note, however, that this is not the interpretation put forward by Saddy. Instead, he focusses on the observed non-standard entailments mentioned in the previous footnote.

32 Note that all the data discussed above have been obtained in off-line experiments, i.e. experiments investigating language comprehension after if has taken place. Results from on-line experiments (i.e. experiments tapping into the ongoing process of language comprehension) are consistent with those obtained in off-line experiments. These studies show that Broca patients are unable to create dependency relations formed by syntactic movement in real time. When non-brain-damaged speakers are parsing sentences as in (18), the moved item is reactivated at its trace position (cf. Bever & McElree 1988; Garney, Tanenhaus & Chapman 1989; see also Shapiro (2000) and Swinney, Love, Nicol, Bouck & Hald (2000) for an overview). It is this reactivation that underlies the interpretation of the sentence. In (18d), the NP the boy has to be reactivated at its trace position in order to be interpreted as the theme of the verb. In Broca patients, parsing is slowed down (cf. Swinney, Zurif & Nicol 1989; Prather, Zurif, Stern & Rosen 1992). As a result, reactivation occurs considerably later (cf. Zurif, Swinney, Prather, Solomon & Bushnell 1993; Swinney, Zurif, Prather & Love 1996) and the dependency relation between
Syntactic movement and comprehension in Broca’s aphasia

Based on this pattern, the comprehension deficit of Broca patients has been characterized in terms of a subject/object asymmetry: intact comprehension of constructions involving movement out of the subject position (17a–c), and impaired comprehension of constructions involving movement out of the object position (17c–f). I have argued, however, that this characterization of patients’ comprehension deficit is somewhat premature, since there are still many open questions concerning the effect of syntactic movement in Broca’s aphasia. First, wh-movement in wh-questions does not seem to affect patients’ comprehension. Secondly, there is some evidence suggesting that the comprehension deficit in Broca patients is not restricted to XP-movement. Instead, patients’ comprehension of constructions involving head movement also seems to be impaired. Finally, it is unclear whether covert movement has any affect on patients’ comprehension.

The data leading to the pattern in (18) result from a large amount of crosslinguistic studies. However, the evidence concerning these three other types of movement (wh-movement in wh-questions, head movement, and covert movement) has been obtained in only one or a couple of studies. Therefore, further research is required to obtain more insight in the way in which these types of syntactic movement affect the comprehension abilities of Broca patients. In this thesis, I will focus on the effect of wh-movement in wh-questions. Before doing so, I will briefly review several explanations of the comprehension deficit in Broca’s aphasia. This is done in the next section.

1.2. Accounts of the comprehension deficit in Broca’s aphasia

The comprehension deficit of Broca patients has intrigued many researchers over the years, and several accounts have been proposed. Generally speaking, these accounts can be divided into two types: structural deficits accounts and processing accounts. The common assumption of the first type of theories is that comprehension in Broca’s aphasia reflects a partial loss of syntactic competence. As a result, the linguistic representation generated when hearing a sentence differs from the one generated by the grammar of non-brain-damaged speakers. This in turn, leads to deficient comprehension. Several theories of this type have been put

33 The term ‘structural deficit hypotheses’ comes from Lukatela et al. (1995).
forward. Here, I will only discuss the most influential one, the Trace Deletion Hypothesis (Grodzinsky 1986a, 1990, 1995a).\(^{34}\) This hypothesis will be presented and discussed in section 1.2.1. Processing theories, in contrast, attribute the comprehension difficulties of Broca patients to an impaired *implementation* of the grammar. The locus of the comprehension deficit is thus claimed to be the processing system and not patients’ grammar. Some examples of this type of account will be discussed in section 1.2.2.

### 1.2.1. Structural deficit theories: the Trace Deletion Hypothesis

The Trace Deletion Hypothesis (TDH) has been proposed by Grodzinsky (1986a). This account is the first in which theoretical linguistic notions are used in explaining the data obtained in neurolinguistic research. The TDH is based on the Government and Binding Theory (Chomsky 1981) and its main claim is that in Broca’s aphasia traces of moved items are missing from the syntactic representation of a sentence. In the Government and Binding Theory, traces are crucial for a correct understanding of the sentence. It is claimed that verbs assign thematic roles to arguments in their base position. Moved items thus receive their thematic roles through their connection with their trace position. Consider, for instance, passive sentences.

\[(19) \text{The boy} \underset{\text{Theme}}{\text{is kissed}} \text{by the girl.}\]

In the structure in (19), the verb *kiss* attributes the thematic role Theme to the object NP at its right (i.e. *the boy*). This NP has been moved. However, the NP still receives the Theme role by its connection to its trace position.

If traces are lost in Broca’s aphasia, comprehension errors are thus expected to occur. Indeed, for a sentence as in (19), the NP *the boy* does not receive a thematic role if the trace is no longer present. Grodzinsky further assumes that moved items are assigned a thematic role by means of a default interpretative mechanism, the so-called Default Principle. Below, the most recent version of the TDH is given (cf. Grodzinsky 1995a).\(^{35}\)

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\(^{34}\) Many other hypotheses of these type have been shown to be unable to account for the data. This is the case for instance of the hypothesis of Caramazza and Zurif (1976) and that of Caplan and Futter (1986), who assumed a complete loss of syntax in Broca’s aphasia. According to them, patients rely solely on their knowledge of the world when interpreting a given sentence. As mentioned above, the data of many studies that have been done since have shown that syntax is largely intact. Similarly, hypotheses assuming a loss of closed-class items (cf. Bradley et al. 1980; Kean 1977) have been shown to be problematic. See Kolk (1998) and Maunier (1995) for an overview of these hypotheses as well as the arguments put forward against them.

\(^{35}\) This version of the TDH differs in two respects from the version proposed in 1986 and 1990. Originally, it was assumed that traces from *all* movement operations were missing from patients’ representation. However, as was mentioned in section 1.1.4.2., evidence observed in the ‘90s suggested that patients’ comprehension of constructions involving head-movement was still intact. Grodzinsky (1995a) therefore restricted the TDH to moved *arguments* (i.e. elements in $\theta$-positions). Further, the Default Principle originally attributed a thematic role to all moved arguments. In order to account for the intact comprehension of object *who*-questions observed by Hickok and Avrutin (1996), Grodzinsky (1995a) restricted the scope of the Default Principle to referential arguments. See Grodzinsky (1995a, 2000b) for a detailed discussion of the assumptions underlying this revision of the TDH.
(20) **Trace Deletion Hypothesis**

a. Traces in 0-positions are deleted from Broca patients’ representation.

b. Assign a referential NP a role by its linear position if it has no 0-role.

To illustrate how this hypothesis accounts for the data, consider again passives. Since traces are lost, the NP *the boy* in (19) does not receive a thematic role. Grodzinsky, following among others Jaeggli (1986) and Baker, Johnson & Roberts (1989), assumes that the *by*-phrase is an argument that has received its thematic role directly from the verb. Therefore, this role is still present in patients’ representation of passives. The representation generated by non brain-damaged speakers and the one generated by the grammar of Broca patients are illustrated below.

(21) **unimpaired representation**

<table>
<thead>
<tr>
<th>The boy is kissed</th>
<th>by the girl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theme: the boy</td>
<td>Agent:</td>
</tr>
</tbody>
</table>

**representation in Broca patients**

<table>
<thead>
<tr>
<th>The boy is kissed by the girl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theme: the boy</td>
</tr>
</tbody>
</table>

Grodzinsky further assumes that the Default Principle assigns the Agent role to the moved NP, since in English clause-initial NPs usually bear the Agent role. The resulting representation is illustrated in (22).

(22) **The boy is kissed by the girl**

| Agent:   |

Patients’ chance-level score observed on passives is explained by the TDH through competition: the two Agents in the thematic representation in (22) compete, inducing chance performance. In other words, since the representation of passive sentences contains two Agents, Broca patients do not know who the real Agent is and hence guess. This results in a chance-level score. The same mechanism accounts for patients’ chance performance on object clefts and object relative clauses (cf. the examples in (18e,f)).

Patients’ relatively good comprehension of active sentences, subject clefts, and subject relative clauses (18a-c) is explained as follows. In these constructions too, patients’ syntactic representation differs from that in non brain-damaged adults. The moved item lacks a thematic role, since its trace is no longer present. However, in these cases the Default Principle assigns the correct thematic role, namely the Agent role, to the moved element. This is illustrated below for active sentences.

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36 The derivation of passives has given rise to a debate, revolving around the syntactic function and the representation of the *by*-phrase. Some (cf. Mauner, Fromkin & Cornell 1993) agree with Grodzinsky and analyze the *by*-phrase as an argument. Others (cf. Hickok 1992), based on Grimshaw (1990), argue that the external argument is suppressed and assume that the *by*-phrase is an adjunct. All stress the fact that the precise nature of the passivization process is controversial in current theories. A detailed discussion of the derivation of passives is outside the scope of this thesis (see Hickok et al. 1993; Grodzinsky 1995b, 2000b; Grodzinsky et al. 1991; Mauner et al. 1993 for more details).

37 See Grodzinsky (1990) for a detailed explanation.
(23) a. The girl kisses the boy  representation in Broca patients
    Theme

b. The girl kisses the boy  representation after use of the Default Principle
    Agent Theme

Following the VP-internal subject hypothesis, the girl in (23a) is generated in Spec,VP and moved to Spec,IP (see section 1.1.3, example 8). This NP receives its thematic role Agent in its base position. If traces are lost in Broca’s aphasia, the girl in (23a) thus bears no thematic role. The Default Principle will then assign the role of Agent to this NP, since in English the first NP in the clause is usually the Agent. This results in the representation in (23b). In other words, under the TDH patients’ above chance performance on sentences involving movement out of the subject position is a mere consequence of the fact that the Agent role assigned by the Default Principle to the moved item happens to be the correct one.

The TDH has been heavily criticized. Numerous studies have been carried out in order to verify the claims of the TDH. In the following sections, I will review the arguments put forward against and in favor of the TDH.

1.2.1.1. Arguments against the TDH
It has been claimed that the TDH has both empirical and theoretical shortcomings. A well-known empirical counterexample concerns patients’ comprehension of the matrix clause in relative constructions. As Hickok et al. (1993) have argued, under the TDH patients’ comprehension of the predicative-adjective relation in the matrix clause of sentences such as (24) should be intact.38

(24) The tiger [OpWh that tOpWh chased the lion] is big.

Since the matrix clause corresponds to the tiger is big, patients are expected to correctly reject pictures in which a small tiger chases a big lion. There is, however, ample evidence indicating that patients are unable to understand the matrix clause of these types of sentences (cf. Caramazza & Zurif 1976, Hickok et al. 1993; Kolk & Weijts 1996; Sherman & Schweikert 1989).

Secondly, it has been argued that the TDH cannot account for patients’ performance on object relative clauses (cf. Beretta 2001; Frisch, Saddy & Friederici 2000; Hickok et al. 1993; Linebarger 1995). If subject arguments always move (cf. section 1.1.1.3), the derivation of object relative clauses involves two movement operations.

(25) The tiger [OpWh that the lion t the lion chased tOpWh] is brown.

If traces are deleted this means that in patients’ representation of (25) both the wh-operator and the NP the lion lack a thematic role. Since the wh-operator lacks a thematic role, the NP the tiger also receives no thematic role of the embedded verb.

38 The precise derivation of these constructions is not important here. See chapter 4, section 3 for details.
Following the Default Principle, *the tiger* would be attributed the role of Agent and *the lion* the role of Theme. Hence, it is predicted that patients will systematically reverse the thematic roles in these kinds of structures, yielding, contrary to fact, below-chance performance.\(^{39}\)

Apart from these empirical problems,\(^{40}\) several theoretical problems of the TDH have been raised. For instance, Sproat (1986) argues that the claim that traces are absent in patients’ representations is problematic, since such a representation would violate principles that have been shown to be intact in Broca’s aphasia, such as the Projection Principle. Similarly, as argued by Newmeyer (2000), the assumption that patients’ representation of object-movement derived sentences contains two Agents (cf. the structure in \(22\)), is difficult to maintain in light of patients’ intact knowledge of the theta-criterion.\(^{41,42}\)

Further, the Default Principle has been criticized of being an unnecessary ad hoc assumption (cf. Caplan & Hildebrandt 1986; Hickok 1992, Hickok et al. 1993; Mauner et al. 1993). Grodzinsky (1986b, 1990, 2000b) has always argued that it is not an ad hoc heuristic, but a very common principle used in the psycholinguistic literature concerning language acquisition (cf. Bever 1970; Slobin & Bever 1982). In the course of the years, the assumption of a non-linguistic strategy was no longer seen as a problem, since it became more and more clear that patients do indeed rely on some sort of heuristic when forced to interpret sentences that are problematic to them (cf. Linebarger 1995). Grodzinsky (1995b) further claimed that the Default Principle is necessary in order to account for the data concerning psych verbs. These data will be discussed in the following section.

A final problem raised against the TDH is a more general one. Caplan (1995, 2000) has argued that the TDH can only account for a subset of the data, namely those on syntactic movement. Broca patients do, however, not only have difficulties with structures involving movement, but also with the interpretation of other referential dependent elements, such as pronouns (cf. Caplan & Hildebrandt 1988a; Hildebrandt et al. 1987). This is, however, a controversial issue (see for instance Grodzinsky, Wexler, Chien, Marakovitz & Solomon 1993; Grodzinsky 2000c for counter evidence), to which I will return in chapter 5.

\(^{39}\) Patients’ performance on short passives is sometimes also used as a counterargument against the TDH (cf. Kolk 1998). It is claimed that the TDH predicts below chance performance on short passives such as ‘*the boy is hit*’. Patients, however, show no difference in the interpretation of full and short passives (cf. Balogh & Grodzinsky 2000; Martin et al. 1989). Balogh & Grodzinsky (2000) argue that these results suggest that the syntactic representation of Broca patients also contains the implicit Agent often assumed in short passives (cf. Manzini 1983).

\(^{40}\) See Grodzinsky (1995b) for a reply on these criticisms.

\(^{41}\) Moreover, Beretta and Munn (1998) set up an experiment to test the double Agent representation and found no evidence for it.

\(^{42}\) Grodzinsky has argued several times that these observations do not constitute an argument against the TDH. Rather, the observation that patients allow a representation violating both the Projection Principle and the theta-criterion supports a modular view of syntactic analysis. At the point at which the representation in \(22\) is made, the system has no longer access to lexical knowledge (cf. Grodzinsky 1986b, 1990, 2000b).
1.2.1.2. Arguments in favor of the TDH

Grodzinsky has extensively argued that the TDH is the only account that is able to explain the pattern of loss and sparing observed in patients’ comprehension (cf. Grodzinsky 1989, 1990, 1995ab, 2000b). Here, I will briefly review some of his arguments.43

First, the TDH captures crosslinguistic differences observed on English- and Chinese-speaking Broca patients. This contrast is illustrated below.

(26) a. subject [zhui gou de] mao hen da chance
chase dog COMP cat very big
‘The cat that chased the dog was very big’

b. object [mao zhui de] gou hen xiao above chance
cat chase COMP dog very small
‘The dog that the cat chased was very small.’

(27) a. subject The cat [that chased the dog] was very big. above chance
b. object The dog [that the cat chased] was very small. chance

As can be seen in (26), Chinese-speaking Broca patients score at chance-level on subject relative clauses and above chance on object relative clauses. English-speaking Broca patients show the opposite pattern (cf. (27) and the examples in (18)). Grodzinsky (2000b) claims that this difference can be explained by the TDH. Chinese relative clauses are head-final. The head noun (mau (‘cat’) in (26a) and gou (‘dog’) in (26b)) follows the relative clause. By contrast, in English, the head noun precedes the relative clauses. As a result, Grodzinsky argues, the Default Principle attributes the Theme role of the embedded verb to the head noun in (26). This results in a chance-level score in (26a), since the NP gou (‘dog’) has already received the Theme role of the embedded verb and the representation thus contains two Themes. By contrast, the Default Principle yields the correct representation for object relative clauses as in (26b).

Secondly, patients’ comprehension of passive sentences containing so-called psych verbs44 has been cited as evidence in favor of the TDH. Grodzinsky (1990) observed a difference between patients’ comprehension of agentive passives (28a) and that of passive sentences containing a psych verb (28b).

(28) a. The girl was pushed by the boy.
b. The girl was admired by the boy.

Patients scored at chance-level on constructions of the type in (28a). However, constructions of the type in (28b) yielded below chance-level performance. This indicates that here, patients consistently reversed the thematic roles. Grodzinsky (1990, 1995a,b) argued that this observation can only be explained by the TDH.

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43 See Grodzinsky (2000b) for a more extensive overview and also additional evidence from neuroimaging studies indicating that Broca’s area and its vicinity are involved in the processing of syntactic movement.

44 Psych verbs (psychological verbs) are a class of verbs expressing an emotion. As was will be illustrated below, these verbs do not assign an Agent role, but an Experiencer role.
Given that the Default Principle always assigns the Agent role to arguments moved to a clause initial position, *the girl* in (28b) will receive the Agent role. Since *the boy* has received the role of Experiencer directly from the verb, no competition arises and patients will interpret these sentences as if the girl was admiring the boy. This accounts for the below-chance performance observed for these constructions. Note however, that studies examining patients’ comprehension of psych verbs have obtained contradictory results. Thus, contra the results of Grodzinsky (1990, 1995b), both Balogh and Grodzinsky (1996) and Pifano (2000b) observed a chance-level score on constructions of the type in (28b). Hence, further research is required before it can be maintained that patients’ comprehension of sentences containing psych verbs forms an argument in favor of or against the TDH.45

To sum up, in this section I have explained the TDH and reviewed several arguments in favor and against this hypothesis. According to the TDH, patients’ comprehension difficulties result from the loss of traces. The following section discusses accounts claiming that patients’ grammar is still intact, but that patients are unable to use their grammar in real time.

1.2.2. Processing theories
Processing theories claim that the locus of the deficit in Broca’s aphasia is not disrupted syntax, but a disruption to the processes implementing syntactic knowledge in real time. Or, to put it differently: these accounts hold that the grammar of aphasics is still intact, but that patients fail to use their grammar during the act of comprehension because brain damage has limited their amount of computational resources.

The first argument often put forward in favor of processing accounts concerns the observation that patients’ performance is related to the type of task. It is for instance argued that a sentence-picture matching task is a very complex task, since patients have to perform several operations at the same time: they have to parse a sentence, parse one or more pictures and perform a matching operation comparing all the resulting derivations. Patients’ impaired performance on this task thus does not reflect impaired comprehension, but rather results from the complexity of the task. This is, for instance, argued by Cupples & Inglis (1993). Other researchers also note the difference between patients’ performance on sentence-picture matching tasks and that on ‘easier’ tasks, such as grammaticality judgement tasks (cf. Linebarger et al. 1983a; Wulfeck 1988; Shankweiler et al. 1989; Lukatela et al. 1995; Milekić, Bošković, Crain & Shankweiler 1995) or acceptability judgment tasks (cf. Friederici & Frazier 1992; Nicol & Love 2000). This difference cannot be accounted for under structural deficit hypotheses. If the syntactic representation of Broca patients lacks traces, it does so independently of the type of task used to examine patients’ comprehension. Hence, patients will show similar patterns of performance in all types of comprehension tasks.

Note, however, that it is unclear whether there is indeed a relation between patients’ comprehension and the complexity of the task. Hickok et al. (1993)

45 See also Mauner (1995) and Beretta and Campbell (2001) for a discussion concerning patients’ comprehension of constructions containing psych verbs.
compared patients’ comprehension on several tasks and found no differences between patients’ performance on the ‘easier’ and the more complex tasks. Further, as argued by Hickok and Avrutin (1996), differences between patients’ comprehension of two types of constructions observed in one and the same task cannot be attributed to the type of task. Since the results in (18) are all obtained in sentence-picture matching tasks, patients’ impaired comprehension of passives, object clefts and object relative clauses cannot be due to the type of task.

A second argument often used as an argument in favor of an analysis in terms of a processing deficit is the variation between patients. It is well known that all the data presented above are subject to a large amount of variation. Some patients perform relatively well on object-extracted constructions (18d-f), whereas others have severe difficulties understanding these constructions (see also footnote 24). It has often been argued that structural deficit analyses cannot account for this variation, whereas variation is expected under a processing account. Indeed, in this type of account the deficiency in processing resources will be gradual, depending for instance on the severity of the lesion. This gradual degradation yields variation in performance (cf. Avrutin 2000; Kolk & Van Grunsven 1985; Lukatela et al. 1995).

If, as assumed in structural deficit theories, syntactic elements such as traces are absent in Broca’s aphasia, object-extracted constructions are expected to be equally difficult in all patients. However, this argument is not valid. As was argued by Grodzinsky et al. (1999), variation in patients’ performance of object-extracted constructions is also expected under structural deficit accounts. In these accounts chance performance on object-extracted constructions is claimed to result from guessing of the patients. This leads inevitably to variation in the individual data, some patients guessing more often correctly than others. It thus seems that both type of accounts can deal with the observed variation. What is however problematic for the structural deficits accounts, is that on this view variation arises by chance and is not related to the severity of the aphasia. This is in contrast to what has been found (cf. Caplan et al. 1985; Kolk & Van Grunsven 1985).

Finally, researchers adopting a processing perspective often cite experiments on non brain-damaged speakers showing that when the computational resources of these speakers are restricted (e.g. by adding a dual task such as counting backwards while performing a comprehension task) they perform in the same way as was observed for Broca patients (cf. Kolk 1998; Milekić et al. 1995). For instance, Miyake, Carpenter and Just (1994) observed that normal comprehension under heavy time constraint parallels observations concerning comprehension in aphasia. The relative order of complexity of several constructions that emerged out of this study was very similar to that observed by Caplan et al. (1985) on a group of aphasic patients.

Several explanations of patients’ comprehension in terms of a limited amount of processing resources have been put forward (cf. Frazier & Friederici 1991; Friederici & Frazier 1992; Avrutin 2000; Piñango 2000a). For reasons of space, I

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46 See also Hickok (1992), Hickok et al. (1993) for an alternative explanation of the variation in patients’ performance.

47 Within the group of researchers claiming limited processing to be at the heart of patients’ comprehension difficulties, the nature of this limitation is a matter of debate. Some argue for a general reduction of computational resources, resulting in slowed down processing (cf. Linebarger et al. 1983a;
will only discuss two of them.

1.2.2.1. The Complexity Limitation Hypothesis
Frazier and Friederici (1991) postulate the Complexity Limitation Hypothesis, which states that patients’ grammar and processor are intact, but that they lack the computational resources to perform all the necessary operations in time (see also Friederici & Frazier 1992). This deficit results in degraded performance that is most apparent in complex structures.

Complexity of a clause depends on a number of factors, but results mainly, according to Frazier and Friederici, from the length of the chain. Structures involving longer chains will be more difficult to understand than structures involving shorter chains. Further, Frazier and Friederici argue that Broca patients rely on the same principles as used by non brain-damaged adults in their processing of a sentence, such as the so-called Most Recent Filler Strategy. Following this strategy, a detected gap is initially and quickly co-indexed with the most recent potential filler.\footnote{The term ‘filler’ and ‘gap’ are used in the psycholinguistic literature for respectively antecedents and related empty elements, such as traces or PRO.} In a later stage, this coindexing can be reanalyzed. Frazier and Friederici argue that the comprehension difficulties in Broca patients (i.e the pattern illustrated in (18)) can be explained by assuming that patients rely on this same strategy. Object-extracted constructions are more difficult than subject-extracted constructions, since they involve longer chains. Moreover, interpretation of subject-extracted constructions is facilitated by the use of the most recent filler strategy, which leads to correct interpretation. In object-extracted constructions this strategy, which is part of the processor and as such takes place involuntarily, complicates interpretation. Consider, for instance, relative clauses. As can be seen in (29), subject relative clauses (29a) involve shorter chains than the one underlying object relative clauses (29b). Moreover, use of the most recent filler strategy associates the trace in (29b) incorrectly with the girl, since this is the most recent NP.

(29)  
\[ \text{a. I see the boy who } \textit{t} \text{ who kisses the girl} \]  
\[ \text{b. I see the boy who the girl kisses } \textit{t} \text{ who} \]  

There is, however, empirical evidence showing that, contra the assumptions of Frazier and Friederici, the length of the chain does not play a role in patients’ comprehension difficulties. This evidence comes from a study by Friedmann and Gvion (2003). They examined comprehension of subject and object relative clauses in which the length of the distance between the antecedent and the trace was varied. Some examples are given below.

\footnote{Frazier & Friederici 1991; Avrutin 2000; Piñango 2003. Others claim that the processing problems of Broca patients are related to a working memory deficit (cf. Kolk & van Grunsven 1985; Caplan & Hildebrandt 1988a,b; Shapiro, McNamara, Zurif, Lanzoni & Cermak 1992; Miyake et al. 1994; Lukatela et al. 1995; Ni, Shankweiler & Crain 1995; Nicol & Love 2000). I will not discuss this question.}
CHAPTER 2

30 Subject relative clauses

a. Ze baxur im zakan she t_baxur malbisch et ha-xayal.
   this guy with beard that ACC the-soldier
   ‘This is a guy with a beard that dresses a soldier.’

b. Zo ha-baxura im ha-mixnasaim ha-xumim ve-ha-xulca ha-levana she t_baxura
   this the-woman with the-pants the-brown and-the-shirt the-white that
   hugs ACC the girl
   ‘This is the woman with the brown pants and the white shirt that hugs the girl.’

31 Object relative clauses

a. Ze ha-baxur she-ha-yeled tofes t_baxur
   this the-guy that-the-kid catches
   ‘This is the man that the boy catches.’

b. Ze ha-xayal she-ha-rofe im ha-xaluk ha-lavan meccayer t_xayal
   this the-soldier that-the-doctor with the-robe the-white draws
   ‘This is the soldier that the doctor with the white robe draws.’

The results showed the classical dissociation with subject relatives being better interpreted than object relatives, but no effect of length of chain was found. These results are a strong argument against the proposal of Frazier and Friederici. In contrast to their claim, the length of the referential chain does not seem to affect patients’ comprehension. Similar findings were obtained by Schwarz et al. (1987).

Further, it has been shown that constructions that are known to be complex for non-brain damaged adults do not necessarily yield impaired comprehension in Broca’s aphasia. Grodzinsky (1989) examined agrammatic comprehension of several types of relative clauses, illustrated below in (32).

32 a. The boy [who is pushing the girl] is tall.
   b. The boy [who the girl is pushing] is tall.
   c. Show me the boy [who is pushing the girl].
   d. Show me the boy [who the girl is pushing].

There are two important differences between these sentences. First, the sentences in (32a,b) are center-embedded relative clauses, whereas the ones in (32c,d) are right-branching relative clauses. Second, the sentences in (32a,c) are subject relative clauses, whereas the ones in (32b,d) are object relative clauses. It has been observed that center-embedded object relative clauses (i.e. 32b) are the most complex type of relative clause for non brain-damaged adults (see references in Grodzinsky 1989). If the comprehension deficit in Broca’s aphasia is related to complexity, it is expected that these patients will have most difficulties comprehending sentences of the type in (32b). This prediction was, however, not confirmed by the data. The Broca patients participating in this study showed better comprehension of subject relative clauses than of their object counterparts, but no effect of type of embedding was found. Grodzinsky argues that these findings cannot be explained by any theory claiming
reduced processing capacities in Broca’s aphasia to be at the heart of their comprehension difficulties.\textsuperscript{49}

1.2.2.2. The Slowed Syntax Hypothesis

The Slowed Syntax Hypothesis has been proposed by Piñango (2003). The essence of this hypothesis is that, since the construction of syntactic structure is slowed down in Broca’s aphasia, patients sometimes rely on non-syntactic mechanisms in their comprehension of a given construction. This claim is also at the heart of Avrutins (2004) explanation of the comprehension and production difficulties of Broca patients. To see how this works, consider again passives.

(33) **The boy** is kissed by the girl.

As was explained in section 1.2.1, syntactic structure is essential for a correct comprehension of the sentence in (33). The NP **the boy** receives the thematic role Theme only through the connection with its trace. The claim of Piñango (2003) and Avrutin (2004) is that in Broca patients the syntactic structure of this sentence is not built in real time.\textsuperscript{50} As a result, these patients rely on other mechanisms, such as argument structure (cf. Piñango 2003) or information structure (cf. Avrutin 2004). Both mechanisms result in the Agent role being attributed to **the boy** in (33). Under Piñango’s analysis this is due to the fact that the Agent is the most prominent argument (following the thematic hierarchy of Jackendoff (1990)) and will therefore be assigned to the first NP in the sentence. Avrutin’s explanation is very similar. He argues that information structure contains a principle assigning the Agent role to Topics. Since **the boy** in (33) is a topic, it will be given the role of Agent.

It is further assumed that at a later stage the syntactic structure of (33) becomes available, yielding the correct interpretation of (33). Patients’ chance-level performance on these constructions is claimed to follow from a competition between the interpretation based on syntactic structure and the one based on non-syntactic principles.

1.2.3. Comparing the TDH and processing theories

According to the TDH, patients’ comprehension difficulties arise from an impaired syntactic representation of the sentence. By contrast, processing theories assume that patients’ syntactic representation of movement-derived constructions is still intact, but that patients do not always use this representation. Despite their different claims concerning the nature of the comprehension deficit in Broca’s aphasia, both types of accounts are very similar in several aspects.

First, both types of accounts assume that in comprehension tasks, Broca patients rely on a non-syntactic principle. The Default Principle of the TDH, the Most

\textsuperscript{49} See however Lukatela et al. (1995) for some criticism of Grodzinsky’s interpretation of these findings as well as contradictory results regarding the effect of the type of embedding.

\textsuperscript{50} The results obtained in on-line studies (cf. footnote 33) provide evidence in favor of this assumption. These studies show that Broca patients do not create dependency relations such as the relation between a moved item and its trace in real time, but around 600 milliseconds later.
Recent Filler strategy, and the mechanisms assumed by Piñango and Avrutin all have the same result: the Agent role is attributed to moved Themes. Further, the Default Principle and the mechanisms of Piñango and Avrutin are all based on the assumption that there is a correlation between topic-hood or the position of the NP and agency.

Secondly, both types of accounts explain the data summarized in (18). Thus, both types of accounts capture the observation that Broca patients are able to understand active sentences, subject clefts, and subject relative clauses, but that their comprehension of the object counterparts of these sentences is severely impaired. In other words, both types of accounts share the assumption that the comprehension deficit of Broca patients is characterized in terms of a subject/object asymmetry: intact comprehension of sentences involving movement out of the subject position, impaired comprehension of sentences involving movement out of the object position. In section 1.1.5, I argued, however, that this characterization of the comprehension deficit is premature. There are still many open questions concerning the effect of other types of syntactic movement on patients’ comprehension. It is unclear whether wh-movement in wh-questions, head movement, and covert movement do also affect patients’ comprehension. Obviously, it first has to be examined in detail if and in which way these types of movement affect patients’ comprehension. This will lead to a more detailed picture of the way in which patients’ comprehension difficulties are related to syntactic movement. Only after this picture has been obtained, an explanation of the comprehension deficit can be proposed.

A final similarity between both types of accounts is that they focus on patients’ difficulties comprehending sentences in which arguments have been moved. In both types of accounts it is assumed that Broca patients have difficulties attributing thematic roles to moved arguments. In doing so, they sometimes (or, depending on the account, always) rely on a non-syntactic heuristic principle. This explains the chance-level performance on sentences in which an argument has been moved out of the object position. However, arguments are not the only elements that can be moved. Apart from argument, adjuncts also move. For example, both sentences in (34) are derived through wh-movement. In (34a), the moved wh-word is an argument, in (34b) it is an adjunct.

(34) a. **What** did you buy \(t_{\text{what}}\)?
    \[\text{\includegraphics[width=1cm]{what}}\]

    b. **Where** did you buy this book \(t_{\text{where}}\)?
    \[\text{\includegraphics[width=1cm]{where}}\]

Crucially, arguments and adjuncts differ in that adjuncts do not receive a thematic role. In both types of accounts presented above, the comprehension deficit of Broca patients is restricted to argument movement. It has to be examined, however, whether this is indeed the case. Thus, it is necessary to examine whether adjunct movement does also affect comprehension in Broca’s aphasia. If so, both types of accounts are too narrow. To my knowledge, no experiments examining patients’ comprehension of sentences involving adjunct movement have been done. This is thus a second example showing that the picture concerning the effect of syntactic
movement on patients’ comprehension is still not detailed enough to propose an explanation of the comprehension deficit in Broca’s aphasia.

To sum up, despite differences, both representational and processing accounts focus on patients’ comprehension of only a subset of constructions involving movement. Further research on other constructions is needed before any conclusion concerning the nature of comprehension deficit in Broca’s aphasia can be drawn. In this thesis, I will therefore not discuss the accounts of patients’ comprehension deficit any further. Instead, its purpose is to contribute to a more detailed picture concerning the effect of syntactic movement on patients’ comprehension.

1.3. Syntactic movement and comprehension deficits in Broca’s aphasia

1.3.1. Summary
Broca patients have difficulties comprehending sentences derived through syntactic movement. In the previous sections, I have discussed these comprehension difficulties and presented two types of explanations. I have argued that it is too early to propose such an explanation, since many data on patients’ comprehension are still lacking. What is clear, is that the comprehension deficit in Broca patients is related to syntactic movement. Further, it is clear that movement out of a subject position yields less comprehension difficulties than movement out of an object position. However, there are still many open questions concerning the effect of other types of syntactic movement on patients’ comprehension. For convenience, these questions are repeated below.

(35) **Questions concerning syntactic movement in Broca’s aphasia**

I. Does wh-movement in wh-questions affect patients’ comprehension?
As was discussed in section 1.1.4.1, English-speaking Broca patients score above chance-level on both subject and object wh-questions. This is a striking observation, since patients’ comprehension of other constructions involving movement out of the object position is impaired. The question thus arises whether this is a language-specific finding or whether Broca patients in general are able to understand subject and object wh-questions. In order to answer this question, data from non English-speaking Broca patients are required.

II. Does head movement affect patients’ comprehension?
As discussed in section 1.1.4.2, there is a discussion concerning the effect of head movement on patients’ comprehension. Some argue that patients’ comprehension of sentences involving this type of movement is intact. Others argue that it is impossible to examine the effect of head movement on patients’ comprehension. Recent data on Hebrew-speaking Broca patients might, however, be taken as a first indication that head movement does affect patients’ comprehension. Again, further research is required.
III. Does covert movement affect patients’ comprehension?
The effect of covert movement on patients’ comprehension has rarely been examined. The only relevant data come from one English-speaking Broca patient. These data suggest that covert movement does not affect patients’ comprehension (cf. section 1.1.4.3). However, here too more data are required.

IV. Does adjunct movement affect patients’ comprehension?
There are no experiments examining the effect of adjunct movement on patients’ comprehension. Accounts of the comprehension deficit in Broca’s aphasia are all based on observations concerning argument movement. It thus has to be examined whether the comprehension deficit of Broca patients is indeed restricted to argument movement.

1.3.2. The focus of this thesis: wh-questions
The purpose of this thesis is to provide more insight in the way in which syntactic movement affects patients’ comprehension. I will focus on the first question in (35) and examine the comprehension of wh-questions in French-speaking Broca patients. The results of these experiments will allow a crosslinguistic comparison with the data obtained on English-speaking Broca patients. However, this is not the only reason for examining comprehension of wh-questions in French-speaking Broca patients. French wh-questions have certain properties allowing an answer to the question whether wh-movement in wh-questions affects patients’ comprehension. Crucially, in French wh-questions the wh-word can either remain in its base position or move. This is illustrated below.

(36) a. Tu as vu qui?
   you have seen who
   ‘Who did you see?’

   b. Qui tu as vu tqui?
   who you have seen
   ‘Who did you see?’

The questions in (36) do not differ in meaning. The only difference between them concerns the movement or non-movement of the wh-word. This makes French a suitable language for the examination of the effect of wh-movement in Broca’s aphasia. Indeed, if wh-movement in wh-questions does not affect patients’ comprehension, it follows that patients will comprehend both types of object wh-questions in (36) equally well. By contrast, if wh-movement in wh-questions does affect patients’ comprehension, questions of the type in (36a) will be understood better than those in (36b). I will therefore compare patients’ comprehension of these two types of wh-questions. In the chapters 3 and 4, it will be shown that such an experiment does not only provide an answer to the first question in (35), but also to some of the other questions. Before being able to do so, the syntactic structure of French wh-questions has to be explained. This is done in the next section.
2. French wh-questions

In the previous section, it was concluded that French is a suitable language to examine the effect of wh-movement in Broca’s aphasia, since in French wh-movement is optional.\(^{51}\) Thus, in French, the wh-word can either remain in its base position or move to the beginning of the sentence, yielding the two types of wh-questions given in (35) above. French wh-questions have received a lot of attention in the theoretical linguistic literature. In this section, I will present a review of the literature on French wh-questions, focusing on those aspects relevant to the research in this thesis.\(^{52}\) In section 2.1, I will discuss the properties of both types of wh-questions in (35). It will be shown that there are certain similarities, but also important syntactic differences between these two types of wh-questions. Section 2.2 presents three analyses of French wh-questions. It will be argued that only one of these analyses can account for the properties of both types of wh-questions.

2.1. Properties of French wh-questions

For convenience, the two types of French wh-questions under scrutiny here are repeated below.\(^{53}\)

\[(37) \begin{align*}
a. \quad & Tu \ as \ vu \ qui? \\
& \text{you have seen who} \\
& \text{‘Who did you see?’} \\

b. \quad & Qui \ tu \ as \ vu \ qui? \\
& \text{who you have seen} \\
& \text{‘Who did you see?’}
\end{align*}\]

\(^{51}\) French is not the only language displaying optional wh-movement. Other examples are Ancash Quechua (cf. Cole & Hermon 1994), European Portuguese (cf. Cheng & Rooryck 2003), and Malay (cf. Cole & Hermon 1998).

\(^{52}\) I will therefore not discuss the problems raised by the optional nature of wh-movement in French. In current linguistic theory (i.e. the Minimalist Program), the existence of optional movement is problematic. In the Minimalist Program, elements do not move around freely. Instead, their movement is always triggered by some other element (recall the discussion on feature movement in section 3.5 of the previous chapter). In essence, this means that elements only move if they are forced to do so. Hence, movement is always obligatory and optional movement does not exist. Optional wh-movement languages thus pose a problem for this theory. See Bošković (1998, 2000) and Cheng & Rooryck (2000) for a possible explanation of the optionality of wh-movement in French.

\(^{53}\) Note that these are not the only possible wh-questions in French. Instead, French allows many ways of asking a wh-question. Apart from the questions in (37), it is also possible to produce a question involving subject-aux inversion (ia), complex inversion (ib), a clefted wh-question (ic), or a question containing the question morpheme est-ce que (id).

\[(i) \begin{align*}
a. \quad & Qui \ as-tu \ vu? \\
& \text{who you have seen} \\
& \text{‘Who did you see?’} \\

b. \quad & Qui \ la \ fille \ a-t-elle \ vu? \\
& \text{who the girl has-CL-she seen} \\
& \text{‘Who did the girl see?’} \\

c. \quad & C’est qui que tu as vu? \\
& \text{it is who that you have seen} \\
& \text{‘Who is it that you have seen?’} \\

d. \quad & Qui est-ce que tu as vu? \\
& \text{who Q you have seen} \\
& \text{‘Who did you see?’}
\end{align*}\]

I will turn to questions of the type in (1d) shortly below. Questions of the types in (ia) through (ic) will not be discussed, since they were not included in the experiments performed for this thesis.
As said before, these questions do not differ in meaning. Further, they share several syntactic properties. However, there are also important syntactic differences between both types of wh-questions. This section gives an overview of the syntactic similarities and differences of both types of questions.

Before proceeding, there is one issue that warrants comment. This concerns the question morpheme est-ce que. The wh-questions in (37) differ only with respect to the position of the wh-word (in-situ versus moved). What is not illustrated in (37), is that there is a second difference between these two types of questions. Wh-questions of the type in (37b) optionally contain the question morpheme est-ce que. This morpheme is not allowed in wh-questions of the type in (37a). This contrast is illustrated below.

(38) a. * Est-ce que tu as vu qui?
   Q you have seen who
   ‘Who did you see?’

   b. Qui est-ce que tu as vu qui?
      who Q you have seen
      ‘Who did you see?’

The sentences in (38) show that in French wh-questions involving wh-movement, the question morpheme est-ce que is optionally present. By contrast, this morpheme never appears in wh-in-situ questions. To complicate matters even further, consider the questions in (39) below.

(39) a. * Qui Jean a vu qui?
   Who Jean has seen

   b. Qui est-ce que Jean a vu qui?
      Who Q Jean has seen
      ‘Who did Jean see?’

In contrast to the questions in (37) and (38), the questions in (39) do not contain a pronominal, but an NP subject. As can be seen in (39), in these types of wh-questions est-ce que is obligatorily present. The distribution of est-ce que will not be

54 To be more precise, there is a difference in the presuppositional nature of the questions in (37) (cf. Chang 1997; Cheng & Rooryck 2000). The question of the type in (37a) does not allow the answer personne (‘no one’). By contrast, this answer is legitimate for questions of the type in (37b). To put it differently, a question of the type in (37a) presupposes a seeing-event. The speaker knows that the addressee has seen someone, but wants to know who this person was. Questions of the type in (37b) are more neutral to the extent that no seeing-event is presupposed. This difference is not relevant to the research performed for this thesis. As will be explained in chapter 3, patients’ comprehension of wh-questions was examined in such a way that they were asked to indicate on a picture the person representing the answer to the question. Thus, there was always a person representing the answer to the question and the answer personne (‘no one’) was never possible. In other words, in all the questions for which patients’ comprehension was examined the event expressed by the verb had taken place.

55 Est-ce que literally means ‘is-it-that’. I follow Blanche-Benveniste, Delofeu, Stéfanini and van den Eynde (1984) and Rooryck (1994) in analyzing est-ce que as a complex question morpheme Q. On this view, the different parts of est-ce que have lost their individual meaning. Est-ce que functions as a single morpheme and is used to mark a sentence as a question.
discussed here. The wh-questions included in the experiments on Broca patients all contain an NP subject. Hence, *est-ce que* is either obligatory present (in the case of wh-questions involving wh-movement) or obligatory absent (in the case of wh-in-situ questions). In the following sections, I will discuss the properties of French wh-questions relevant to our purposes.

### 2.1.1. Island effects

This section discusses an important syntactic property shared by both types of wh-questions in (37): both exhibit the so-called *island effects*. The notion ‘island’ refers to a syntactic domain out of which elements cannot move. Consider, for example, the sentence in (40).

(40) John likes the book that Mary has written.

It is in principle possible to turn the statement in (40) into a question asking the name of the author of the book that John likes. To do so, *Mary* has to be replaced by the wh-word *who* and this wh-word moves to the beginning of the sentence. This yields the question in (41).

(41) *Who* does John like the book that *who* has written?

Such a question is ungrammatical. This has been explained by assuming that complex NPs form islands for extraction (cf. Cinque 1990 and references cited therein). Complex NPs are NPs containing of an N and an XP complement. As is illustrated in (42) below, the sentence in (41) contains a complex NP. The NP *the book* takes a CP as its complement.

(42) *Who* does John like [NP the book [CP that *who* has written?]]

The wh-word *who* cannot move out of this complex NP. If it does, an ungrammatical sentence results. Apart from complex NP islands, there are several other islands, such as adjuncts islands and wh-islands. I will not discuss these different islands. What is important here, is that in theoretical linguistics, islands are commonly used as a *diagnostics for movement*. The ungrammaticality in island constructions such as (41) is the result of a movement violation. Consequently, whenever an island effect shows up, this indicates that movement has taken place.

With this in mind, consider now the French wh-questions in (37). I will start with questions of the type in (37b). The question in (43) below parallels the English example in (41) in that the wh-word has been moved out of a complex NP.

(43) *Qui* *est-ce que* Jean aime [NP le livre [CP que *qui* a écrit]]?

*Qui* est-ce que Jean aime [NP le livre [CP que *qui* a écrit]]?

With this in mind, consider now the French wh-questions in (37). I will start with questions of the type in (37b). The question in (43) below parallels the English example in (41) in that the wh-word has been moved out of a complex NP.

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56 See Cheng & Rooryck (2000) for a detailed discussion an and analysis of *est-ce que*.
57 See Cinque (1990) and Rizzi (1990) for a discussion of these and other islands.
Parallel to the English example in (41), the French question in (43) is ungrammatical. Given the reasoning explained above, this ungrammaticality is expected. The NP *le livre .... écrit* is a complex NP, since *le livre* takes a CP complement. Hence the entire NP forms an island for extraction and the wh-word *qui* is not allowed to move out of this island. If it does, this movement results in an ungrammatical sentence, i.e. the sentence in (43).

Let us now turn to French wh-questions of the type in (37a). Crucially, these questions too show island effects (cf. Obenauer 1994; Cheng & Rooryck 2000, 2003; Mathieu 2002). This is illustrated below.\(^{58}\)

(44) * Jean aime le livre que qui a écrit?  
  Jean likes the book that who has written  
  ‘Who is the person \(x\) such that Jean likes the book that \(x\) has written?*

Again the NP *le livre....écrit* is a complex NP. This NP thus forms an island for movement. The wh-word is not allowed to move out of this NP. Crucially, as is illustrated in (44), the wh-word *qui* does not move out of the complex NP. Instead, it remains within the NP. Still, the question in (44) is ungrammatical. The sentence in (44) thus shows the same island violation as the one in (43), despite the fact that in (43) the wh-word has not been moved. How can this be explained?

There is only one possible explanation for the ungrammaticality of (44): something must have been moved out of the complex NP. Island effects indicate that movement has taken place. Hence, in (44) something must have been moved out of the complex NP. This can only be the wh-word *qui*, since there is no reason for the other elements to move. It is true that *qui* has not been moved visibly. Still, the parallelism between (43) and (44) suggest that *qui* (or parts of it, as will be shown later) has moved to the beginning of the sentence. In other words, since island effects reflect a movement violation, the ungrammaticality of (44) shows that French wh-in-situ questions are derived through some kind of movement. This is indeed the position usually adopted in the literature on French wh-questions (cf. Bošković 1998, 2000; Pollock, Munaro & Poletto 1998; Mathieu 1999, 2002; Cheng & Rooryck 2000, 2003). The type of movement involved in French wh-in-situ questions is, however, a matter of controversy, to which I will turn in section 2.2.

Note that wh-in-situ questions do not universally exhibit island effects. In contrast to French, Chinese wh-items are allowed to remain in-situ in islands (cf. Huang 1982; Aoun & Li 1993; Tsai 1994; Cheng & Rooryck 2000).\(^{59}\) This is illustrated in (45) (taken from Aoun & Li (1993)). The sentence in (45) contains a complex NP, but no island effects occurs.

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\(^{58}\) See, however, Plunket (2000) for some contrasting judgments.

\(^{59}\) This is only the case for wh-arguments. As was observed by Huang (1982), Chinese wh-adverbials cannot remain in-situ in islands. See Cheng and Rooryck (2003) and reference cited therein for a discussion of this phenomenon.
(45) Ni xihuan shei xie de shu?
  ‘Who is the person x such that you like the book that x wrote?’

Since island effects are a diagnostic of movement, the absence of an island effect in (45) suggests that nothing has been moved out of the complex NP. In other words, in Chinese wh-words do not move at all. This is indeed the analysis of Chinese wh-questions that is nowadays standardly adopted (cf. Cheng 1991; Aoun & Li 1993; Tsai 1994; Cheng & Rooryck 2000, 2003; Simpson 2000).60

To sum up, both French wh-questions in (37) exhibit island effects. This indicates that both types of questions are derived through movement of the wh-word (or parts of it). This wh-movement is visible in questions of the type in (37b): the wh-word has been moved overtly to the beginning of the sentence. However, in (37a), the wh-word has not been moved visibly. Still, the island effect in (44) shows that here too, movement has taken place. In section 2.2, I will discuss in more detail what exactly moves in French wh-in-situ questions. For now, it is sufficient to conclude that both types of wh-questions in (37) are similar in that they both involve movement.

2.1.2. Embedded clauses

In this and the following section, I will discuss two differences between French wh-in-situ questions (37a) and French wh-questions involving overt wh-movement (37b). It will be shown that French wh-in-situ questions, in contrast to their counterparts involving overt wh-movement, are subject to syntactic restrictions.

The first difference between French wh-in-situ questions and their counterparts involving overt wh-movement concerns the fact that French wh-in-situ is restricted to matrix questions (cf. Obenauer 1994; Chang 1997; Bošković 1998, 2000; Mathieu 1999; Cheng & Rooryck 2000, 2003). Thus, French wh-words cannot remain in-situ in finite embedded clauses.61 This is shown in the examples below.62

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60 The references listed here provide different analyses of Chinese wh-in-situ. These differences do not concern us here. See Aoun & Li (1993), Cheng (2003), and Simpson (2000) for a discussion of the arguments on which an analysis of Chinese wh-in-situ is based.

61 Wh-in-situ is possible in infinitival or subjunctive embedded clauses (cf. Bošković 1998; Boeckx, Stateva & Stepanov 1999; Mathieu 1999, 2002; Plunkett 2000).

(i) a. Tu veux faire quoi aujourd’hui? b. Il veut qu’elle fasse quoi?
  You want do what today  He wants that she does SUBJ what
  ‘What do you want to do today?’  ‘What does he want her to do?’

See Bošković (1998) and Boeckx et al. (1999) for a possible explanation of this phenomenon.

62 Note that there is quite some dialectal variation with respect to these judgments. According to some, questions of the type in (46a) are grammatical (cf. Mathieu 2004; Starke 2002; Tellier 1991). Similarly, it has been noted that some speakers of French accept sentences of the type in (46b) under certain conditions (cf. Boeckx et al. 1999; Mathieu 2002). This dialectal variation is acknowledged in most of the recent literature on French wh-in-situ (cf. Bošković 2000; Cheng & Rooryck 2003). However, many aspects of this variation are still unknown. First of all, the factors determining variation in judgments are unclear. It seems to be the case that the age of the informants plays an important role, in that the younger generation tends to accept sentences of the type in (46), while the older generation rejects them. However, this cannot be the only factor, since the split in judgments has also been observed in students of the same generation (cf. Cheng & Rooryck 2003, fn. 2). Further, it is unknown whether the differences in judgments on these constructions correlate with the variation in judgments concerning the intervention...
(46) a. * Jean pense [CP que Marie a vu qui]?
   Jean thinks that Marie saw who?
   ‘Who does Jean think that Marie saw?’
b. * Je me demande [CP que/si Jean a vu qui].
   I me wonder that/whether John has seen who
   ‘I wonder who Jean has seen.’

By contrast, French wh-questions involving overt wh-movement (i.e. questions of the type in (37b)) are not restricted to matrix clauses.

(47) a. Qui est-ce que Jean pense [CP que Marie a vu t qui]?
   who Q Jean thinks that Marie has seen
   ‘Who does Jean think that Marie saw?’
b. Je me demande [CP qui Jean a vu t qui].
   I me wonder who Jean has seen
   ‘I wonder who Jean has seen.’

The contrast between (46) and (47) shows that in certain contexts, French does not allow a free choice between a wh-in-situ question or a question involving overt wh-movement. Possible explanations of this difference will be discussed in section 2.2.

Before turning to these explanations, I will present a second difference between French wh-in-situ questions and their counterparts involving overt wh-movement.

2.1.3. Intervention effects

In the previous section, it was shown that French wh-in-situ questions are restricted to matrix clauses. However, this is not the only restriction on French wh-in-situ questions. In fact, not all matrix clauses allow the wh-word to remain in-situ. As was observed by Chang (1997), French wh-words cannot stay in-situ when preceded by quantifiers, negation, or modals. Her examples are given below.

(48) a. * Tous les étudiants ont rencontré qui?64
   All the students have met who
   ‘Who did all the students meet?’
b. * Il n’a pas rencontré qui?
   He not has NEG met who
   ‘Who didn’t he meet?’

As was the case for the restriction to matrix questions, there is a lot of variation here too. Not all speakers reject all of the examples in (48) (see Mathieu 1999, 2002; Plunkett 2000; Cheng & Rooryck 2003). For reasons discussed above, I will not go into the details or the reasons for this variation.

The only available reading is an echo reading (cf. Chang 1997). Echo-questions are a different type of questions, which will not be discussed here.
In the literature, the ungrammaticality of the examples in (48) is known as the *intervention effect*. This effect was first observed for German by Beck (1996). The relevant examples are given below.

   whom of the musicians has Hans met
   ‘Who among the musicians has Hans met?’

   b. Wen hat Hans [t_wen von den Musikern] getroffen?
      who has Hans of the musicians met
      ‘Who among the musicians has Hans met?’

      who has no student of the musicians met
      ‘Who among the musicians has no student met?’

As can be seen in (49), in German it is allowed to move the entire wh-phrase wen von den Musikern (49a), or to move only the wh-word and leave the rest of the phrase in-situ (49b). However, this ‘separation construction’ is no longer possible if the sentence contains the quantifier keine (49c). This does not only hold for keine, but for all the elements given in (48) for French. Thus, the intervention of elements such as quantifiers and negation blocks a separation construction. As is shown in (50) below, movement of the entire wh-phrase is still allowed.

(50) [Wen von den Musikern] hat keine Studentin [wen von den Musikern] getroffen?
   who of the musicians has no student met
   ‘Who among the musicians has no student met?’

The intervention effect thus occurs in constructions in which two parts of a complex wh-phrase have been separated from each other. This separation is blocked by the intervention of certain elements (see Pesetsky (2000) for a more precise characterization of the intervention effect). In sections 2.2.2 and 2.2.3, I will discuss in more detail in what way French wh-in-situ questions are similar to the German separation constructions in (49b). For now, it is sufficient to note that French wh-in-situ questions are sensitive to the intervention effect.

In contrast to French wh-in-situ questions, French wh-questions involving overt wh-movement are not sensitive to the intervention effect. The grammaticality of the examples in (51) is similar to that of the German example in (50).
The intervention effect in French wh-in-situ questions, as well as its absence in wh-questions involving overt wh-movement, has been extensively discussed in the literature (Cheng & Rooryck 2000, 2003; Mathieu 1999, 2002; Starke 2002). In the next section, I will discuss several accounts proposed for this phenomenon.

To sum up, there are two differences between French wh-in-situ questions and French wh-questions involving overt movement. First, French wh-in-situ questions are restricted to matrix clauses. By contrast, French wh-questions involving overt movement also allow embedded constructions. Secondly, French wh-in-situ questions, but not their counterparts involving overt wh-movement, are subject to the intervention effect. The next section discusses how these differences can be explained.

2.2. Analyses of French wh-questions

French wh-questions have been the topic of many studies (cf. Aoun, Hornstein & Sportiche 1981; Obenauer 1994; Chang 1997; Bošković 1998, 2000; Boeckx 1999, Boeckx et al. 1999; Mathieu 1999, 2002; Cheng & Rooryck 2000, 2003; Plunkett 2000; Poletto & Pollock 2000). Hence, the literature contains a whole range of proposals for this construction. For reasons of space, I will limit myself to a discussion of three of these analyses. I will examine whether these analyses are able to account for the properties of French wh-questions discussed in section 2.1. Thus, for each analysis it will be determined whether it can account for the island effects observed on both types of wh-questions. Further, it will be examined if and in what way the analysis explains the differences between French wh-in-situ questions and their counterparts involving overt wh-movement. How does the analysis capture the observation that French wh-in-situ questions, but not French wh-questions involving overt wh-movement, are restricted to matrix clauses and subject to the intervention effect?
2.2.1. Pollock et al.
Pollock and colleagues (Pollock et al. 1998; Poletto & Pollock 2000) have not only examined French wh-questions. Instead, their goal is to provide an analysis for different types of wh-questions in several Romance languages. Their analysis is based on two main assumptions. First of all, following Rizzi (1997), they assume that the CP layer consists of several functional projections. I will not discuss these projections, but simply call them X, Y, and Z (see Poletto & Pollock (2000) for details). Their second claim is that covert movement does not exist. The consequence of this second claim is that wh-questions can only be derived through overt movement operations.

To see how this works for French wh-questions, consider first questions of the type in (37b) repeated below for convenience.

(52) Qui est-ce que tu as vu?
    who Q you have seen
    ‘Who did you see?’

Poletto and Pollock (2000) assume that the structure for this question is as illustrated in (53). The IP tu as vu qui is part of a larger syntactic structure containing several functional projections called here X, Y, and Z.

(53) \[ ZP \]
    \[ Z' \]
    \[ Z \]
    \[ est-ce que \]
    \[ YP \]
    \[ Y' \]
    \[ Y \]
    \[ XP \]
    \[ X' \]
    \[ X \]
    \[ IP \]
    \[ tu as vu qui \]

They further assume that the first movement that takes place, is the movement of the wh-word into Spec,XP. This results in the configuration illustrated below. For reasons of space, I will use a bracketed structure.

(54) \[ \{ ZP est-ce que [YP Y' [XP qui X' [IP tu as vu qui]]]] \]

Poletto and Pollock assume that the derivation does not end here. Instead, several movement steps are claimed to follow. First, they argue that the remnant IP in (54), i.e. the IP without the wh-word, moves to a position before the wh-word, namely Spec,YP. This resulting configuration of this remnant IP movement is given in (55).

(55) \[ZP \text{est-ce que} \ [YP \text{tu as vu qui}]\]

This is still not the end of the derivation. Pollock and colleagues assume that now the wh-word moves to the highest position in the tree, namely to Spec,ZP. This last movement operation is illustrated below.

(56) \[ZP \text{qui est-ce que} \ [YP \text{tu as vu qui}]\]

Thus, Pollock and colleagues claim that French wh-questions of the type in (52) involve three overt movement operations: movement of the wh-word out of the IP (cf. 54), followed by movement of the remnant IP (cf. 55), followed by a second movement of the wh-word to Spec,ZP (cf. 56). Consider now French wh-in-situ questions, repeated in (57) below.

(57) Tu as vu qui?
    you have seen who
    ‘Who did you see?’

Pollock and colleagues claim that the difference between questions of the type in (57) and those of the type in (52) lies in the number of functional projections the syntactic structures of these questions contain. They argue that the structure of French wh-in-situ questions is as in (58).

(58)

The structure in (58) is similar to that in (53) except that it lacks the ZP-projection. The derivation of French wh-in-situ questions proceeds in a similar way as explained above for French wh-questions of the type in (52). The only difference is that in French wh-in-situ questions the second movement of the wh-word (i.e. the movement illustrated in (56)) does not take place. The derivation of French wh-in-situ questions is sketched below.
As can be seen in (59), Pollock and colleagues claim that French wh-in-situ questions too involve several movement operations. First, the wh-word moves out the IP (59a). This movement is followed by movement of the remnant IP to Spec,YP (59b). Crucially, here the derivation stops. The wh-word cannot move to a position before the remnant IP, because there is no such position. Consequently, it appears in a sentence-final position. Pollock and colleagues thus claim that French wh-in-situ questions are only apparent wh-in-situ constructions. The French wh-word does not remain in-situ, but moves to a higher position. It only shows up in a sentence-final position, because the IP has been moved to a position before the wh-word and the wh-word itself cannot move any further.

To summarize, Pollock and colleagues argue that both types of French wh-questions in (52) and (57) involve overt wh-movement. The two types of questions differ only in the number of functional projections their underlying structure contains. Wh-in-situ questions have fewer functional projections, and therefore fewer movement steps. They lack the movement of the wh-word to the highest position in the clause (i.e. the movement illustrated in (56)). As a result, the wh-word appears in a sentence-final position.

Let us now consider whether this analysis can explain the properties of French wh-questions discussed in section 2.1. The fact that both types of wh-questions exhibit island effects follows straightforwardly on the assumption that island effects reflect a movement violation. Since both types of questions involve overt wh-movement, island effects are expected to occur. To my knowledge, however, Pollock and colleagues do not discuss the differences between these two types of questions. It is therefore difficult to say whether their analysis accounts for the restrictions on wh-in-situ as well as for the absence of these restrictions in wh-questions involving overt wh-movement. It is, however, possible to show that Pollock and colleagues are forced to make a rather implausible assumption. To see this, I will focus here on the intervention effect.

Recall that under the analysis of Pollock and colleagues, French wh-in-situ questions in (57) only differ from questions of the type in (52) in that they lack the ZP projection and therefore the second movement of the wh-word to the Spec,ZP position. The observed differences between both types of questions have to be related to their underlying syntactic structure. In essence, this means that the sensitivity to the intervention effect of French wh-in-situ questions has to follow from the fact that in these questions the wh-word does not move to the Spec,ZP position. This is a very unlikely assumption in light of the characterization of the intervention effect given in section 2.1.3. As was explained there, the intervention effect occurs in constructions where scope-bearing elements such as negation or quantifiers intervene between two parts of a complex unit that have been separated from each other (cf. the examples in (49b)). In essence, this means that the
intervention effect is a consequence of syntactic movement. The word \textit{wen} (‘who’) in (49b) has been moved away from the rest of the NP. This movement is blocked by the intervention of the quantifier \textit{keine} (‘no’). Thus, in French wh-in-situ questions too, the intervention effect results from syntactic movement. Crucially, neither the first movement of the wh-word, nor the movement of the remnant IP can be responsible for the intervention effect. If this were true, it follows that not only French wh-in-situ questions, but also wh-questions of the type in (52) are sensitive to the intervention effect. As was shown in (51), this is not the case. Pollock and colleagues thus have to assume that the intervention effect in French wh-in-situ follows from the absence of the second movement of the wh-word. Such an assumption is impossible to maintain, since the intervention effect is rather an indication of the \textit{presence} than of the \textit{absence} of syntactic movement. In short, the analysis of Pollock and colleagues can account for the fact that both types of French wh-questions in (52) and (57) exhibit island effects. However, it falls short in explaining the differences between the two types of questions. The restrictions of wh-in-situ questions, as well as the absence of these restrictions in wh-questions involving overt wh-movement remain unexplained. I will therefore not adopt their analysis.

2.2.2. Mathieu
The main claim of Mathieu (1999, 2002, to appear.) is that French wh-in-situ questions are underlying Split-DP constructions. Split-DP refers to constructions in which a DP has been split into two parts. In other words, this phenomenon is the same as the separation construction discussed in section 2.1.3 for German. A French example of such a construction is given in (60b). This paradigm was first observed by Obenauer (1984).\footnote{See also Rizzi (1990), Obenauer (1994), and Pesetsky (2000) for a discussion of these examples.}

\begin{enumerate}
\item \textit{Combien de livres} as-tu lu?
  \begin{itemize}
  \item How many of books have you read
  \item ‘How many books have you read?’
  \end{itemize}
\item \textit{Combien} as-tu \textit{de livres}?
  \begin{itemize}
  \item How many have you read of books
  \item ‘How many books have you read?’
  \end{itemize}
\end{enumerate}

Mathieu argues that French wh-in-situ questions are an instance of Split-DP constructions. He shows that French wh-words are similar to the complex wh-phrase \textit{combien de livres} (‘how many books’) in (60) in that they contain a wh-operator and an indefinite.\footnote{See Mathieu (2002) for the details of his argumentation.} The only difference between a bare wh-word and a wh-phrase such as \textit{combien de livres} is that the former contains a phonologically empty wh-operator. This is illustrated in (61), in which the morphological structure of both wh-phrases is given.
Mathieu further argues that the structure of French wh-in-situ questions parallels that of (60b). In both cases, the wh-operator has been moved, leaving the indefinite in-situ. This is illustrated below.\(^{68}\)

\[(62)\]

\[\begin{align*}
\text{a. } & \text{ [CP Combien [IP ..... [tcombien de livres]]]} & \text{Split-DP} \\
\text{b. } & \text{ [CP Opwh [IP ..... [tOpwh qui]]]} & \text{wh-in-situ}
\end{align*}\]

Thus, French wh-in-situ questions involve movement of an empty wh-operator. By contrast, French wh-questions of the type in (37b) involve movement of the entire wh-word. Both types of questions, as well as their derivations are given in (63).

\[(63)\]

\[\begin{align*}
\text{a. } & \text{ Tu as vu qui? [CP Opwh C0 [IP tu as vu [tOpwh qui]]]} & \text{you have seen who ‘Who did you see?’} \\
\text{b. } & \text{ Qui est-ce que tu as vu? [CP qui est-ce que [IP tu as vu tqui]]} & \text{who Q you have seen ‘Who did you see?’}
\end{align*}\]

As is illustrated in (63), under Mathieu’s account both types of French wh-questions involve movement. The difference lies in the type of element that has been moved: a wh-operator (63a) or an entire wh-word (63b).

Can this analysis account for the properties of French wh-questions as discussed in section 2.1? Mathieu (1999, 2002, to appear) focuses on the intervention effect. If French wh-in-situ questions are Split-DP constructions, their sensitivity to the intervention effect follows straightforwardly. As explained in section 2.1.3, the kind of separation illustrated in (62) is blocked by the intervention of elements such as quantifiers and negation. Thus, both French constructions in (62a) are expected to be sensitive to the intervention effect. This expectation is borne out.

\[(64)\]

\[\begin{align*}
\text{a. } & \text{ Tu n’a pas vu qui? [CP C0 [IP tu n’a pas vu [tqui]]]} & \text{you not have NEG seen who ‘Who didn’t you see?’} \\
\text{b. } & \text{ Combien n’as-tu pas lu de livres? [CP [IP combien n’as-tu pas lu de livres]]} & \text{how many not have you NEG read of books ‘How many books didn’t you read?’}
\end{align*}\]

The absence of the intervention effect in wh-questions of the type in (63b) is also captured under Mathieu’s account. In these wh-questions, the entire wh-word has

\(^{68}\) Note that this is not the only aspect of Mathieu’s proposal. Apart from the syntactic similarities between the two structures in (62), Mathieu (2002, to appear) also discusses and explains their semantic similarities. A review of this part of his proposal is outside the scope of this thesis.

\(^{69}\) The ungrammaticality of (64b) was first observed by Obenauer (1984).
been moved. Hence, there is no separation construction and consequently no intervention effect arises. French wh-questions of the type in (63b) are thus similar to the construction in (65), in which there is also no intervention effect.

(65) **Combien de livres** n’as-tu pas lu **tcombien de livres**?
   how many of books not have you NEG read
   ‘How many books didn’t you read?’

Mathieu (2002) explains the intervention effect by means of the Scopal ECP (Williams 1994). The precise characterization of this principle is not important here. The only point relevant here is that the Scopal ECP prohibits adjuncts to cross scope-bearing elements, since their traces have to be locally bound. By contrast, arguments are free to move over scope-bearing elements. To see how the Scopal ECP works, consider the structure of the sentence in (64a), given in (66).

(66) [OpWH tu n’as pas vu [tOpWH qui]]?

Mathieu argues that the moved wh-operator in (66) is an adjunct. Therefore, it cannot cross scope-bearing elements such as negation. This explains the ungrammaticality of (64a). By contrast, in sentences of the type in (63b), the moved element is an argument and as such free to cross scope-bearing elements.\(^70\)

Mathieu’s analysis thus accounts for one of the differences between French wh-in-situ questions and French wh-questions involving overt wh-movement. It is however unclear whether his analysis also captures the other properties of French wh-questions. Consider first the island effects discussed in section 2.1.1. Under Mathieu’s account it is unexpected that French wh-in-situ questions exhibit island effects. Mathieu relates all properties of French wh-in-situ questions to the Scopal ECP. However, as Mathieu (2002) acknowledges himself, the Scopal ECP does not cover islands violations. This principle only captures illicit movement operations over **scope-bearing** elements. Crucially, the constructions yielding island effects, such as complex NPs, are no scope-bearing elements. Hence, under Mathieu’s analysis extra assumptions are required in order to account for the island effects of French wh-in-situ questions. Further, Mathieu does not discuss the fact that French wh-in-situ questions are restricted to matrix clauses (cf. section 2.1.2). Again, it is hard to see how this property could follow from the Scopal ECP.

In sum, under Mathieu’s account all properties of French wh-in-situ questions are explained in terms of scope. As a result, his analysis falls short in explaining the syntactic restrictions on French wh-in-situ questions, such as their sensitivity to

\(^70\) Note that Mathieu’s account is more complicated than the way it is presented here. Mathieu does not claim that adjunct in general are not allowed to move over scope-bearing elements. If this were the case, a question such as (i) would incorrectly be predicted to be ungrammatical.

(i) **Pourquoi est-ce que Jean ne vient pas aujourd’hui** t**pourquoi**?
   Why Q Jean not come NEG today
   ‘Why doesn’t Jean come today?’

Mathieu (2002) distinguishes several types of adjuncts as well as several types of scope-bearing elements. He shows that a certain class of adjuncts is not allowed to cross a certain class of scope-bearing elements and that the Scopal ECP is the only mechanism that can account for these facts.
islands and their restriction to matrix clauses. Let us therefore turn to the last analysis of French wh-questions to be discussed in this thesis.

2.2.3. Cheng & Rooryck

Cheng and Rooryck (2000, 2003) argue that the two types of French wh-questions under scrutiny here differ with respect to the \(Q\)-morpheme they contain. In theoretical linguistics, it is generally assumed that in interrogatives \(C\) contains a question morpheme, called \(Q\)-morpheme. This question morpheme is sometimes phonologically realized, as is for instance the case in French interrogatives with \textit{est-ce que} (cf. example (38b) and the discussion there). Cheng and Rooryck (2000) argue that three different types of \(Q\)-morphemes have to be distinguished: \([Q:\text{wh}]\), \([Q:\text{y/n}]\), and \([Q:\ ]\). The first two types of \(Q\)-morphemes mark respectively wh-questions and yes/no questions. Cheng and Rooryck call the third type the defective \(Q\)-morpheme. They show that this morpheme is unspecified for \(\text{wh}\) or \(\text{y/n}\)-features and as such can function in both types of interrogatives. Thus, they propose that there are three types of interrogatives, schematized below.

\[(67)\]
\[
a. \quad [CP \quad C^o \quad [IP \ldots]] \quad \text{wh-question} \\
\quad \quad \quad \quad [Q^{\text{wh}}]
\]
\[
b. \quad [CP \quad C^o \quad [IP \ldots]] \quad \text{yes/no-question} \\
\quad \quad \quad \quad [Q^{\text{y/n}}]
\]
\[
c. \quad [CP \quad C^o \quad [IP \ldots]] \quad \text{wh- and yes/no-question} \\
\quad \quad \quad \quad [Q^{\text{\ }}]
\]

They further claim that French wh-questions involving overt wh-movement contain the \(Q\)-morpheme illustrated in (67a). By contrast, French wh-in-situ questions contain the defective \(Q\)-morpheme in (67c).\(^{71}\) In (68) both types of wh-questions as well as their underlying structure proposed by Cheng and Rooryck are given.

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\(^{71}\) The claim that the defective \(Q\)-morpheme is underspecified for \(\text{wh}\) or \(\text{y/n}\) features is crucial for Cheng and Rooryck. As will be shown later their analysis of feature movement in French wh-in-situ questions follows directly from the underspecification of the \(Q\)-morpheme. The proposed underspecification is based on the observation that French wh-in-situ questions are similar to French yes/no questions both with respect to their intonation and interpretation (see Cheng & Rooryck (2000) for details). Cheng and Rooryck argue that these similarities suggest that both types of questions are licensed in the same way and thus contain the same \(Q\)-morpheme. Consequently, this \(Q\)-morpheme has to be underspecified. Mathieu (2002, to appear) does not agree with their judgments. According to him, French wh-in-situ questions and French yes/no questions do not share the same intonation pattern or interpretational properties. He therefore concludes that the analysis of Cheng and Rooryck cannot be correct. Note however, that such a strong conclusion does not have to be necessary. Mathieu’s judgments are simply another example of the individual variation observed earlier concerning the properties of French wh-in-situ questions. As was noted in the footnotes 61 and 62, some speakers allow the wh-word to remain in-situ in constructions where others reject it. This variation obviously has to be accounted for. However, in the absence of such an account it is perfectly legal to propose an analysis covering only the judgments of one set of speakers. In other words, the assumption that French wh-in-situ questions contain an underspecified \(Q\) is a plausible assumption, even if the evidence on which it is based does not hold for everyone.
(68) a. Tu as vu qui? [CP C\[IP tu as vu qui]\] you have seen who ‘Who did you see?’
b. Qui (est-ce que) tu as vu? [CP (est-ce que) [IP tu as vu qui]] who Q you have seen ‘Who did you see?’

As can be seen in (68), the main difference between the two types of French wh-question lies in the Q-morpheme. Cheng and Rooryck argue that because of these different Q-morphemes, the questions in (68) involve different types of syntactic movement. Consider first the wh-in-situ question in (68a). Cheng and Rooryck (2000) argue that the underspecification of the Q-morpheme has to be resolved. Q has to be specified as either [Q:wh] or as [Q:y/n]. In other words, the interrogative has to be typed as either a wh-question or a yes/no question. In order to do so, the wh-features of the wh-word move into the Q-morpheme. This derivation is illustrated below.

(69) [CP C [IP tu as vu qui]]
       [Q:wh] [twh]

By contrast, in questions of the type in (68b), the Q-morpheme is already specified as [Q:wh]. In other words, the interrogative is already specified as being a wh-question. Cheng and Rooryck claim that in this construction, the wh-features of the Q-morpheme need to be checked. Hence, the entire wh-word moves to a position where it can check the wh-features of the Q-morpheme, namely Spec,CP.73

(70) [CP qui (est-ce que) [IP tu as vu qui]]
       [wh] [Q:wh]

The structures in (69) and (70) illustrate the difference between the two types of French wh-questions in (68). Under Cheng and Rooryck's account, these questions differ with respect to the type of syntactic movement through which they are derived. French wh-in-situ questions involve feature movement. By contrast, French wh-questions of the type in (68b) involve XP-movement of the wh-word.

Having sketched the main points of Cheng and Rooryck's analysis, I now turn to the question whether this analysis can explain the properties of French wh-questions. The fact that both types of wh-questions exhibit island effects (cf. section 2.1.1) follows straightforwardly from their analysis. Since both types of questions involve movement (either feature movement or wh-movement), island effects are expected to occur. Further, it can be shown that the differences between both types

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72 See chapter 1, section 2.4 for the assumptions behind feature checking.
73 Note that their analysis of these types of wh-questions is more complicated than presented here. See Cheng and Rooryck (2003) for details. The exact derivation of these questions is not relevant here. The only relevant point is that these questions, in contrast to wh-in-situ questions, involve overt wh-movement.
of questions follow from the different Q-morpheme. As discussed in section 2.1.2, French wh-in-situ questions, in contrast to their counterparts involving overt wh-movement, are restricted to matrix clauses. To account for this restriction, Cheng and Rooryck propose that the defective Q is a root morpheme. Root morphemes are morphemes appearing only in matrix clauses and not in embedded clauses. The sentences in (71) illustrate a root morpheme in Chinese. This example is taken from Aoun & Li (1993).

(71) a. Shei laile (ne).
     Who came Q
     ‘Who came?’

b. Wo zhidao [shei laile (*ne)]?
     I know who came *Q
     ‘I know who came.’

The sentence in (71a) shows that Chinese matrix questions optionally contain the question particle ne. This particle is not allowed to appear in embedded clauses, as is illustrated in (71b). According to Cheng and Rooryck (2000) the Chinese Q-morpheme in (71) and the defective Q-morpheme in French are of the same type. They are root-morphemes and as such can only occur in matrix clauses. This accounts for the ungrammaticality of French wh-in-situ in embedded clauses. The examples in (46) are repeated here as (72).

(72) a. *Jean pense que Marie a vu qui?
    Jean thinks that Marie has seen who
    ‘Who does Jean think that Marie has seen?’

b. *Je me demande que/si Jean a vu qui.
    I me wonder that/whether Jean has seen who
    ‘I wonder who Jean has seen.’

In order to license the in-situ qui in (72), the Q-morpheme would have to be inserted in the C node of the embedded CP. This is not allowed, since the defective Q-morpheme is a root morpheme. By contrast, French wh-questions of the type in (68b) contain the [Q:wh] morpheme. This morpheme can be inserted in both matrix and embedded clauses. Hence, French wh-questions of the type in (68b) are not restricted to matrix clauses.

As discussed in section 2.1.3, the French wh-questions in (68) differ not only with respect to the possibility to occur in embedded constructions. The second difference concerns their sensitivity to the intervention effect. Under Cheng and Roorycks account, this difference follows again from the different Q-morphemes marking both types of wh-questions. Consider first wh-in-situ questions (68a). Pesetsky (2000) has shown that constructions derived through feature movement are sensitive to the intervention effect. He argues that these constructions are similar to the German example in (49b) and the French example in (60b) in that here too, two parts of a complex unit have been separated. For French wh-in-situ questions, this can be seen in (69) above, where the wh-features of qui have been separated from their originating lexical item. As argued by Pesetsky, such a separation construction
is blocked by the intervention of elements such as quantifiers and negation. This is shown again below for the relevant constructions.

   who has no student of the musicians met
   ‘Who among the musicians has no student met?’

b. *Combien n’as-tu pas lu [tcombien de livres?]
   how many not have you NEG read of books
   ‘How many books didn’t you read?’

c. *FF qui tu n’as pas vu qui?
   you not have NEG seen who
   ‘Who didn’t you see?’

Pesetsky further claims that the intervention effect can be used as a diagnostics for feature movement. The analysis Cheng and Rooryck propose for French wh-in-situ questions is thus in line with Pesetsky’s claims on feature movement and the intervention effect. If the intervention effect can indeed be used as a diagnostics for feature movement, its occurrence in French wh-in-situ questions shows that these questions are derived through feature movement. This also explains the absence of the intervention effect in French wh-questions of the type in (68b). These wh-questions are similar to the examples in (50) and (60a) in that an entire element has been moved. As was there, such a movement operation is not sensitive to the intervention effect.

To sum up, Cheng and Rooryck propose that the French wh-questions in (68) differ in the type of Q-morpheme and hence in the type of syntactic movement through which they are derived. I have shown that their analysis captures both the similarities and the differences between these two types of wh-questions. I will therefore adopt their analysis. In examining patients’ comprehension of the wh-questions in (68), it will thus be assumed that questions of the type in (68a) involve feature movement and those of the type in (68) involve overt wh-movement.

2.3. Conclusion

French displays optional wh-movement in that the wh-word can either remain in-situ or move to the beginning of the sentence. The relevant examples are repeated here.
(74) a. Tu as vu qui?
   you have seen who
   ‘Who did you see?’

b. Qui (est-ce que) tu as vu?
   who (Q) you have seen
   ‘Who did you see?’

Since this thesis examines the way in which these questions are understood by French-speaking Broca patients, it is necessary to know the syntactic structure of both types of questions. I have argued that the analysis proposed by Cheng & Rooryck (2000) has to be preferred over other proposals, since it is the only analysis capable of explaining the properties of both types of wh-questions. Under their account, the questions in (74) differ with respect to the type of movement through which they are derived. Questions of the type in (74a) involve feature movement, those in (74b) wh-movement. For convenience, the syntactic structures of both types of questions are repeated below.

(75) a. \[
\begin{array}{c}
\text{CP} \\
\text{Q:wh} \\
\text{[IP tu as vu qui]} \\
\text{[Q:twh]} \\
\end{array}
\]

b. \[
\begin{array}{c}
\text{CP} \\
\text{qui (est-ce que)} \\
\text{[IP tu as vu tqui]} \\
\text{[wh]} \\
\end{array}
\]

In section 1.3, I concluded that examining comprehension of wh-questions in French-speaking Broca patients has two purposes. First, it provides data allowing a crosslinguistic comparison with the data obtained on English-speaking Broca patients. Secondly, it provides insight in the way in which wh-movement affects the comprehension abilities of Broca patients. In the next chapter, the experiments investigating patients’ comprehension of the wh-questions in (74) will be discussed. It will be shown that data obtained in these experiments are not only interesting for the two reasons mentioned above. They also provide an answer to other questions concerning the effect of syntactic movement on patients’ comprehension and as such provide more insight in the way in which syntactic movement in general affects comprehension in Broca’s aphasia.
3 Wh-questions in Broca’s aphasia: experiments

The purpose of this thesis is to provide more insight into the way in which syntactic movement affects comprehension in Broca’s aphasia. I will focus on one construction which has received relatively little attention in studies on the comprehension deficit of these patients: wh-questions. This chapter describes the experiments I have done. The first three experiments all investigate patients’ comprehension of wh-questions, each experiment focusing on a different type of wh-question. The fourth experiment differs from the other three in that it does not investigate patients’ comprehension of wh-questions. Rather, it focuses on the question whether French-speaking Broca patients have retained the syntactic structure of wh-in-situ questions.

The chapter is organized as follows. Section 1 discusses a general methodological question, namely the choice between a group study and a single case study. In this thesis, the results of a group of French-speaking Broca patients will be compared to that obtained on a group of non brain-damaged speakers of French. These two groups are presented in section 2. Section 3 describes and discusses the three comprehension experiments, while experiment 4 is the subject of section 4. Finally, section 5 gives a general discussion of the results obtained in all these experiments.

1. Group studies versus single case studies

This section discusses the type of study to be performed. Broadly speaking, there are two types of studies: group studies and single case studies. In section 1.1, I will explain the differences between these two experimental paradigms. It will be shown that the choice for either of these paradigms is determined by the research question under scrutiny and that the research questions of this thesis require a group study. However, there is a debate in the neurolinguistic literature concerning the question whether group studies can be used in research on aphasic patients. This debate is summarized in section 1.2. Section 1.3 outlines the approach taken in this thesis.

1.1. Differences between group and single case studies

In a group study, the performance of one group is compared to that of another. So, in aphasiologic research, the performance of a group of Broca patients can be compared to that of a group of aphasic patients suffering from a different type of aphasia or to that of a group of non brain-damaged individuals. The results of these kinds of experiments allow inferences on the language problems of Broca patients in general. In this way, several differences have been observed between Broca and Wernicke patients (see Grodzinsky (2000) and Zurif (1995) for an overview).

In single case studies, one individual is tested in detail. In aphasiologic research, these kinds of studies are used to thoroughly describe the language difficulties of a specific aphasic patient. Does (s)he have any semantic, phonological, or lexical
To sum up, group studies allow generalizations concerning the population from which the participants have been drawn. Single case studies, in contrast, allow inferences concerning the relation between language and the brain in a specific individual. The goal of the experiments run for this thesis, is to provide more insight in the way in which wh-movement affects comprehension in Broca’s aphasia. Clearly, such a research question requires a group study. By comparing the results of a group of Broca patients with that of a group of non brain-damaged speakers, conclusions can be drawn concerning the difficulties Broca patients suffer in comprehending wh-questions.

1.2. Group studies in aphasiology

In the neurolinguistic literature, there has been a sharp debate concerning the validity of group studies in aphasiologic research. The discussion centered around the question whether studies of groups of aphasic patients allow inferences about the language system in non brain-damaged individuals. In a series of papers, Caramazza and colleagues have argued that these kinds of inferences cannot be made (cf. amongst others Badecker & Caramazza 1985; Caramazza 1984, 1986; Caramazza & McCloskey 1988; Caramazza & Badecker 1989, 1991). According to them, the language system can only be examined through detailed single-case studies. Others argue that group studies are allowed for this purpose, and that group studies with aphasic patients have lead to interesting results that would never have been observed in single case studies. This position is mainly defended by Grodzinsky, Zurif and colleagues (cf. Grodzinsky 1991; Grodzinsky et al. 1999; Zurif, Gardner & Brownell 1989; Zurif, Swinney & Fodor 1991; Zurif & Piñango 1999).

Note, however, that this discussion is not directly relevant to the purposes of this thesis. Crucially, I will not discuss the question what the data of Broca patients reveal of the language system in general. Instead, the object of this thesis is more modest. It aims to provide more insight into the way in which syntactic movement affects the comprehension abilities of Broca patients. As explained above, this can only be done by means of a group study. Still, although the above-mentioned discussion is not directly relevant, it is important to summarize its main points. Indeed, the discussion has raised several important issues concerning the design of group studies. Since I will do a group study, these issues should be taken into account. Below, I will therefore briefly describe the arguments against and in favor of group studies in aphasiologic research.

1.2.1. Problems with group studies on aphasic patients

The main argument against group studies put forward by Caramazza and colleagues is that in aphasiologic research the homogeneity requirement cannot be met.77 Group

77 See Caramazza & Martin (1983) for a detailed discussion of this requirement.
studies are based on the assumption that the participating subjects form a homogeneous group representing the population from which they are drawn. Only on that condition, the results of the group can be averaged and generalized. Caramazza and colleagues argue that this assumption cannot be maintained in studies on groups of aphasic patients. This, they argue, is due to the fact that there are no well-defined criteria for the selection of patients. Often, patients are selected on the basis of syndrome-type. In this way, patients classified as Broca aphasics are selected as a group for study. Caramazza and colleagues claim that this way of selecting patients is problematic for several reasons. First of all, the definition of syndrome-types is rather vague and broad. Broca’s aphasia, for instance, is traditionally defined as follows: effortful, telegraphic speech, in which function morphemes are omitted and/or substituted, but with relatively good comprehension. It is however unclear what is meant by ‘relatively good comprehension’ (cf. Caramazza & Martin 1983). Secondly, patients suffering from a similar type of aphasia do not necessarily share the same cognitive deficit (cf. Caramazza & Badecker 1991). For instance, the literature contains several examples of patients showing the production difficulties typically associated with Broca’s aphasia, but with intact comprehension (cf. Kolk et al. 1985a; Miceli et al. 1983; Nespoulous et al. 1988). Finally, the performance of aphasic patients always shows variation. Miceli, Silveri, Romani and Caramazza (1989) observed a considerable amount of variation in the omission or substitution of grammatical morphemes in the speech of patients classified as Broca patients. Similarly, Berndt et al. (1996) report of a large amount of variation in the comprehension difficulties observed in Broca patients. According to some, the variation in patients’ performance therefore shows that it is impossible to select a homogeneous group of patients (cf. Caplan 1995; Caramazza & Martin 1983; Miceli et al. 1989).

1.2.2. Possibilities and advantages of group studies on aphasic patients
The position of Caramazza and colleagues is challenged by Grodzinsky, Zurif, and colleagues (cf. Grodzinsky 1991; Grodzinsky et al. 1999; Zurif et al. 1989, 1991; Zurif & Piñana 1999). First, they show that it is possible to select a homogeneous group of patients based on syndrome type. Although it is true that there is no fine-grained definition of syndrome types, the classical syndromes still provide clearly distinguished groups. Thus, patients with Broca’s aphasia differ in several respects from those with Wernicke’s aphasia. First of all, these patients differ with respect to their production. While the speech of Broca patients is slow, effortful, and telegraphic, Wernicke patients speak fluently and use long and complex phrases. Secondly, Broca and Wernicke patients differ with respect to their lesion site. Broca’s aphasia is the result of damage in the left frontal brain regions, whereas Wernicke’s aphasia results from damage in the left posterior regions (see chapter 1). Finally, on-line experiments have shown that Broca and Wernicke patients have different underlying disruptions in their processing mechanism. Broca patients, in contrast to Wernicke patients, are unable to establish dependency relations such as

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78 See also Caplan 1995.
79 See chapter 1, section 1.1 for an example of the spontaneous speech of a patient with Broca’s aphasia and that of a patient with Wernicke’s aphasia.
the relation between a moved item and its trace in real time (cf. Zurif et al. 1993; Swinney et al. 1996). This indicates that Broca’s and Wernicke’s aphasia are clearly distinguishable syndromes (see also Swinney & Zurif 1995 and Zurif 1995). Contra the claim of Caramazza and colleagues, it is thus possible to select a homogeneous group of aphasic patients on the basis of syndrome-type. Grodzinsky et al. (1999) use the following criteria for selection: (a) patients must be classified as Broca’s aphasics on the basis of standardized aphasia batteries, (b) the lesion site, if known, should be compatible with the neuro-anatomical characterization of Broca’s aphasia.

Grodzinsky (1991) further argues, contra Caramazza and colleagues, that variation in patients’ performance does not imply that the homogeneity requirement is not met. Since the severity of the aphasia varies per patient, variation in performance is expected and therefore not very revealing. It is more interesting to focus on the similarities in patients’ performance. He shows that despite individual variation, one can indeed observe interesting similarities in the performance of a group of selected patients. These similarities have led to interesting observations concerning language difficulties in specific types of aphasia. Thus, the pattern of comprehension in Broca’s aphasia discussed in chapter 2, only emerges by considering the results of a group of Broca patients and not if one only looks at the individual results.80 Therefore, he claims, studies on groups of aphasic patients are not only a valid option, but a necessary tool in aphasiologic research (see also Grodzinsky et al. 1999 and Zurif & Piñango 1999).

Moreover, both Grodzinsky and Zurif have noted several advantages of group studies. First, group studies are less prone to idiosyncratic results than single-case studies (cf. Grodzinsky et al. 1991; Zurif et al. 1989, 1991).81 In a single case study, one runs the risk of examining a statistical outlier (i.e. a patient performing much better or worse than other patients with a comparable lesion). Further, the results of a single patient might be influenced by all kinds of irrelevant factors, such as fatigue or having a bad day. The findings obtained on such patients are misleading and may thus lead to incorrect conclusions. In group studies, the influence of these factors is minimized, since the results of several patients are taken together and averaged.

Finally, it has been argued that studies comparing patients’ performance on two conditions can only be performed on groups of patients (cf. Caplan & Hildebrandt 1988a). The difference might be too small to be detected by any reasonable number of observations in a single-case study. As will be discussed below, the main question of the experiments performed for this thesis is the question whether there is a difference between patients’ comprehension of two types of wh-questions. Given this question, a group study forms the best paradigm.

80 As is shown by this example, the debate about the validity of group studies in aphasic research is tightly related to the debate on variation in patients’ performance. As was explained in chapter 2 (see footnote 25), there is a discussion in the literature concerning the question whether there is a pattern or not in the comprehension data of Broca patients. Some underscore the great heterogeneity in patients’ performance and claim that there is no pattern. Others emphasize that despite this variation, the results of the group of Broca patients do show a clear pattern of performance. The opponents of group studies use the variation in performance as an argument against group studies. According to them, the great amount of variation shows the lack of homogeneity of the selected group. The defenders of group studies note that variation in performance is normal, since patients vary with respect to the severity of theiraphasia. Despite this variation, a clear pattern can be discerned (see Grodzinsky et al. 1999 and references cited therein).

81 See Caramazza (1986) for a discussion concerning this problem of single-case studies.
1.3. Conclusion: a combination

In this section, I have argued that the choice between a group study and a single case study depends on the research question. I have further argued that the research questions my study aims to answer require a group study approach. I will therefore do a group study and compare the performance of a group of French-speaking Broca patients with that of a control group of non brain-damaged speakers of French. The results of the group of Broca-patients will be interpreted as reflecting comprehension of wh-questions in French-speaking Broca patients in general.

At several times, I will not only discuss the results of the group of Broca patients, but also those obtained on an individual patient. The reason for this is that there is indeed individual variation. Sometimes, the results of one patient deviate considerably from that obtained on other patients. This is, for instance, the case in experiment 4 (see section 4). After presenting the group results, I will therefore there also discuss the results of each patient individually.

In short, in this thesis, I will combine both methods. The design of the study is that of a group study in that it compares the performance of a group of Broca patients to that of a group of non brain-damaged adults and in that the results of the group of Broca patients are interpreted as reflecting properties of Broca’s aphasia in general. When necessary, the results of an individual patient will be discussed in more detail.

2. Subjects

In this section, the two groups participating in the experiments will be presented. The discussion concerning the validity of group studies in aphasic research summarized in section 1.2 has shown that is important to carefully select the patients participating in the experiments. Below, I will therefore first describe the selection criteria I used.

2.1. Broca patients

2.1.1. Patient selection

Patients were tested in France (Toulouse), Belgium (Brussels), and in francophone Canada (Montréal). The patients from France and Belgium were referred to me by their speech therapists. The Canadian patients were found in two ways. Some of them were referred to me by their speech therapists. Others were found via self-help groups of several patient associations. In these self-help groups, aphasic patients who are no longer having any speech therapy, meet on a regular basis and do all

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82 There are several differences between the French spoken in Canada, Belgium and France. Crucially however, all three variants allow the wh-word to move or to stay in-situ. Moreover, in all three variants, the in-situ one belongs to a more informal register and the wh-question in which the wh-word has been moved to a more formal one. Despite these differences in register, several sociolinguistic studies have shown that the type of question involving overt wh-movement is the type spoken most frequently (Coveney 1996; Lefebvre 1987).
kinds of linguistic activities (word games, reading etc.). Patients whose speech was non-fluent and telegraphic were asked to participate in the study. All of the patients were asked to sign an informed consent form.

Patients were selected for inclusion on the basis of the following criteria. First of all, patients had to be classified as Broca’s aphasics on the basis of standardized neuropsychological tests used in French, Canadian and Belgium rehabilitation centers: the Montréal-Toulouse test (Nespoulous, Lecours, Lafond, Lemay, Puel, Joanette, Cot & Rascol 1986) and the Batterie Longue de UCL/ULG (de Partz), respectively. This classification had to be confirmed by the speech therapist. Secondly, the speech of the patients had to be non-fluent and telegraphic. Therefore, a spontaneous speech sample of about 10 minutes was recorded from each patient. This was obtained from a free conversation between the patient and me. Only non-fluent patients were included in the experiment. Thirdly, the lesion site should correspond to what is usually found in patients with Broca’s aphasia. In other words, the aphasia should have been the result of brain damage in the left frontal regions. Finally, all patients were tested on the French version of the sentence comprehension task of the VAST (Verb and Sentences Test by Bastiaanse, Edwards & Rispens 2002). This is a standardized comprehension test, examining comprehension of active sentences, passives sentences, subject clefts and object clefts. This test was used as a criterion for inclusion only for those patients for whom there was no neurological information available. Unfortunately, for some patients found in the self-help groups, I was unable to find any information concerning their lesion site or the type of aphasia. From these patients, I included only those whose speech was non-fluent and telegraphic and whose score on the VAST showed the comprehension pattern typically found in Broca’s aphasia. Only patients that were significantly better in interpreting canonical sentences (active sentences and subject clefts) than in interpreting non-canonical sentences (passive sentences and object clefts) were included in the study. The criteria for inclusion are summarized below.

(1) **Selection criteria**

a) Patients are classified as Broca patients.
b) The spontaneous speech of the patients is non-fluent and telegraphic.
c) Patients are right-handed and have had a lesion in the left frontal brain regions.
d) On the VAST, patients score significantly better on canonical sentences than on non-canonical sentences.

(*This criterion is only used for those patients for whom no information concerning criteria (a) and (c) could be obtained*)

I tested 16 Canadian, four Belgian, and two French French-speaking Broca patients. Unfortunately, many of these patients could not be included because they did not meet all the criteria given in (1). There were various reasons why patients did not meet these criteria. For some patients, their spontaneous speech, although non-fluent, was not telegraphic. These patients correctly inflected verbs and produced grammatical morphemes, such as determiners. Others turned out not to have been
classified as a Broca patient or had almost recovered and were no longer Broca aphasic. There were also patients whose score on the VAST did not show the typical Broca comprehension pattern. These patients scored equally poor on all types of constructions.

The group of French-speaking Broca patients that could be included consisted of nine patients. Table 1 gives some background information on these patients.83

Table 1
Patient characteristics

<table>
<thead>
<tr>
<th>Patient</th>
<th>age</th>
<th>gender</th>
<th>nationality</th>
<th>m.p.o.84</th>
<th>employment</th>
<th>spontaneous speech</th>
<th>Etiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>35</td>
<td>F</td>
<td>Canadian</td>
<td>134</td>
<td>Secretary</td>
<td>non fluent</td>
<td>Left CVA85 Aneurism in left posterior communicating artery</td>
</tr>
<tr>
<td>JD</td>
<td>62</td>
<td>M</td>
<td>Canadian</td>
<td>48</td>
<td>Cook</td>
<td>non fluent</td>
<td>No lesion information available</td>
</tr>
<tr>
<td>AM</td>
<td>68</td>
<td>F</td>
<td>Canadian</td>
<td>72</td>
<td>Accountant</td>
<td>non fluent</td>
<td>Left fronto-temporal CVA Apraxia of speech</td>
</tr>
<tr>
<td>AR</td>
<td>68</td>
<td>M</td>
<td>Canadian</td>
<td>164</td>
<td>Fireman</td>
<td>non fluent</td>
<td>No lesion information available</td>
</tr>
<tr>
<td>ST</td>
<td>57</td>
<td>F</td>
<td>Canadian</td>
<td>209</td>
<td>Pharmacist’s assistant</td>
<td>non fluent</td>
<td>Left CVA</td>
</tr>
<tr>
<td>LD</td>
<td>48</td>
<td>F</td>
<td>Belgian</td>
<td>23</td>
<td>Saleswoman and union consultant</td>
<td>non fluent</td>
<td>Left ischemic CVA Hypodensity in the middle cerebral arteries</td>
</tr>
<tr>
<td>MG</td>
<td>51</td>
<td>M</td>
<td>Belgian</td>
<td>82</td>
<td>Manager</td>
<td>non fluent</td>
<td>Left CVA</td>
</tr>
<tr>
<td>SM</td>
<td>37</td>
<td>F</td>
<td>Belgian</td>
<td>84</td>
<td>Manager</td>
<td>non fluent</td>
<td>Left CVA</td>
</tr>
<tr>
<td>BS</td>
<td>39</td>
<td>F</td>
<td>Belgian</td>
<td>11</td>
<td>Physiotherapist</td>
<td>non fluent</td>
<td>Several trombi in the left carotid artery resulting in a CVA in the left middle artery.</td>
</tr>
</tbody>
</table>

As can be seen in table 1, all of the patients are non-fluent aphasic patients. Further, most of the patients were selected on the basis of the first three criteria in (1). These patients (patients CA, AM, ST, LD, MG, SM and BS) are all diagnosed as Broca patients and their aphasia results from brain damage in the left frontal regions. For two patients, JD and AR, no neurological information has been obtained. These

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83 As can be seen in table 1, unfortunately no patients from France were included. This is due to the fact that none of the patients tested in France met the criteria for selection given in (1). However, the absence of French patients in this experiment is not problematic, since the aspects of wh-questions examined in this thesis are identical in all three variants of French (see the previous footnote).
84 M.P.O.: months post onset. This indicates the number of months that have passed since the brain accident.
85 C.V.A.: cerebro-vascular accident
patients were included because their comprehension of canonical sentences (active sentences and subject clefts) was significantly better than that of non-canonical sentences (passives and object clefts) (see table 2 below). All patients were monolingual francophones. Premorbidly, all of them were right-handed. Most of the patients were paralyzed on the right side, suggesting a left frontal lesion. The mean age of the patients was 51.7 years (range 35-68) and the mean time post onset 91.9 months (range 11-209 months).

2.1.2. Language testing
As was explained above, the results of the VAST have been used as a criterion for selection for those patients for whom I was unable to obtain any neuropsychological information. However, this is not the only purpose of administering the VAST. This test also provides information on patients’ comprehension of other constructions than wh-questions. Recall that Broca patients typically show better comprehension of sentences involving subject movement (active phrases, subject relative clauses and subject clefts) than of their counterparts involving object movement. It is important to know whether the patients participating in the present study show the same pattern of comprehension difficulties. Only on that condition, can the findings on wh-questions obtained in the present study be generalized to Broca patients (see also Hickok & Avrutin (1996) and Thompson et al. (1999) for using the same line of reasoning). Moreover, these data allow us to compare patients’ comprehension of wh-questions with that of other constructions involving syntactic movement. This will shed more light on the effect of syntactic movement in general on patients’ comprehension abilities. Table 2 gives the individual results on the VAST.

Table 2
Percentage correct on the VAST sentence comprehension task

<table>
<thead>
<tr>
<th>Patient</th>
<th>Active phrase</th>
<th>Passive phrase</th>
<th>Subject cleft</th>
<th>Object cleft</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>100</td>
<td>37.5</td>
<td>62.5</td>
<td>75.0</td>
</tr>
<tr>
<td>JD</td>
<td>100</td>
<td>75.0</td>
<td>87.5</td>
<td>37.5</td>
</tr>
<tr>
<td>AM</td>
<td>50.0</td>
<td>25.0</td>
<td>75.0</td>
<td>25.0</td>
</tr>
<tr>
<td>AR</td>
<td>100</td>
<td>75.0</td>
<td>100</td>
<td>25.0</td>
</tr>
<tr>
<td>ST</td>
<td>87.5</td>
<td>50.0</td>
<td>75.0</td>
<td>12.5</td>
</tr>
<tr>
<td>LD</td>
<td>87.5</td>
<td>37.5</td>
<td>75.0</td>
<td>37.5</td>
</tr>
<tr>
<td>MG</td>
<td>50.0</td>
<td>62.5</td>
<td>37.5</td>
<td>62.5</td>
</tr>
<tr>
<td>SM</td>
<td>75.0</td>
<td>37.5</td>
<td>75.0</td>
<td>37.5</td>
</tr>
<tr>
<td>BS</td>
<td>100</td>
<td>50.0</td>
<td>75.0</td>
<td>75.0</td>
</tr>
<tr>
<td>Mean</td>
<td><strong>83.3</strong></td>
<td><strong>50.0</strong></td>
<td><strong>73.6</strong></td>
<td><strong>43.1</strong></td>
</tr>
</tbody>
</table>

The data in table 2 show that there is some variation in patients’ comprehension difficulties. This is not surprising. As was noted in chapter 2, the results of comprehension tasks on Broca patients all reveal a large amount of variation.

86 Significance was determined using Fisher’s exact test. The two-tailed p-values for the difference between patients’ score on canonical and non canonical sentences are: p=0.037 for JD and p=0.0024 for AR, respectively.
Following Grodzinsky (1990, 1991, see also Grodzinsky et al. 1999), I will not focus on the variation, but rather on the pattern emerging out of the results of the group. On this view, the data in table 2 show the pattern typically observed in Broca patients: above chance-level performance on active sentences and subject clefts (respectively: \( t(8)=6.63, \ p<0.001 \) and \( t(8)=6.35, \ p<0.001 \)) and chance-level performance on passive sentences and object clefts (respectively: \( t(8)=2.12, \ p=0.067 \) and \( t(8)=0.74, \ p=0.48 \)).\(^{87}\) Hence, it is possible to compare patients’ comprehension of wh-questions with that of other constructions involving syntactic movement and to draw inferences about the way in which syntactic movement in general affects the comprehension abilities of Broca patients.

2.2. Control group

The control group consisted of 14 non brain-damaged speakers of French. This group was matched as much as possible to the group of Broca patients in terms of age, gender, nationality and level of education. The relevant background information of each individual is given below.

\(^{87}\) Note that some patients score extremely low on some conditions (e.g. ST on object clefts). This score is worse than what is normally observed (see for instance the English data on these constructions in table 2 in the previous chapter). This might be due to the fact that in the VAST patients have to choose between four rather than two pictures. For each stimulus sentence, the set of pictures contains the correct picture, a syntactic foil (in which the thematic roles are reversed), and two lexical foils. For example, for the sentence \textit{l’enfant est poussé par la mère} (‘the child is pushed by the mother’), patients have to choose between four pictures representing the situations given in (i-a-id).

(i) a. a woman pushing a child \hspace{1cm} \text{(correct picture)}
   b. a child pushing a woman \hspace{1cm} \text{(reversal of thematic roles)}
   c. a woman pulling a child \hspace{1cm} \text{(lexical error)}
   d. a child pulling a woman \hspace{1cm} \text{(lexical error and reversal of thematic roles)}

As a result, the chance of choosing the correct picture when guessing is lower than in a binary choice task.
Table 3  
*Background information on non brain-damaged control subjects*

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Gender</th>
<th>Nationality</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-CD</td>
<td>20</td>
<td>F</td>
<td>Canadian</td>
<td>Student</td>
</tr>
<tr>
<td>JacL</td>
<td>79</td>
<td>M</td>
<td>Canadian</td>
<td>Priest/ PhD philosophy</td>
</tr>
<tr>
<td>JL</td>
<td>40</td>
<td>F</td>
<td>Canadian</td>
<td>System manager</td>
</tr>
<tr>
<td>JM</td>
<td>31</td>
<td>M</td>
<td>Canadian</td>
<td>Student</td>
</tr>
<tr>
<td>MS</td>
<td>54</td>
<td>F</td>
<td>Canadian</td>
<td>Receptionist</td>
</tr>
<tr>
<td>CV</td>
<td>59</td>
<td>F</td>
<td>Canadian</td>
<td>Secretary</td>
</tr>
<tr>
<td>GV</td>
<td>24</td>
<td>F</td>
<td>Canadian</td>
<td>Secretary</td>
</tr>
<tr>
<td>SB</td>
<td>20</td>
<td>F</td>
<td>Belgian</td>
<td>Student</td>
</tr>
<tr>
<td>AB</td>
<td>33</td>
<td>F</td>
<td>Belgian</td>
<td>Speech therapist</td>
</tr>
<tr>
<td>SD</td>
<td>30</td>
<td>F</td>
<td>Belgian</td>
<td>Secretary</td>
</tr>
<tr>
<td>MvD</td>
<td>52</td>
<td>M</td>
<td>Belgian</td>
<td>House decorator</td>
</tr>
<tr>
<td>SK</td>
<td>33</td>
<td>F</td>
<td>Belgian</td>
<td>Physician</td>
</tr>
<tr>
<td>FD</td>
<td>43</td>
<td>M</td>
<td>French</td>
<td>Pharmacist assistant</td>
</tr>
<tr>
<td>MC</td>
<td>58</td>
<td>F</td>
<td>French</td>
<td>Assistant professor of French</td>
</tr>
</tbody>
</table>

All of these subjects are native speakers of French. Further, although some of them live in bilingual countries, they all speak and understand primarily French. Only some of the Canadian controls, namely M-CD and JacL, speak and understand English. Of the Belgian controls, AB and SK understand some Dutch. Importantly, none of these subjects can be called bilingual in the sense that they are native speakers of two languages. Not all of the control subjects participated in every experiment. When discussing the experiments, I will specify the control group tested for each experiment.

3. Comprehension experiments

This section describes the three comprehension experiments done for this thesis. In each experiment a different type of wh-questions is examined: *who*-questions, *what*-questions, and adjunct questions. Before going into the experiments, I briefly discuss the question how patients’ comprehension of wh-questions can be examined.

3.1. Methodology: testing comprehension of wh-questions

In chapter 2 it was explained that the comprehension of Broca patients is usually tested by means of a sentence-picture matching task. In such a task, patients are shown several pictures. The experimenter reads a sentence and patients are asked to point to the picture corresponding to the sentence (see chapter 2, section 1.1.1).

However, such a task cannot be used in the examination of patients’ comprehension of wh-questions. In contrast to declarative sentences, comprehension of wh-questions entails more than the selection of the picture depicting the action described in the question. It also entails a correct *answer* to the question. Suppose that patients’ comprehension of the question *Who does the boy hit?* would be tested...
by asking the patient to point to the correct picture. In this example, the set of pictures out of which the patient had to choose would contain a picture of a boy hitting a girl and a picture in which the situation is reversed. Crucially, if the patient would select the picture of the boy hitting the girl, this does not necessarily mean that (s)he has parsed the question correctly. In contrast, (s)he could have selected this picture solely on the basis of the words *the boy hits* and have ignored the wh-word completely. Thus, in order to examine whether patients have attributed the correct thematic role to the wh-word, a task is needed in which patients are required to give an answer to the wh-question.

Hickok and Avrutin (1996) report of such a task. The experimental paradigm of this task is as follows. The experimenter acts out a scenario with toy figurines and asks a wh-question about one of the figurines. The patient responds to this question by pointing to the correct figurine. All of the scenarios involve three animals and are set up as follows. One animal $x$ performs some action $y$ on a second animal $z$, which in turn performs the same action on another animal of type $x$. For example, one scenario involves a white horse chasing a giraffe who in turn is chasing a black horse. The patient is asked a wh-question, such as *Who did the giraffe chase?* and to point to the animal representing the answer to this question. In this example, the correct reaction would be to point to the black horse.

Hickok and Avrutin argue that this type of task requires little task-specific processing load and that the results therefore cannot be related to the complexity of the task, but reveal real linguistic comprehension difficulties. Thompson et al. (1999) replicated the experiment of Hickok and Avrutin. Apart from the figurine manipulation task, they also used a picture-pointing task, in order to examine the effect of the type of task on patients’ performance. The experimental design of the picture-pointing task was identical to the figurine manipulation task. Thus, on each picture one animal performed some action on a second animal, which in turn performed the same action to a third animal. The experimenter asked a target wh-question and patients responded by pointing to the animal representing the answer to the question. The results of their study showed no difference in comprehension patterns obtained in either the figurine manipulation or the picture-pointing task. In testing comprehension of wh-questions in French-speaking Broca patients, I will use a picture-pointing task. The procedure of this task is identical to the picture-pointing task of Thompson et al. (1999).

88 As mentioned before (cf. section 1.2.2 of the previous chapter) there is a discussion in the literature concerning the use of sentence-picture matching tasks in examining the comprehension abilities of aphasic patients. It has been argued that this task is extremely difficult, since patients have to perform several mental operations at the same time. They have to parse a sentence, parse two or more pictures and compute a comparison between the resulting linguistic representations. Since the processing resources in Broca patients are limited, it is unclear whether the findings obtained in these experiments do indeed reflect a comprehension deficit, or whether they are the result of the complexity of the task. Supporting evidence for this last possibility comes from an experiment performed by Cupples and Inglis (1993). They compared patients’ comprehension on two types of task: a sentence-picture matching task and an act-out task. In this last type of task, patients are required to act-out the situation of a given sentence (e.g. *The bear hits the dog*) by using toy figurines. Since this task does not involve a comparison between several linguistic representations, it is said to be less difficult. Interestingly, patients showed comprehension difficulties on the sentence-picture matching task, but scored perfectly on the act-out task. However, these results have not been replicated. Hickok et al. (1993) also compared patients’ comprehension on several tasks and found no differences between the ‘easier’ and more complex tasks.
3.2. Experiment 1: subject and object who-questions

Research questions
In chapter 2, section 1.1.4.1, it was shown that English-speaking Broca patients exhibit a striking difference between their comprehension of who-questions and that of other constructions derived through syntactic movement. In the latter type of constructions, these patients show the pattern typically associated with Broca’s aphasia: above chance-level performance on constructions involving movement out of the subject position (e.g. active sentences, subject clefts, and subject relative clauses), and chance-level performance on their object counterparts. However, this subject/object asymmetry was not found in patients’ comprehension of who-questions. English-speaking Broca patients score above chance-level on both types of questions exemplified in (2) below, despite the fact that in (2b) the wh-word has been moved out of the object position.89

(2) a. Who t_who chased the tiger?
   b. Who did the tiger chase t_who?

A possible explanation for this finding is that movement of who does not affect patients’ comprehension. This is reminiscent of the Trace Deletion Hypothesis (Grodzinsky 1995a). As was explained in section 1.2.1 of the previous chapter, the TDH claims that the Default Principle only applies to moved referential arguments. Moved non-referential arguments do not receive a thematic role through the Default Principle.90 Following the TDH, traces are deleted in Broca patients’ representation of the sentences in (2). Hence, who is lacking a thematic role. Since who is non-referential, the Default Principle does not assign a thematic role to who. Instead, it is claimed that patients use their lexical knowledge to infer the thematic role of who in these sentences. Since in both sentences the tiger already bears a thematic role (Theme in (2a) and Agent in (2b)), patients assign the only other available role to who (i.e. Agent in (2a) and Theme in (2b). This results in above chance-level performance on both types of sentences.

The first goal of experiment 1 is to examine whether movement of non-referential arguments does indeed not affect comprehension in Broca’s aphasia. In order to do so, I will compare patients’ comprehension of two types of object questions, exemplified in (3).

(3) a. La fille frappe qui?
   the girl hits who
   ‘Who does the girl hit?’
   b. Qui est-ce que la fille frappe t_who?
      who Q the girl hits
      ‘Who does the girl hit?’

89 See table 1, chapter 2 for the individual results.
90 See Grodzinsky (1995a) for arguments supporting this assumption.
If movement of non-referential arguments does not affect comprehension in Broca’s aphasia, no difference between patients’ comprehension of these two types of sentences is expected. If, however, syntactic movement in general affects patients’ comprehension, independently of the referentiality of the moved items, it is expected that French-speaking Broca patients will have more difficulties comprehending wh-questions of the type in (3b) than those in (3a). The first research question of this experiment can be formulated as follows: do French-speaking Broca patients have more difficulties with the comprehension of non-referential object wh-questions involving movement of the wh-word than with their wh-in-situ counterparts?

The second goal of this experiment is to examine whether the findings obtained on English-speaking Broca patients can be generalized to French. In other words, its goal is to find out whether it is also the case for French-speaking Broca patients that they understand both subject and object who-questions equally well. As said before, the absence of a subject/object asymmetry in the English data on who-questions gives rise to important questions concerning the effect of syntactic movement in Broca’s aphasia (cf. chapter 2, section 1.1.4.1). For instance, these data might suggest, contrary to the commonly held assumption, that the comprehension deficit in Broca’s aphasia is not related to the position out of which syntactic movement has taken place. It is therefore important to investigate whether the findings obtained on English-speaking Broca patients hold crosslinguistically. Is the relatively intact comprehension of both subject and object who-questions a general characteristic of Broca patients, or is it a language-specific property of English-speaking Broca patients? In order to answer this question, I will examine the comprehension of subject and object who-questions by French-speaking Broca patients. The two research questions of experiment 1 are given below.

(4) Research questions
   a. Do French-speaking Broca patients have less difficulty with the comprehension of wh-in-situ object who-questions than with those in which the wh-word has been moved overtly?
   b. Do French-speaking Broca patients show comparable patterns in their comprehension of subject and object who-questions as observed for English-speaking Broca patients?

Participants
All of the Broca patients mentioned in table 1 participated in this experiment. Thus, there was a group of nine Broca patients (three men, six women, mean age 51.7 years (range 35-68)). Further, six non brain-damaged speakers of French (one man, five women) served as controls: MCD, JaCL, JL, MS, GV, and MC (see table 3). The mean age of this group is 45.8 years (range 20-79).
Materials and procedure
As discussed above in section 3.1, comprehension of wh-questions was tested using a picture-pointing task. Each picture represented a reversible action performed by three persons or animals. An example is given in figure 1.

![Example of a stimulus picture](image)

For each picture, a question was read aloud by the experimenter\(^91\) (e.g. *le garçon arrose qui?* 'the boy splashes who?') and patients were asked to point to the person representing the answer to the question. Questions were repeated upon request, but never more than once. Prior to testing patients received two practice items. During these items, feedback was provided when necessary. After these items, all of the patients demonstrated understanding of the task.

The test contained 18 items per condition.\(^92\) For each item, an artist had drawn a black-and-white line picture. Each picture was printed on a carton of 21 by 29.7 cm (A4). There were four conditions: wh-in-situ object questions (5a), object questions in which the wh-word had been moved (5b), and two types of subject questions (5c, 5d). In French, a subject question can be formed either with or without the question morpheme *est-ce que*. The question without the question morpheme is here referred to as short subject question (5c), while the one with the question morpheme is dubbed long subject question (5d). Examples of the conditions are given below. These examples all belong to the picture in figure 1. A complete list of the stimulus sentences can be found in appendix 1.

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\(^{91}\) I have been the experimenter of all experiments. I am not a native speaker of French, but I do speak it fluently.

\(^{92}\) Originally, there were more items. In order to be sure that the meaning of the pictures was completely clear, I included only those items that were understood by all of the non brain-damaged speakers.
WH-QUESTIONS IN BROCA’S APHASIA: EXPERIMENTS

Examples of the conditions

a. *Le garçon arrose qui?*  
   Object in-situ  
   The boy splashes who  
   ‘Who does the boy splash?’

b. *Qui est-ce que le garçon arrose t* qui ?  
   Object moved  
   Who Q the boy splashes  
   ‘Who does the boy splash?’

c. *Qui t* qui arrose le garçon?  
   Short subject  
   Who splashes the boy  
   ‘Who splashes the boy?’

d. *Qui est-ce qui t* qui arrose le garçon?  
   Long subject  
   Who Q splashes the boy  
   ‘Who splashes the boy?’

The long subject question was included to control for a possible effect of length. One of the goals of this experiment was to examine whether movement of non-referential words such as *qui* affects the comprehension abilities of Broca patients. To this end, patients’ comprehension of questions of the type in (5a) will be compared to that of questions of the type in (5b). Note, however, that the two types of object questions do not only differ in the presence or absence of overt syntactic movement, but also in length. Suppose that patients score better on object questions of the type in (5a) than on object questions of the type in (5b). This observation can be explained in two ways: questions in which the wh-word have been moved are more difficult than wh-in-situ questions because (1) they are formed through overt wh-movement, or (2) they are longer. In order to verify the second explanation, long and short subject questions were included. These questions only differ in length. If sentence length influences patients’ comprehension, it is expected that patients will score better on subject questions of the type in (5c) than on those on the type in (5d). If no such difference is observed, it can be concluded that sentence length is not a factor affecting comprehension in Broca’s aphasia.

Stimulus pictures were shown four times, each time in a different condition. Thus, the picture in figure 1 was shown four times, while each time one of the questions in (5) was asked. The conditions were presented in pseudo-random order, in that I avoided identical pictures being shown too close after another (i.e. with less than ten pictures in between them). The order of the sentences was counterbalanced across different patients in order to control for factors such as nervousness at the beginning of the session, fatigue at the end, and the influence of surrounding test items. Therefore two versions of this test were developed, containing the same set of stimulus sentences, but differing with respect to the order of these sentences.

---

93 Note that the wh-word can only remain in-situ in object questions. As will be discussed in chapter 4 (section 2.2.2), French subject questions involve movement of the wh-word to Spec,CP. Thus, in both (5c) and (5d), the wh-word has been moved. Hence, the difference between wh-in-situ and wh-questions involving wh-movement can only be examined for object questions.

94 Note that the question morpheme *est-ce que* is spelled out as *est-ce qui* in subject questions. This is an important morphological change to which I will come back in chapter 4, section 3.2.1.
Apart from the stimulus sentences, fillers were developed. Several types of questions served as fillers, such as *Qui porte des bottes?* (‘Who wears boots?’), *Où est le policier?* (‘Where is the policeman?’). For these questions, too, a picture was shown in which three persons were performing an action towards each other. However, the questions never related to the depicted action. For instance, the question *Who wears boots?* was shown for a picture in which a girl was hitting a boy, who was hitting another girl. One of these persons was wearing boots.

**Results**

**Control group**
The results of the non brain-damaged speakers of French are given in table 4.

**Table 4**

*Percentage correctly interpreted wh-questions per question type (control group)*

<table>
<thead>
<tr>
<th>Name</th>
<th>Object in-situ</th>
<th>Object moved</th>
<th>Short subject</th>
<th>Long subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-CD</td>
<td>94.1</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>JacL</td>
<td>100</td>
<td>94.4</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>JL</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>MS</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>GV</td>
<td>100</td>
<td>94.1</td>
<td>100</td>
<td>94.1</td>
</tr>
<tr>
<td>MC</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Mean</td>
<td>99.0</td>
<td>98.1</td>
<td>100</td>
<td>99.0</td>
</tr>
</tbody>
</table>

As can be seen in table 4, the non-brain damaged speakers exhibit virtually perfect scores on all conditions.

**Broca patients**
The results of the Broca patients are given in table 5.

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95 M-CD and GV were only tested with the earliest version of this test. After testing the controls, several pictures were removed and one new picture was added. For M-CD and GV, only the results on the items also present in the new version of the test are taken into account. Therefore, there are 17 items per condition for these persons.
Before going into these results, it is necessary to discuss the way in which these data will be interpreted.

**Interpretation of the data**

As mentioned in chapter 2, studies on the comprehension deficit in Broca’s aphasia usually relate patients’ scores on a certain construction to chance. Using this approach, it has been observed that Broca patients score above chance-level for the comprehension of constructions involving subject movement. By contrast, patients’ performance drops to chance-level in constructions involving movement out of the object position (cf. chapter 2, section 1.1.3). These results are interpreted as follows: above chance-level score indicates that patients’ comprehension of these constructions is still intact. Chance-level scores indicate that patients’ comprehension of these constructions is impaired. In their comprehension of these sentences, patients do not know who is doing what to whom and therefore resort to guessing. This results in a chance-level performance.

In this thesis, I will adopt a different way of representing and interpreting the data. Instead of relating patients’ scores for a certain construction to chance-level, I will compare patients’ scores for two types of constructions relative to each other. There are two reasons for choosing this approach. First, an above-chance-level score does not necessarily imply intact comprehension. If patients score above chance-level on a certain construction, it can be concluded that they are not guessing. Crucially however, from this it does not follow that their comprehension of this construction is intact. To see why this is so, consider the scores on object questions involving wh-movement (i.e. questions of the type in (5b)) in table 5. As a group,

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**Table 5**

*Percentage correctly interpreted wh-questions per question type (Broca patients)*

<table>
<thead>
<tr>
<th>Patient</th>
<th>Object in-situ</th>
<th>Object moved</th>
<th>Short subject</th>
<th>Long subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>83.3</td>
<td>66.7</td>
<td>33.3</td>
<td>50</td>
</tr>
<tr>
<td>JD</td>
<td>100</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM</td>
<td>77.8</td>
<td>61.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AR</td>
<td>94.4</td>
<td>94.4</td>
<td>94.4</td>
<td>100</td>
</tr>
<tr>
<td>ST</td>
<td>83.3</td>
<td>77.8</td>
<td>27.8</td>
<td>33.3</td>
</tr>
<tr>
<td>LD</td>
<td>100</td>
<td>88.9</td>
<td>88.9</td>
<td>100</td>
</tr>
<tr>
<td>MG</td>
<td>66.7</td>
<td>38.9</td>
<td>38.9</td>
<td>16.7</td>
</tr>
<tr>
<td>SM</td>
<td>88.9</td>
<td>72.2</td>
<td>44.4</td>
<td>50.0</td>
</tr>
<tr>
<td>BS</td>
<td>66.7</td>
<td>50.0</td>
<td>33.3</td>
<td>33.3</td>
</tr>
<tr>
<td>Mean</td>
<td>84.6</td>
<td>72.2</td>
<td>51.6</td>
<td>54.8</td>
</tr>
</tbody>
</table>

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90 Patients JD and AM were tested with the pilot version of the test used for experiment 2 (see below). At the time of testing, this test did not contain subject questions. After running the pilot for this test, it was slightly changed, turning into the test used for experiment 2. Further, I developed a new test, the one used in experiment 1. Unfortunately, patients JD and AM were no longer available for testing by the time I had developed this new test. Therefore, these patients are not tested on subject questions. Since the results of patients who participated in both the pilot-test and experiment 1 do not differ, it is legitimate to add the scores of JD and AM.
patients score 72.2% correct on this type of object questions. Although this is above chance ($t(8)=3.27$, $p=0.011$), it seems to me that it would be incorrect to state that patients’ comprehension of this type of object questions is intact. If it were intact, a considerably higher score might be expected, comparable to the score obtained by the group of non brain-damaged speakers. Thus, in order to know whether patients’ comprehension of a certain construction is intact, it is necessary to compare patients’ score on this construction to that of a comparable group of non brain-damaged speakers. Only if there is no significant difference between the scores of both groups, can it be concluded that patients’ comprehension is intact.

The second reason for not comparing patients’ scores to chance-level is that this approach yields too coarse a view on patients’ comprehension. Under this approach, only three levels of performance can be distinguished: above chance-level, chance-level, and below chance-level. Important observations following from the data obtained on Broca patients might therefore be overlooked. The data in table 5 can again be used to illustrate this issue. On both types of object questions, patients score above chance ($t(8)=8.19$, $p<0.0001$ for wh-in-situ questions, and $t(8)=3.27$, $p=0.0011$ for wh-questions involving wh-movement). However, there is an interesting difference between patients’ scores on both these types of questions: wh-in-situ object questions are interpreted significantly better than their counterparts involving overt wh-movement ($t(8)=4.06$, $p=0.004$). As will be shown in chapter 4, this observation leads to important conclusions concerning the effects of different types of movement on patients’ comprehension. In other words, relating data points only to chance-level masks important differences between two above chance-level scores. In this thesis, I will therefore compare patients’ scores on two types of constructions relative to each other and as such examine the relative difficulty of each construction.

Results obtained on French-speaking Broca patients
Following the approach outlined above, it can be shown that patients’ comprehension of wh-questions is impaired. In all conditions, patients score significantly lower than the control group of non brain-damaged speakers. The Mann-Whitney U-test shows a significant difference between the scores of both groups on object in-situ questions ($z=-2.37$, $p=0.018$), object questions involving overt wh-movement ($z=-2.58$, $p=0.01$), short subject questions ($z=-3.16$, $p=0.002$), and long subject questions ($z=-2.18$, $p=0.029$). Thus, French-speaking Broca patients have difficulties comprehending both subject and object who-questions.

Further, several observations can be made with respect to the data in table 5. First, as was already mentioned, patients’ comprehension of wh-in-situ object questions (5a) is significantly better than that of their counterparts involving overt wh-movement (5b). Secondly, there is no difference between patients’ comprehension of short (5c) and long (5d) subject wh-questions ($t(8)=-0.68$, $p=0.52$). Thirdly, object questions are understood better than subject questions. This

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97 Following Hickok and Avrutin (1996) and Thompson et al. (1999) chance was calculated as 50% correct rather than 33% correct because patients never pointed to the non-questioned person. Thus, for the examples in (5), patients never pointed to the boy, but always to one of the two girls.
difference is significant for the wh-in-situ object questions ($t(8)=3.87$, $p=0.008$). The difference between subject and object questions does not reach significance if patients’ scores on object questions involving overt wh-movement (5b) are compared to short and long subject questions (5c,d), although a trend may be observed ($t(8)=2.43$, $p=0.051$).

Finally, it is interesting to note that the comprehension of patients JD and AR is within the normal range. That is, the scores obtained by these patients do not differ from those obtained on non-brain-damaged speakers of French (see table 4). Still, in other constructions these patients do show the comprehension deficit typically associated with Broca’s aphasia, as was shown by their results of the VAST (see table 2). In chapter 4 section 4, I will discuss some possible explanations for this difference. Omitting the data of these patients (because of their ceiling performance) does not change the results.

**Discussion**

The purpose of this experiment was twofold. The first goal was to test whether movement of a non-referential element such as *qui* (‘who’) affects comprehension in Broca’s aphasia. To this end, patients’ comprehension of wh-in-situ object questions was compared to that of object questions involving wh-movement (cf. the research question in (4a)). Secondly, this experiment examined whether the results of the French-speaking Broca patients pattern with those observed on English-speaking Broca patients. (cf. the research question in (4b)). In order to answer this question, patients’ comprehension of object questions was compared with that of subject questions. Below, I will discuss both research questions in turn.

**In-situ versus movement**

The data in experiment 1 showed that French-speaking Broca patients understand wh-in-situ object questions better than their counterparts involving overt wh-movement. For convenience, the examples of these two object questions are repeated here.

(6) a. Le garçon arrose qui?
the boy splashes who
‘Who does the boy splash?’

b. Qui est-ce que le garçon arrose *t qui*?
who Q the boy splashes
‘Who does the boy splash?’

The answer to the first research question in (4a) is clearly affirmative. French-speaking Broca patients do have less difficulties comprehending sentences of the type in (6a) than those of the type in (6b). As was noted before, this difference may

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*98 The scores on both subject questions have been combined, since there is no difference between them.
*99 A trend is defined here as follows: all subjects show the same behavior (in this case: better comprehension of object wh-questions involving wh-movement than of subject wh-questions) and the $p$-value is between 0.05 and 0.07. As can be seen in table 5, most of the patients perform better on object questions involving movement than on subject questions. The only two exceptions are patients AR and LD, but this might be due to their ceiling performance.*
in principle be explained in two ways. Indeed, the object question in (6b) differs in two ways from its counterpart in (6a): it involves wh-movement and it is longer. Hence, patients’ poorer performance on object questions of the type in (6b) could result either from the wh-movement or from the increased length of the question.

The results on subject questions suggest, however, that this second explanation cannot be correct. The subject question of the type in (5d) is clearly longer than that of the type in (5c). Still, patients show no difference in their comprehension of these two types of subject questions (see table 5). This indicates that sentence length does not influence patients’ comprehension. This finding is in line with previous findings also showing no effect of sentence length on patients’ comprehension (cf. Schwartz et al. 1987; Friedmann & Gvion 2003).100 Moreover, there is no difference in length between subject and object relative clauses or between subject and object clefts. Still, patients’ comprehension of the subject variants of these constructions is better than that of their object counterparts.

It seems therefore fair to conclude that the difference observed in patients’ comprehension of the two types of object questions in (6) is not related to the length of the sentence. Only the other option remains, that is that this difference results from the movement of the wh-word. In other words, French-speaking Broca patients have more difficulties with the comprehension of object questions of the type in (6b) than with those of the type in (6a), because the former involve overt wh-movement.

This finding also suggests that a new explanation for the data obtained on English-speaking Broca patients is needed. Movement of non-referential qui (‘who’) does affect patients’ comprehension. It is true that the results on French object questions of the type in (6b) pattern with those obtained on English object who-questions (2b) to the extent that Broca patients score above chance-level on both constructions. However, it cannot be maintained that patients correctly attribute the Theme role to the moved wh-word and that their comprehension of these object questions is intact. This view would predict, incorrectly, that French-speaking Broca patients understand both types of object questions in (6) equally well. The observed difference between patients’ comprehension of the two types of object questions in (6) shows the need for a more detailed description and account of the relation between syntactic movement and the comprehension deficit in Broca’s aphasia. In chapter 4, I will propose such a description.

Comparing the English and the French results

English-speaking Broca patients understand both subject and object who-questions equally well. On both types of questions in (7), patients score about 80% correct.

(7) a. Who chased the tiger? 
    b. Who did the tiger chase?

As noted before, this is a striking observation in the light of patients’ comprehension of other constructions derived through movement. These patients show the comprehension deficit typically associated with Broca’s aphasia: difficulties with the comprehension of constructions involving movement out of the object position.

100 The findings of Friedmann & Gvion (2003) were discussed in section 1.2.2.1 of the previous chapter.
Apparently, these difficulties do not extend to object who-questions. Experiment 1 therefore was designed to check whether the findings obtained on English-speaking Broca patients are language-specific, or whether it is also the case for French-speaking Broca patients that they understand subject and object questions equally well.

The results have shown that this is not the case. French-speaking Broca patients do not understand both types of wh-questions equally well. Instead, their comprehension of subject questions (8a) is worse than that of object questions (8b).\textsuperscript{101}

\begin{equation}
\begin{align*}
\text{(8)} & \quad \text{a. Qui (est-ce qui) arrose le garçon?} \quad \text{subject question} \\
& \quad \text{Who (Q) splashes the boy} \\
& \quad \text{‘Who splashes the boy?’} \\
& \quad \text{b. Qui est-ce que le garçon arrose?} \quad \text{object question} \\
& \quad \text{Who Q the boy splashes} \\
& \quad \text{‘Who does the boy splash?’}
\end{align*}
\end{equation}

The results of French-speaking Broca patients thus show that the relatively intact comprehension of both subject and object who-questions observed on English-speaking Broca patients is not a general characteristic of Broca’s aphasia. The findings obtained on English-speaking Broca patients might result from a property of English who-questions. I will not discuss this any further here, but instead analyze several other observations resulting from a comparison between the French and the English findings on wh-questions.

First of all, the poor performance of French-speaking Broca patients on subject questions, as well as the crosslinguistic difference between the French and the English data on subject questions are highly unexpected. In comprehending active sentences, passive sentences, clefts, and relative clauses both French and English-speaking Broca patients show the subject/object asymmetry which is said to characterize comprehension in Broca’s aphasia. In all of these constructions, Broca patients of both languages exhibit better comprehension of constructions involving movement out of the subject position than of their object counterparts.\textsuperscript{103} The only exception to this strong similarity involves wh-questions. Why do French-speaking Broca patients have such severe difficulties with the comprehension of subject questions, while English-speaking Broca patients understand the exact English counterparts much better? Why are questions of the type in (8a) so hard to understand for Broca patients, while those of the type in (7a) are not? In addition, why do French subject questions turn out to be so much more difficult than the derivationally closely related subject relative clauses?

\textsuperscript{101} A comparison between subject questions and wh-in-situ object questions is not relevant here, since only object questions of the type in (8b) are derived in the same way as English object who-questions in (7b).

\textsuperscript{102} Since there is no difference between patients’ comprehension of short and long subject questions (see table 5), they have been combined here.

\textsuperscript{103} See table 2 chapter 2 for the findings on English-speaking Broca patients and table 2 of the present chapter for the findings on French-speaking Broca patients.
Note that this cannot be explained by any of the existing accounts of the comprehension deficit discussed in chapter 2. Indeed, all these accounts are based on the standard characterization of the comprehension deficit in Broca’s aphasia. Thus, they all explain why Broca patients have difficulties comprehending constructions involving movement out of the object position. All these accounts thus need extra assumptions in order to account for the findings on French-speaking Broca patients concerning subject questions.\textsuperscript{104}

Second, it is interesting to note that, despite crosslinguistic differences, the data on French and English-speaking Broca patients are very similar in one respect: they both show that patients’ comprehension of wh-questions differs from that of other constructions involving movement. For both French and English-speaking Broca patients the pattern observed in active sentences, passive sentences, clefts, and relative clauses does not extend to wh-questions. In both groups of patients, subject wh-questions are not better understood than object wh-questions. This suggests again that the characterization of the relation between syntactic movement and the comprehension deficit has to be refined. Movement out of an object position does not always yield comprehension difficulties, as is shown by the comprehension of who-questions by English-speaking Broca patients. Further, patients’ comprehension of constructions involving movement out of a subject position is not always intact, as is shown by the comprehension of subject questions by French-speaking Broca patients. The pattern observed on many constructions involving syntactic movement (i.e. the pattern in example (18) of the previous chapter) thus does not extend to wh-questions.\textsuperscript{105} In chapter 4, I will propose a new characterization of the comprehension deficit in Broca’s aphasia and the way in which this deficit is related to syntactic movement. This new characterization will capture both the findings on wh-questions and those on other constructions derived through movement.

\textbf{Conclusion}

The results of experiment 1 have led to several observations. First of all, it was shown that movement of non-referential elements does affect the comprehension abilities of Broca patients. Hence the difference between patients’ comprehension of object who-questions and that of other constructions involving movement out of the object position cannot be related to the referentiality of the moved object.

Secondly, the results of experiment 1 revealed that French-speaking Broca patients have severe difficulties with the comprehension of subject who-questions. It was argued that this observation is difficult to explain under the existing accounts of the comprehension deficit in Broca’s aphasia.

Finally, it was observed that for both French and English-speaking Broca patients their comprehension of wh-questions differs from that of other constructions involving movement. This led to the conclusion that the characterization of the

\textsuperscript{104} However, Avrutin (p.c.) has informed me that his model is able to explain the findings on French subject questions. I will discuss his ideas in section 5 of the next chapter.

\textsuperscript{105} Note, however, that recent data on the comprehension of wh-questions by Hebrew-speaking Broca patients do pattern with those observed on other constructions involving movement. Biran and Friedmann (2003) found that, as a group, patients scored higher on subject who-questions than on object who-questions. Such a finding shows the need for a large pool of crosslinguistic data concerning the comprehension of wh-questions by Broca patients.
relation between syntactic movement and the comprehension deficit in Broca’s aphasia needs to be refined.

In chapter 2 section 1.1.5, it was argued that many data concerning the effect of syntactic movement on patients’ comprehension are still lacking and that it is therefore too early to state that Broca patients have difficulties comprehending constructions involving movement out of the object position. The results of experiment 1, in combination with the findings on wh-questions obtained on English-speaking Broca patients, underscore the importance of this issue. Patients’ comprehension of wh-questions differs from that of other constructions derived through movement. Findings on both English and French-speaking Broca patients suggest that the comprehension deficit in Broca’s aphasia is not related to the position out of which movement has taken place. Before going in to the question what is a proper characterization of the relation between movement and comprehension in Broca’s aphasia, I will first present two other experiments examining comprehension of wh-questions by French-speaking Broca patients. The next experiment focuses on the effect of head-movement.

3.3. Experiment 2: what-questions

In the previous chapter, it was noted that it is unclear whether head movement affects comprehension in Broca’s aphasia (cf. section 1.1.4.2). Some claim that head movement is intact, since patients correctly detect violations of this type of movement, such as the Head Movement Constraint (cf. Grodzinsky & Finkel 1998). Others have shown, however, that patients have difficulties understanding constructions derived through head movement, such as triggered inversion in Hebrew (cf. Friedmann et al. to appear).

The goal of experiment 2 is to bring new evidence relevant to this discussion. To that end, I will examine the comprehension of what-questions by French-speaking Broca patients. Before going into the details of the experiment, I will first explain why data on French what-questions are useful in a study on the effect of head movement.

**Head movement in French what-questions**

French what-questions are similar to who-questions in that the wh-word can either remain in-situ or move.

(9)  a. Tu as acheté **quoi**?
    you have bought what
    ‘What did you buy?’

  b. **Qu’est-ce que** tu as acheté?
    what Q you have bought
    ‘What did you buy?’

As can be seen in this example, the French morpheme expressing ‘what’ has two allomorphs: **quoi** and **que**. The distribution of these allomorphs is not free, but is related to their position in the sentence. As is illustrated in (10) below, **quoi**
obligatorily occurs in wh-in-situ questions, and *que in wh-questions involving overt wh-movement.

(10) a. Tu as acheté quoi/*que?
    You have bought what
    ‘What did you buy?’

b. *Quoi/Qu’est-ce que tu as acheté?
    What Q you have bought
    ‘What did you buy?’

It is generally assumed that *que is the weak form of quoi, similar to weak/strong pronoun pairs such as *me-moi (‘me’) and te-toi (‘you’) (cf. Bouchard & Hirschbühl 1987; Obenauer 1994; Boeckx et al. 1999; Rooryck 2000; Poletto & Pollock 2000). This claim is based on the observation that *que and weak pronouns show a similar distribution. The examples in (11) (from Bouchard and Hirschbühl (1987)) illustrate that *me, similar to *que, cannot remain in-situ, but has to move.

(11) a. Jean donne le livre à moi/*me.
    Jean gives the book to me
    ‘Jean gives the book to me.’

b. Jean me/*moi donne le livre.
    Jean me gives the book
    ‘Jean gives me the book.’

Further, both *que and weak pronouns cliticize unto the verb. This is illustrated by the examples in (12) and (13) (from Rooryck 2000) below. No lexical material can intervene between *que and the verb or between the weak pronoun *le (‘it/him’) and the verb.

(12) a. L’as-tu dit?
    it have you said
    ‘Did you tell it?’

b. Qu’as-tu dit?
    what have you said
    ‘What did you say?’

(13) a. *Le tu as dit?
    it you have said
    ‘Did you tell it?’

b. *Que tu as dit?
    what you have said
    ‘What did you say?’

By contrast, qui does not cliticize unto verb. The examples below (from Bouchard & Hirschbühl 1987) show a contrast between qui and que in that qui can be separated from the verb.

---

106 See Obenauer (1977) for a competing view, analyzing *que in (9b) as a complementizer and not a wh-pronoun. Both Goldsmith (1981) and Bouchard & Hirschbühl (1987) have argued convincingly against this claim.
Weak items such as *me, *le, and que are called clitics. Since clitics are heads, que is commonly seen as a head (cf. Plunkett 1994; Rooryck 2000). If que is a head, French what-questions of the type in (9b) are derived through head movement.

Bastiaanse et al. (2003) have argued that patients’ comprehension of constructions involving head movement cannot be tested by means of a sentence-picture matching task. There is no reason to expect patients to select the wrong picture for sentences derived through verb movement (the type of head movement usually tested in studies on Broca’s aphasia), since the order of the arguments has not been changed. They argue that it is therefore impossible to examine patients’ comprehension of sentences involving verb movement. The only possibility is to examine patients’ parsing of these constructions by means of a grammaticality judgment task. Keeping this in mind, consider now French what-questions of the type in (9b). Crucially, in these sentences the moved head is an argument. Hence, comprehension difficulties with these types of sentences can be expected. French what-questions thus provide a possibility to examine the effect of head movement on patients’ comprehension. In order to do so, patients’ comprehension of French wh-in-situ what-questions (15a) will be compared to that of what-questions involving movement of the wh-word (15b). If patients’ performance on the latter type of questions is worse than of the in-situ one, it can be concluded that head movement does affect comprehension in Broca’s aphasia.

Research question
The research question of experiment 2 is given below.

Do French-speaking Broca patients have less difficulty with the comprehension of wh-in-situ what-questions than with those in which the wh-word has been moved?
Participants

All patients mentioned in table 2, except AR, participated in this experiment. Thus, the group of Broca patients consisted of eight persons (two men, six women, mean age 49.6 years (range 35-68). The control group consisted of three men and three women (JacL, JM, MS, CV, AB, and FD). The mean age of this group is 49.8 years (range 31-79).

Materials and procedure

The design of experiment 2 was similar to that of experiment 1, except that only object questions were included. The test contained 12 items-pairs of what-questions (12 in-situ what-questions, and 12 what-questions involving overt wh-movement). Further, 18 item-pairs for who-questions (18 in-situ who-questions, and 18 who-questions involving overt wh-movement) were also included. These items were the same as the ones used in experiment 1. Thus, the test contained a total of 60 target questions. All questions were semantically reversible. Appendix 2 gives a complete list of all the stimulus sentences used in this experiment. There were four conditions, exemplified in (17) below.

(17) Examples of the conditions

a. *Le garçon arrose qui?*  
   *Qui (‘who’) in-situ*  
   The boy splashes who  
   ‘Who does the boy splash?’

b. *Qui est-ce que le garçon arrose qui?*  
   *Qui (‘who’) moved*  
   Who Q the boy splashes  
   ‘Who does the boy splashes?’

c. *L’hélicoptère poursuit quoi?*  
   *Quoi (‘what’) in-situ*  
   The helicopter follows what  
   ‘What does the helicopter follow?’

d. *Qu’est-ce que l’hélicoptère poursuit quoi?*  
   *Que (‘what’) moved*  
   What Q the helicopter follows  
   ‘What does the helicopter follow?’

An example of the pictures used for the who-questions was given in figure 1 above. Figure 2 gives an example of the pictures used for what-questions. This picture belongs to the sentences in (17c) and (17d).

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109 As was the case in experiment 1, the test contained more items of what-questions, but I counted only those items that were correctly understood by the control group.
The procedure was identical to that used in experiment 1. Thus, pictures were presented twice, once with a wh-in-situ question and the other time with a wh-question involving overt wh-movement. The conditions were again presented in pseudo-random order and counterbalanced across patients. Apart from stimulus sentences, fillers were included. There were two types of filler sentences: subject who-questions and yes/no questions. Subject questions were included to avoid a learning strategy. If only object questions are tested, patients might discover that the wh-word always refers to the object. Hence, they might always point to the person or object representing the object of the action without really parsing the question the experimenter is asking them. To avoid such a strategy, subject who-questions were included.

Results
The results have been calculated as follows: for who-questions I have taken the results obtained in experiment 1, for what-questions I have taken the results obtained in experiment 2. The reason for doing this is that the test described above was originally a pilot-test and as such has changed considerably during the testing period. The first version of the test contained no subject questions, but did contain several adjunct questions. In a later version, these adjunct questions were removed and a new test examining comprehension of adjunct questions was designed (experiment 3, see below). Further, subject questions were added as filler sentences. Finally, several items were replaced by others. All of the Canadian patients were tested with the first version of this test and all of the Belgian patients with the later version. Unfortunately, it was not possible to retest the Canadian patients with the later version. As a consequence, there is a considerable amount of noise in the data obtained in experiment 2. However, all of the patients participating in experiment 2 also participated in experiment 1. For these patients, the results for who-questions obtained in these two experiments do not differ. The results of experiment 1 are more reliable than those obtained in experiment 2, since experiment 1 is a fully developed test for which all patients have been tested on the same items. For who-
questions, I have therefore used the data obtained in experiment 1. Since what-questions have not been tested in a new experiment, I have used the data obtained in experiment 2. I have only counted those items tested on all patients. Items added in a later version are not taken into account.

Control group

Table 6 gives the results obtained from the group of non brain-damaged speakers of French.

**Table 6**  
Percentage correctly interpreted wh-question per question type: control group

<table>
<thead>
<tr>
<th>Name</th>
<th>Who-questions (qui)</th>
<th></th>
<th>What-questions (quoi/que)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>wh-in-situ</td>
<td>wh-moved</td>
<td>wh-in-situ</td>
<td>wh-moved</td>
<td></td>
</tr>
<tr>
<td>JacL</td>
<td>100</td>
<td>94.4</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>JM</td>
<td>94.4</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>MS</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>CV</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>AB</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>FD</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>99.1</strong></td>
<td><strong>99.1</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table 6 shows that the non brain-damaged speakers of French perform perfectly on who- and what-questions.

**Broca patients**

The results of the Broca patients are presented in table 7. Recall that all questions are object questions (cf. the examples in (17)).

**Table 7**  
Percentage correctly interpreted wh-questions per question type: Broca patients

<table>
<thead>
<tr>
<th>Patient</th>
<th>Who-questions (qui)</th>
<th></th>
<th>What-questions (quoi/que)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>wh-in-situ</td>
<td>wh-moved</td>
<td>wh-in-situ</td>
<td>wh-moved</td>
<td></td>
</tr>
<tr>
<td>CA</td>
<td>83.3</td>
<td>66.7</td>
<td>75.0</td>
<td>75.0</td>
<td></td>
</tr>
<tr>
<td>JD</td>
<td>100</td>
<td>100</td>
<td>91.7</td>
<td>83.3</td>
<td></td>
</tr>
<tr>
<td>AM</td>
<td>77.8</td>
<td>61.1</td>
<td>50.0</td>
<td>41.7</td>
<td></td>
</tr>
<tr>
<td>ST</td>
<td>83.3</td>
<td>77.8</td>
<td>75.0</td>
<td>66.7</td>
<td></td>
</tr>
<tr>
<td>LD</td>
<td>100</td>
<td>88.9</td>
<td>83.3</td>
<td>83.3</td>
<td></td>
</tr>
<tr>
<td>MG</td>
<td>66.7</td>
<td>38.9</td>
<td>50.0</td>
<td>58.3</td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td>88.9</td>
<td>72.2</td>
<td>58.3</td>
<td>83.3</td>
<td></td>
</tr>
<tr>
<td>BS</td>
<td>66.7</td>
<td>50.0</td>
<td>33.3</td>
<td>33.3</td>
<td></td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>83.3</strong></td>
<td><strong>69.4</strong></td>
<td><strong>64.6</strong></td>
<td><strong>65.6</strong></td>
<td></td>
</tr>
</tbody>
</table>
Three observations can be made at the basis of these data. First of all, the Mann-Whitney U-test shows that for all conditions patients’ comprehension of wh-questions is significantly poorer than that of the non brain-damaged speakers of French ($z=-2.35, p=0.019$ for in-situ who-questions (17a); $z=-2.76, p=0.006$ for who-questions involving overt wh-movement (17b); $z=-3.23, p=0.001$ for in-situ what-questions (17c), and $z=-3.24, p=0.001$ for what-questions involving overt wh-movement (17d)). This indicates that patients’ comprehension of both who- and what-questions is impaired.

Secondly, in line with the results of experiment 1 wh-in-situ who-questions are understood significantly better than their counterparts involving overt wh-movement ($t(7)=4.68, p=0.002$). However, in contrast to the observations on who-questions, there is no significant difference between patients’ score on in-situ what-questions and what-questions involving overt wh-movement ($t(7)=-0.26, p=0.80$).

Finally, table 7 shows that patients’ score on what-questions is generally lower than that on who-questions. This difference is significant ($t(13)=2.4, p=0.032$).

**Discussion**

This experiment aimed at examining the effect of head movement on patients’ comprehension. To this extent, patients’ comprehension of French in-situ what-questions was compared to that of what-questions in which the wh-word had been moved. This latter type of question is derived through head movement. For convenience, the relevant examples in (17) are repeated here as (18).

(18) a. *L’hélicoptère poursuit quoi?*  
*Quoi* (‘what’) in-situ  
The helicopter follows what  
‘What does the helicopter follow?’

b. *Qu’est-ce que l’hélicoptère poursuit t_{Q}c.?*  
*Que* (‘what’) moved  
What Q the helicopter follows  
‘What does the helicopter follow?’

The results revealed no difference between patients’ comprehension of the two types of questions. At first sight, this suggests that head movement does not affect comprehension in Broca’s aphasia. Indeed, if this type of movement affects the comprehension abilities of these patients, French-speaking Broca patients are predicted to understand questions of the type in (18a) better than those of the type in (18b). Since no such difference is observed, head movement apparently does not affect patients’ comprehension.

However, the results of experiment 2 do not allow to draw the conclusion that patients’ comprehension of sentences derived through head movement is intact. On the contrary, patients’ comprehension of sentences of the type in (18b) is clearly impaired, since patients’ performance on these sentences is considerably poorer than that obtained by non brain-damaged speakers of French. There is thus a contradiction: head movement does not affect patients’ comprehension, but patients’ comprehension of sentences derived through head movement is still impaired.

To solve this contradiction, I suggest that the poor performance on what-questions obtained on French-speaking Broca patients is not only related to the type of movement through which these questions are derived, but also to the inanimate
feature that characterizes the wh-element in these questions. The results of experiment 2 have shown that patients’ comprehension of what-questions is generally worse than that of who-questions. This observation is in line with findings on English-speaking Broca patients. Thompson et al. (1999) found that these patients show better comprehension of animate than of inanimate questions. This suggests that syntactic movement is not the only factor influencing comprehension in Broca’s aphasia. Animacy also plays a role: sentences containing inanimate arguments are more difficult to understand for these patients than their animate counterparts. It might be possible that this animacy effect masks the effect of head movement. I will return to this possible interaction between syntactic movement and animacy in more detail in chapter 4, section 2.3.3.

Conclusion
The results of experiment 2 do not allow for an answer to the question whether head movement affects comprehension in Broca’s aphasia. Patients’ comprehension of sentences derived through head movement is impaired, but it is unclear whether this is due to syntactic movement or to the inanimate nature of the wh-element. In chapter 4, section 2.3.3, I will discuss the findings on French what-questions in more detail. I will now turn to the last comprehension experiment done for this thesis.

3.4. Experiment 3: adjunct questions

Research questions
The third experiment examines the effect of adjunct movement on patients’ comprehension. As was mentioned in chapter 2, this has not been examined systematically before. Still, most theories accounting for the comprehension deficit in Broca’s aphasia restrict their explanation to moved arguments. They claim that Broca patients have difficulties attributing thematic roles to moved arguments (cf. section 1.2.3 of chapter 2). For instance, the TDH explicitly states that in patients’ representation of a sentence, only traces of theta-positions are deleted (cf. Grodzinsky 1995a). On this view, it follows that traces of moved adjuncts are still present. Hence, it is expected that Broca patients will be able to understand sentences involving movement of an adjunct. The first goal of this experiment is to verify this prediction. In order to do so, patients’ comprehension of wh-in-situ adjunct questions (19a) will be compared to that of adjunct questions involving movement of the wh-adjunct (19b).

110 Interestingly, however, this animacy effect has not been found in other constructions. Grodzinsky (1995b) observed no difference between patients’ comprehension of sentences containing animate arguments (i) and that of their inanimate counterparts (ii). Patients scored above chance on both types of active sentences (ia, iia) and at chance on both types of passive sentences (ib, iib).

(i) a. The policeman stops the soldier. b. The soldier is stopped by the policeman.
(ii) a. The car blocks the truck. b. The truck is blocked by the car.

Obviously, it has to be explained why the animacy effect in patients’ comprehension seems to be restricted to wh-questions. A detailed examination of this issue falls outside the scope of this thesis.
If adjunct movement does indeed not affect patients' comprehension, no difference between patients' performance on these two types of questions is expected. Further, this experiment also compares patients' comprehension of adjunct questions with that of argument questions. There are several differences between arguments and adjuncts. Arguments are selected by the verb and as such part of the lexical entry of the verb. Their presence in the sentence is usually obligatory. By contrast, adjuncts are not selected by the verb and can freely be omitted. Apart from these differences, the traces of moved arguments and moved adjuncts also differ. Consider the sentences below.

(20) a. 'Which problem do you wonder [how John could solve which problem how]?
   b. *How do you wonder [which problem John could solve which problem how]?

Leaving technical details aside, this example shows that argument movement and adjunct movement involve different kinds of movement (see e.g. Cinque 1990).

Argument/adjunct distinctions have also been found in studies on Broca patients' production. The results of therapy studies have shown that for Broca patients too, argument and adjunct movement differ (cf. Thompson, Shapiro, Tait, Jacobs & Schneider 1996). Treatment of constructions involving argument movement (e.g. who-questions) resulted in improved production of these and other constructions involving argument movement (both who and what-questions), but not in that of constructions involving adjunct movement (e.g. when and where-questions). Similarly, treatment of constructions involving adjunct movement only resulted in improved production of other constructions derived through adjunct movement. Thompson and colleagues argue that these results indicate that the argument/adjunct distinction is not only a theoretical distinction, but also extends to patterns found in Broca's aphasia. Their study focused on the production of Broca patients. In the last comprehension experiment of this thesis it will therefore be examined whether there is also a difference in patients' comprehension of sentences involving argument movement and those involving adjunct movement. The two research questions of experiment 3 are given below.

(21) **Research questions**
   a. Does adjunct movement affect comprehension in Broca's aphasia?
   b. If so, is there a difference between the effect of adjunct movement and that of argument movement on patients' comprehension?
Participants
All of the Broca patients mentioned in table 1, except AR and JD, participated in this experiment. Thus, the group of Broca patients consisted of seven persons (one man, six women; mean age 47.9 years (range 35-68); mean m.p.o 87.9 months (range 11-209). Out of the control group mentioned in table 3, eight persons participated in this experiment: JacL, MS, SB, SD, MvD, SK, FD, and MC (three men, five women; mean age 46.13 years (range 20-79)).

Materials and procedure
For this experiment, a picture-pointing task similar to the ones used in the previous two experiments was developed. Thus, patients were shown a picture while a question was read. Patients were asked to point to the person, animal, or object representing the answer to the question.

However, using this kind of task makes it difficult to examine the effect of adjunct movement in patients’ comprehension of adjunct questions such as where and when-questions. Let me illustrate this by means of an example. Suppose that patients’ comprehension of where-questions is examined. The sentences in (19) would then be possible stimulus sentences. The picture belonging to these sentences would represent a train entering a railway station. If adjunct movement does affect patients’ comprehension, it is expected that questions of the type in (19b) are more difficult than those of the type in (19a). This means that patients will make more errors in questions of the type in (19b). Crucially, however, in this example patients cannot make any errors. The only possible answer to the question where the train is arriving is the railway station. There simply is no other object to which patients can point. Thus, in order to make sure that patients can make errors, semantically reversible sentences and pictures are needed. Therefore, adjunct questions containing PP adjuncts, such as the one in (22), were used.

(22) a. La fille dort sur qui?
   the girl sleeps on who
   ‘On who does the girl sleep?’

   b. Sur qui est-ce que la fille dort ?
   on who Q the girl sleeps
   ‘On who does the girl sleep?’

Figure 3 illustrates the picture belonging to these sentences.

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111 A different way of examining whether questions of the type in (19b) are more difficult than those in (19a) would be to measure reaction times. If the reaction times for questions of the type in (19b) are higher than those for (19a), it indicates that questions of the type in (19b) are more difficult. However, such experiments do not provide information concerning the nature of the complexity of a certain sentence type.
In this example, patients can make errors. They can point to the wrong person, namely the boy lying on the girl rather than the boy on which the girl is lying. Following the same reasoning as explained above, patients are expected to make more errors with questions of the type in (22b) than with those of the type in (22a). Using PP adjuncts thus makes it possible to examine the effect of adjunct movement.

However, the use of PP adjuncts also adds a possibly interfering factor to the test. It is well known that prepositions are difficult for Broca patients both in production and in comprehension (Friederici 1981; Goodglass, Gleason, Bernholtz & Hyde 1972; Schwartz et al. 1980). Patients’ performance on these types of adjunct questions can therefore not be compared with their performance on argument questions obtained in experiment 1. The arguments tested in experiment 1 are not embedded within a PP. Hence, any difference between patients’ comprehension of adjunct questions and that of argument questions observed in experiment 1 could be due either to the type of question or to the presence or absence of a preposition. In order to enable a comparison between patients’ comprehension of argument and adjunct questions, argument questions containing a PP argument were therefore included. Care was taken to develop minimal pairs as much as possible. So, patients’ comprehension of adjunct questions in (22) was compared with their performance on argument questions containing the same preposition.\footnote{As can be seen in appendix 3, it was not always possible to construct minimal pairs. Arguments and adjuncts are often introduced by different prepositions. I therefore also tried to form minimal pairs in terms of the verb. An example of this is given in table 8 below where the verb pousser (‘push/grow’) is combined either with an argument PP or with an adjunct PP.} An example is given below.

(23) a. La fille tape \textit{sur qui}?
   the girl taps on who
   ‘On who does the girl tap?’
b. *Sur qui* est-ce que la fille tape *sur qui*?
   on who Q the girl taps
   ‘On who does the girl tap?’

Figure 4 illustrates the picture belonging to this example.

*Fig. 4 Example of a picture for argument questions*

The test contained both animate and inanimate questions. Hence, there are eight conditions, illustrated in the table below.
### Table 8

*Examples of the conditions*

<table>
<thead>
<tr>
<th>Type of PP</th>
<th>Animacy</th>
<th>Place of PP</th>
<th>Example</th>
</tr>
</thead>
</table>
| **Argument** | animate | in-situ | La fille tape sur qui?  
‘On who does the girl tap?’ | | moved | Sur qui est-ce que la fille tape?  
‘On who does the girl tap?’ |
|            | inanimate | in-situ | L’arbre pousse contre quoi?  
‘Against what does the tree push?’ | | moved | Contre quoi est-ce que l’arbre pousse?  
‘Against what does the tree push?’ |
| **Adjunct** | animate | in-situ | La fille dort sur qui?  
‘On who does the girl sleep?’ | | moved | Sur qui est-ce que la fille dort?  
‘On who does the girl sleep?’ |
|            | inanimate | in-situ | L’arbre pousse sous quoi?  
‘Under what does the tree grow?’ | | moved | Sous quoi est-ce que l’arbre pousse?  
‘Under what does the tree grow?’ |

Examples of the pictures belonging to the animate questions were given above: figure 3 for animate adjunct questions (cf. the examples in (22)) and figure 4 for animate argument questions (cf. the examples in (23)). Figures 5 and 6 represent the pictures used for respectively inanimate argument and inanimate adjunct questions. Examples of the sentences belonging to these pictures are given in (24) and (25) respectively.

![Fig. 5 Example of a picture used for inanimate argument questions](image-url)
(24) a. L’arbre pousse contre quoi?
   the tree pushes against what
   ‘Against what does the tree push?’
   
b. Contre quoi est-ce que l’arbre pousse contre quoi?
   against what the tree pushes
   ‘Against what does the tree push?’

Fig. 6: Example of a picture used for inanimate adjunct questions

(25) a. L’arbre pousse sous quoi?
   the tree grows under what
   ‘Under what does the tree grow?’
   
b. Sous quoi est-ce que l’arbre pousse sous quoi?
   under what the tree grows
   ‘Under what does the tree grow?’

For each condition, eleven stimulus questions were developed. Hence, the test contained a total of 44 argument questions and 44 adjunct questions. This set of 44 was subdivided as follows: 22 animate and 22 inanimate questions. Of each set of 22 questions, eleven were in the in-situ condition and eleven involved syntactic movement. Appendix 3 gives a complete list of the stimulus sentences used in this experiment. Further, two types of filler sentences were included: yes/no questions (Est-ce que la fille se fâche? ‘Is the girl angry?’) and subject wh-questions. The latter also contained a complement PP. An example of this type of filler sentence is: Qui tire sur le loup? (‘Who shoots the wolf?’). All of the pictures, both those combined with a stimulus sentence and those combined with a filler sentence, represented three persons, animals, or objects. Again, two versions of this test were developed differing with respect to the order of the stimulus sentences. Thus, the order of the sentences is counterbalanced across patients. The procedure of this test is identical to the one described in experiment 1.

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113 Again, the test contained originally more items per condition. Only items understood by all of the non brain-damaged control speakers were included in the final version of the test.
Results

Control group

The results of the non brain-damaged speakers of French are illustrated in Table 9.

Table 9
Percentage correctly interpreted question per question type: control group

<table>
<thead>
<tr>
<th>Name</th>
<th>Argument</th>
<th></th>
<th></th>
<th>Adjunct</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Animate</td>
<td>Inanimate</td>
<td></td>
<td>Animate</td>
<td>Inanimate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>wh-in-situ</td>
<td>wh-moved</td>
<td></td>
<td>wh-in-situ</td>
<td>wh-moved</td>
<td></td>
</tr>
<tr>
<td>JacL</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>90.9</td>
<td>100</td>
<td>90.9</td>
</tr>
<tr>
<td>MS</td>
<td>90.9</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>SB</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>90.9</td>
<td>100</td>
<td>90.9</td>
</tr>
<tr>
<td>SD</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>MvD</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>SK</td>
<td>90.9</td>
<td>90.9</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>SD</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>90.9</td>
<td>100</td>
<td>90.9</td>
</tr>
<tr>
<td>MC</td>
<td>90.9</td>
<td>81.8</td>
<td>90.9</td>
<td>90.0</td>
<td>100</td>
<td>81.8</td>
</tr>
<tr>
<td>Mean</td>
<td>96.6</td>
<td>95.5</td>
<td>97.7</td>
<td>96.6</td>
<td>98.9</td>
<td>97.7</td>
</tr>
</tbody>
</table>

As can be seen in Table 9, the non brain-damaged speakers of French obtain virtually perfect scores on all conditions. There is no significant difference between the overall score on argument and adjunct questions (t(7)=-0.7, p=0.5). Further, no effect of wh-movement is observed. There is no significant difference between patients’ score on the wh-in-situ and the wh-movement condition ((t(7)=1.53, p=0.17 for argument questions; t(7)=1.93, p=0.095 for adjunct questions).

Broca patients

Table 10 gives the individual results of the Broca patients.

Table 10
Percentage correctly interpreted question per question type: Broca patients

<table>
<thead>
<tr>
<th>Patient</th>
<th>Argument</th>
<th></th>
<th></th>
<th>Adjunct</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Animate</td>
<td>Inanimate</td>
<td></td>
<td>Animate</td>
<td>Inanimate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>wh-in-situ</td>
<td>wh-moved</td>
<td></td>
<td>wh-in-situ</td>
<td>wh-moved</td>
<td></td>
</tr>
<tr>
<td>CA</td>
<td>81.8</td>
<td>63.6</td>
<td>54.5</td>
<td>36.4</td>
<td>36.4</td>
<td>27.3</td>
</tr>
<tr>
<td>AM</td>
<td>63.6</td>
<td>36.4</td>
<td>72.7</td>
<td>36.4</td>
<td>45.5</td>
<td>27.3</td>
</tr>
<tr>
<td>ST</td>
<td>81.8</td>
<td>90.9</td>
<td>72.7</td>
<td>63.6</td>
<td>45.5</td>
<td>27.3</td>
</tr>
<tr>
<td>LD</td>
<td>81.8</td>
<td>81.8</td>
<td>81.8</td>
<td>100</td>
<td>81.8</td>
<td>63.6</td>
</tr>
<tr>
<td>MG</td>
<td>72.7</td>
<td>45.5</td>
<td>63.6</td>
<td>54.5</td>
<td>36.4</td>
<td>18.2</td>
</tr>
<tr>
<td>SM</td>
<td>72.7</td>
<td>72.7</td>
<td>54.5</td>
<td>54.5</td>
<td>45.5</td>
<td>36.4</td>
</tr>
<tr>
<td>BS</td>
<td>72.7</td>
<td>81.8</td>
<td>54.5</td>
<td>36.4</td>
<td>27.3</td>
<td>27.3</td>
</tr>
<tr>
<td>Mean</td>
<td>75.3</td>
<td>67.5</td>
<td>64.9</td>
<td>54.5</td>
<td>51.9</td>
<td>28.6</td>
</tr>
</tbody>
</table>

114 For both conditions, the results on the inanimate and the inanimate types of questions have been combined.
By comparing the data in the tables 9 and 10 it can be seen that for all question types, patients’ comprehension is worse than that of the non brain-damaged control group. The Mann-Whitney U-test reveals that this difference is significant in all conditions. The results of this test for argument questions are: $z=-3.34$, $p=0.001$ for animate wh-in-situ questions, $z=-2.97$, $p=0.003$ for animate questions involving wh-movement, $z=-3.37$, $p=0.001$ for inanimate wh-in-situ questions, $z=-2.71$, $p=0.007$ for inanimate questions involving wh-movement. Similarly, for adjunct questions, the following results were obtained: $z=-3.43$, $p=0.001$ for animate wh-in-situ questions, $z=-3.53$, $p=0.001$ for animate questions involving wh-movement, $z=-3.45$, $p=0.001$ for inanimate wh-in-situ questions, $z=-3.32$, $p=0.001$ for inanimate questions involving wh-movement. This indicates that patients’ comprehension of all of these questions is impaired.

Focusing now on the data of Broca patients, several observations can be made. This experiment contains several factors: sentence type (argument versus adjunct questions), animacy (animate versus inanimate questions), and position of the wh-word (wh-in-situ versus wh-moved). The ANOVA first reveals a main effect of sentence type ($F(1,48)=47.8$, $p<0.001$). This means that patients’ comprehension of argument questions differs significantly from that of adjunct questions independently of the animacy of these questions or of the position of the wh-word in these questions. The overall score on argument questions is 65.6% correct, while adjuncts yield a score of only 37% correct. Hence, patients’ comprehension of argument questions is significantly better than that of adjunct questions ($t(6)=12.05$, $p<0.001$).

The ANOVA further shows a main effect of animacy ($F(1,48)=16.7$, $p<0.001$), indicating that patients’ comprehension of animate questions differs significantly from that of inanimate questions. The overall score on animate questions is 59.7% correct, that on inanimate questions is 42.9% correct. Patients’ comprehension of animate questions is thus significantly better than that of inanimate questions ($t(6)=4.23$, $p=0.006$). Thirdly, no main effect of position of the wh-word is observed (ANOVA: $F(1,48)=3.56$, $p=0.065$). This means that there is no significant difference on patients’ overall score on wh-in-situ questions versus that on wh-questions involving overt wh-movement.

Finally, the ANOVA does not reveal any significant interaction between the different factors: sentence type*animacy, $F(1,48)=1.6$, $p=0.22$; sentence type*position of wh-word, $F(1,48)=0.1$, $p=0.76$; animacy*position of the wh-word, $F(1,48)=0.0$, $p=1.0$; sentence type*animacy*position of the wh-word, $F(1,48)=0.1$, $p=0.76$.

This experiment focused on two possible contrasts in patients’ comprehension: wh-in-situ questions versus questions involving wh-movement and argument versus adjunct questions. For clarity’s sake the animate/inanimate distinction will therefore for the moment be disregarded. In table 11 the results obtained in experiment 3 are given again, but in this table the results on the animate and inanimate questions have been combined.

115 I will briefly return to animacy in the discussion.
Table 11
Percentage correctly interpreted wh-questions per question type: Broca patients

<table>
<thead>
<tr>
<th>Patient</th>
<th>Argument</th>
<th>Adjunct</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>wh-in-situ</td>
<td>wh-moved</td>
</tr>
<tr>
<td>CA</td>
<td>68.2</td>
<td>50.0</td>
</tr>
<tr>
<td>AM</td>
<td>68.2</td>
<td>36.4</td>
</tr>
<tr>
<td>ST</td>
<td>77.3</td>
<td>77.3</td>
</tr>
<tr>
<td>LD</td>
<td>81.8</td>
<td>90.9</td>
</tr>
<tr>
<td>MG</td>
<td>68.2</td>
<td>50.0</td>
</tr>
<tr>
<td>SM</td>
<td>63.6</td>
<td>63.6</td>
</tr>
<tr>
<td>BS</td>
<td>63.6</td>
<td>59.1</td>
</tr>
<tr>
<td>Mean</td>
<td>70.1</td>
<td>61.0</td>
</tr>
</tbody>
</table>

As can be seen in this table, for both argument and adjunct questions the wh-in-situ questions are understood better than their counterparts involving overt wh-movement. However, this difference is only significant in adjunct questions (t(6)=2.97, p=0.025), but not in argument questions (t(6)=1.7, p=0.14).

Discussion

The effect of adjunct movement

The first goal of this experiment was to examine the underlying assumption shared by several accounts of the comprehension deficit in Broca’s aphasia, namely that this deficit is restricted to moved arguments. The results obtained on French-speaking Broca patients suggest that this assumption is incorrect. These patients showed better comprehension of wh-in-situ adjunct questions than of their counterparts involving movement of the wh-adjunct. For convenience, an example is repeated below.

(26) a. La fille dort sur qui?
    the girl sleeps on who
   ‘On who does the girl sleep?’
   b. Sur qui est-ce que la fille dort que?
    on who Q the girl sleeps
    ‘On who does the girl sleep?’

Movement of the adjunct in sentences such as (26b) yields poorer performance relative to sentences of the type in (26a). This shows that adjunct movement does affect comprehension in Broca’s aphasia. The results of French-speaking Broca patients thus suggest that the accounts of the comprehension deficit in Broca’s aphasia have to be refined in such a way that they can capture the observed effect of adjunct movement on patients’ comprehension.

Note, however, that the results on arguments questions obtained in this experiment do not replicate those observed in experiment 1. There, it was observed that patients’ comprehension of wh-in-situ argument questions was significantly better than that of their counterparts involving wh-movement (cf. section 3.2). The
results of experiment 3 show a similar trend, but this difference does not reach significance. The absence of a significant effect is probably due to the limited amount of patients (experiment 3 examined seven patients, whereas nine patients participated in experiment 1), but it might also indicate that experiment 3 has experimental set-up problems or contains interfering factors (e.g. the presence of the preposition) that make it impossible to examine the effect of movement. Therefore, the results on adjunct questions obtained in experiment 3 should be interpreted with considerable caution. I will thus take the results obtained on French-speaking Broca patients as a first indication that movement of an adjunct affects comprehension in Broca’s aphasia. Further research is required to examine whether this observation can be generalized.

This experiment only contained prepositional adjuncts. It would be interesting to examine whether movement of non-prepositional adjuncts, such as when and where, has the same effect on patients’ comprehension.

Argument versus adjunct questions
The second goal of experiment 3 was to examine whether adjunct movement has a different effect on patients’ comprehension than argument movement. The results do not sustain such a conclusion. In both argument and adjunct questions a similar pattern is observed: better comprehension of wh-in-situ questions than of their counterparts involving wh-movement. The observation that this difference is greater in adjunct questions than in argument questions might indicate that adjunct movement has more effect on patients’ comprehension than adjunct movement. Further research is required to examine whether argument and adjunct movement do indeed differ in the sense that adjunct movement yields poorer comprehension than adjunct movement.

There is one aspect in which the results on argument and those on adjunct questions clearly differ. Patients’ comprehension of adjunct questions is considerably worse than that of argument questions. This observation is in line with earlier findings. It has been observed before that Broca patients have more difficulties with the comprehension of prepositional adjunct phrases than with that of prepositional argument phrases (cf. Canseco-Gonzalez, Shapiro, Zurif & Baker 1990; Shapiro et al. 1992). These difficulties are usually attributed to processing load. For non brain-damaged speakers it has been shown that the processing of adjunct PPs requires more processing resources than that of argument PPs (Clifton,

116 Note, however, that a comparison between the results on argument questions obtained in experiment 1 and those in experiment 3 does not support the hypothesis that the presence of preposition in experiment 3 is an interfering factor. The ANOVA reveals no interaction between the preposition and syntactic movement (F(1,24)=0.52, p=0.48).

117 Note however that the pattern seems to be reversed in production. Several studies (see Grodzinsky 1988 for an overview) have shown that Broca patients have more difficulties producing argumental rather than adjunct PPs. Thus, Friederici (1982) observed that patients more often omit prepositions in sentences of the type in (i) than in those of the type in (ib).

(i) a. Peter hofft auf den Sommer. b. Peter steht auf dem Stuhl
   Peter hopes on the summer   Peter stands on the chair
   ‘Peter is longing for the summer.’  ‘Peter is standing on the chair’

As was said in the first chapter of this thesis, the relation between production and comprehension in Broca’s aphasia is an interesting research topic, but will not be discussed in this thesis.
Speer & Abney 1991; Shapiro, Nagel & Levine 1993). The difficulties of Broca patients with these constructions are thus claimed to follow from their reduced processing capacity.

The results of experiment 3 are consistent with other findings on prepositional arguments and adjuncts in Broca’s aphasia. It would, again, be interesting to examine whether the observations on prepositional argument and adjunct questions obtained in experiment 3 can be generalized. In other words, it is interesting to examine whether patients’ comprehension of argument questions is generally better than that of adjunct questions. To this end, patients’ comprehension of non-prepositional adjunct questions, such as where and when-questions, should be compared to that of non-prepositional argument questions, who and what-questions. I will leave this as a topic for further research.

Animacy
A final observation following from the results in experiment 3 concerns the role of animacy. Patients’ comprehension of animate questions is better than that of inanimate questions. This is consistent with the results of experiment 2 and with those observed on English-speaking Broca patients (cf. section 3.3). As was noted there, the influence of animacy on the comprehension of wh-questions by Broca remains as yet unexplained. Since this thesis focuses on the effect of syntactic movement on patients’ comprehension, I will not discuss animacy any further here. It will be clear, however, that any explanation of the comprehension deficit in Broca’s aphasia should cover both patients’ difficulties with syntactic movement and those with inanimate wh-questions.

Conclusion
The results of experiment 3 lead to the conclusion that the comprehension deficit in Broca’s aphasia is not restricted to moved arguments. Movement of an adjunct also affects the comprehension abilities of these patients. The existing accounts of the comprehension deficit thus have to be revised. Since this experiment only examined prepositional adjuncts, further research on non-prepositional adjuncts is required.

3.5. Comprehension of wh-questions: summary
In this section, I have described three experiments examining the comprehension of wh-questions in French-speaking Broca patients. For three different types of questions (who-questions, what-questions, and adjunct questions), these experiments all examined whether patients’ comprehension of wh-in-situ questions was better than that of their counterparts involving overt wh-movement. Further, patients’ comprehension of argument questions was compared with that of adjunct questions. The results of these experiments can be summarized as follows:

(27) Comprehension of wh-questions in French-speaking Broca patients
- Patients’ comprehension of in-situ who-questions is better than that of their counterparts involving overt wh-movement (experiment 1).
In contrast to who-questions, no effect for wh-movement has been observed in what-questions (experiment 2).

Patients’ comprehension of wh-in-situ adjunct questions is better than that of questions in which the wh-adjunct has been moved (experiment 3).

Patients’ comprehension of argument questions is better than that of adjunct questions (experiment 3).

Patients’ comprehension of animate questions is better than that of inanimate questions (experiments 2 and 3).

Thus, there are three observations resulting from these experiments. First, wh-in-situ questions are understood better than their counterparts involving overt wh-movement (except for what-questions). Secondly, argument questions are better understood than adjunct questions. Finally, syntactic movement is not the only factor influencing patients’ comprehension, but animacy also seems to play a role: patients’ performance on inanimate wh-questions is worse than that on animate wh-questions.

The results of the French-speaking Broca patients were further compared with those obtained on English-speaking Broca patients, in order to examine their crosslinguistic validity. This has led to the findings summarized in (28) below.

(28) **Comparing the French and the English results**

- In both English and French-speaking Broca patients, their comprehension of wh-questions differs from the one observed in other movement-derived constructions. For both groups of patients, comprehension of subject who-questions is not better than that of object who-questions (experiment 1).
- French-speaking Broca patients have more difficulties comprehending subject questions than the English-speaking Broca patients do (experiment 1).
- Both English- and French-speaking Broca patients are sensitive to animacy: comprehension of inanimate questions is worse than that of animate questions (experiment 2).

In chapter 4, I will discuss these observations in detail and show their implications with respect to the effect of syntactic movement on patients’ comprehension. Before doing so, one final experiment has to be discussed. This experiment differs from the other three in that in does not examine patients’ comprehension of wh-questions. Instead, it is a repetition task. In the next section, I will discuss why this experiment has been done, describe its procedure and the obtained results.
4. Experiment 4: repetition task

4.1. The reason for performing experiment 4

The last experiment done for this thesis investigates a different aspect of wh-questions in French-speaking Broca patients than the three experiments discussed in section 4. These experiments all examined the question whether patients’ comprehension of wh-in-situ questions is better than that of their counterparts involving overt movement. By contrast, the purpose of experiment 4 is to examine whether French-speaking Broca patients have retained their premorbid knowledge concerning the syntactic characteristics of French wh-in-situ questions. It aims at answering the following question: does the grammar of French-speaking Broca patients assign the same syntactic structure to wh-in-situ questions as the one argued for in non brain-damaged French?

The answer to this question is a necessary prerequisite for the analysis of the data obtained in the previous three experiments. Let me illustrate this by means of an example. The results of experiment 1 showed that patients’ comprehension of object wh-in-situ who-questions is better than that of object who-questions involving overt movement. In chapter 2, section 2.2.3, I have argued that in non brain-damaged French these two questions are derived differently: the first type of questions involve movement of only the wh-features, the latter of the entire wh-word. The two structures are repeated below.

\[(29) \begin{align*}
a. \quad & \text{La fille frappe qui?} \\
& \text{the girl hits who} \\
& \text{‘Who does the girl hit?’} \\
& \quad [CP \ C \ [IP \text{ la fille frappe qui}]] \\
& \quad \text{move wh-features} \\

b. \quad & \text{Qui est-ce que la fille frappe?} \\
& \text{who Q the girl hits} \\
& \text{‘Who does the girl hit?’} \\
& \quad [CP \text{ qui est-ce que [IP la fille frappe tqui]]} \\
& \quad \text{move wh-word}
\end{align*}\]

Based on these structures, the results of experiment 1 could be interpreted as follows: Broca patients have less difficulty with the comprehension of constructions involving feature movement than with those involving overt wh-movement. Such an interpretation is based on the assumption that the syntactic structure of the wh-questions has not been changed in French-speaking Broca patients. In other words, the grammar of these patients still assigns the structure in (29a) to object wh-in-situ questions and that in (29b) to object questions involving wh-movement. This is the approach I will take in chapter 4. In proposing a new characterization of the comprehension deficit in Broca’ aphasia, I will depart from the syntactic structures of wh-questions in non brain-damaged French and English. Crucially, this is possible if and only if the grammar of Broca patients assigns the same structure to these questions as the ones proposed for non brain-damaged speakers. It is thus necessary to verify this assumption.

Experiment 4 focuses on the structure of French wh-in-situ questions. The main question of this experiment is whether French-speaking Broca patients have retained
the syntactic structure of French wh-in-situ questions. In other words: are these questions still derived by feature movement? In chapter 2, I have argued that one of the properties of feature movement is that it yields the intervention effect: the separation of the moved features and their originating lexical element is blocked by the intervention of negation or of a quantifier (cf. section 2.2.3). Hence, French wh-in-situ questions containing these elements are ungrammatical. The relevant examples are repeated below.

(30) a. *La fille ne frappe pas qui ? 
   the girl not hits NEG who
   ‘Who doesn’t the girl hit?’

   b. *Toutes les filles frappent qui?  
   all the girl hits who
   ‘Who do all the girls hit?’

In order to find out whether the syntactic representation of wh-in-situ questions in French-speaking Broca patients is identical to the one in (29a), I will examine whether French-speaking Broca patients obey the restrictions of the intervention effect on French wh-in-situ questions. In other words, I will examine whether questions of the type in (30) are also ungrammatical for these patients. The procedure of the experiment will be explained in more detail in section 4.3. Before doing so, I will first discuss the question which type of test is best suited for the research question under scrutiny.

4.2. Methodology

As was explained above, experiment 4 examines whether French-speaking Broca patients have retained the syntactic structure of French wh-in-situ questions. If so, patients will obey the syntactic restrictions of French wh-in-situ questions, such as their sensitivity to the intervention effect. The question now arises how to investigate the syntactic structure of wh-in-situ questions in French-speaking Broca patients.

It has been argued that a grammaticality judgment task is an appropriate task for the investigation of the available syntactic knowledge in Broca patients (cf. Linebarger et al. 1983a,b; Shankweiler et al. 1989; Sproat 1986). Many studies on aphasics patients have made use of this type of task (cf. among others Linebarger et al. 1983a,b; Shankweiler et al. 1989; Sproat 1986). This example shows that it has to be verified whether the syntactic structure of wh-in-situ questions in French-speaking Broca patients is identical to the one in non brain-damaged speakers of French.
However, it is not certain whether grammaticality judgment tasks do indeed reflect the syntactic knowledge of aphasic patients. Caplan (1995) argued that a correct performance on a grammaticality judgment task does not necessarily imply that aphasic patients have intact syntactic knowledge (see also Zurif & Grodzinsky 1983; Grodzinsky 1990). He notes that aphasic patients could correctly judge the grammaticality of a sentence based on an incomplete syntactic representation of that sentence. Consider for example the sentences in (31).

(31) a. When did the teacher smile?
b.* Who did the teacher smile?

These sentences were used by Linebarger et al. (1983a) to determine whether aphasic patients could correctly analyze wh-movement. However, as argued by Caplan (1995), the fact that patients accept a sentence such as (31a) and reject a sentence such as (31b) does not imply that the mechanism of wh-movement is still intact. Patients could use other ways to determine the grammaticality of a sentence. Since the theta-criterion has been shown to be intact in Broca patients (cf. Lapointe 1985; Sproat 1986; Frazier & Friederici 1991; Grodzinsky 1995a), the sentence in (24b) could be ruled out simply because who is an argument that has not received a thematic role.

A second drawback of the grammaticality judgment task is that it runs into several methodological problems. Patients could for instance have a yes-bias. In this case, patients do not want to show that they do not know whether a certain sentence is grammatical or not. Therefore, they accept almost every sentence. Mauner (1995) has argued that to rule out the effect of this kind of factors and obtain reliable results, the experiment has to contain over a hundred items per condition. He has also shown that almost none of the grammaticality judgment tasks performed on aphasic patients meet this and other reliability requirements.

In examining the syntactic structure of wh-in-situ questions in French-speaking Broca patients, I will therefore not make use of a grammaticality judgment task, Instead, I will use a sentence repetition task. At first sight, this might seem a strange choice. Patients are only repeating a given sentence. What do the results of such a task show with respect to the available syntactic structure of this sentence? It is true that the results of a sentence repetition task do not directly reflect patients’ syntactic knowledge. Still, in an indirect way, these results can show whether Broca patients have retained the syntactic structure of a certain construction. In the remainder of this section, I will explain how.

It has been observed that Broca patients, in a sentence repetition task, correctly convey the meaning of the target sentence, but omit syntactic operations and function morphemes of this sentence. Goodglass and Mayer (1985) observed that errors typically made by Broca patients were: loss of interrogative form and loss of subordination and coordination. For example, sentences of the type in (32a) and (32b) were repeated as illustrated in the prime examples. As can be seen in these

119 See Linebarger et al. (1983b) and Linebarger (1995) for a reply on these commentaries.
examples, patients omit functional elements, such as the determiner and tense morphemes.

(32) Target sentence Repetition by Broca patients
a. Did the man come? a'. a man come
b. The darker the sky became, b'. darker sky and rain come faster
   the more the rain came down. down.

This tendency to produce simpler forms has been observed more often (cf. Thompson, Shapiro & Roberts 1993; Friedmann 2002). In producing a sentence, Broca patients typically avoid movement and resort to structures without movement (cf. Bastiaanse et al. 2003).

Based on this finding, it is expected that French-speaking Broca patients will repeat wh-questions involving overt wh-movement as wh-in-situ questions. The results of the comprehension experiments discussed in section 3 have shown that French-speaking Broca patients have less difficulty understanding wh-in-situ questions than wh-questions involving overt wh-movement. Hence, wh-in-situ questions are easier questions for them. It thus follows that, when asked to repeat a wh-question involving wh-movement, French-speaking Broca patients are expected to produce a wh-in-situ question. This expectation is schematized below.

(33) Expected pattern of performance in a sentence repetition task

<table>
<thead>
<tr>
<th>Condition</th>
<th>Target sentence</th>
<th>Repetition by the patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>wh-in-situ</td>
<td><em>Jean a vu qui?</em></td>
<td>→ <em>Jean a vu qui?</em></td>
</tr>
<tr>
<td></td>
<td>Jean has seen who</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>‘Who did Jean see?’</em></td>
<td></td>
</tr>
<tr>
<td>wh-movement</td>
<td><em>Qui est-ce que Jean a vu t qui?</em></td>
<td>→ <em>Jean a vu qui?</em></td>
</tr>
<tr>
<td></td>
<td>Who Q Jean has seen</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>‘Who did Jean see?’</em></td>
<td></td>
</tr>
</tbody>
</table>

This is the first step. If such a pattern is indeed observed, the next step is to examine patients’ repetition of wh-questions in which the wh-word obligatorily moves. In chapter 2, I have discussed several conditions in which in non brain-damaged French the wh-word cannot remain in-situ, such as the presence of negation, quantifiers and quantificational adverbs. These elements yield the intervention effect (cf. section 2.2.1.3.). In questions containing such an element, the wh-word cannot remain in-situ, but has to move. The contrast is illustrated again below.

(34) a. *Jean n’a pas vu qui?*
   Jean not has NEG seen who
   ‘Who didn’t Jean see?’

b. *Tous les étudiants ont rencontré qui?*
   all the students have met who
   ‘Who did all the students meet?’
c. * Il admire toujours qui?
   He admires always who
   ‘Who does he always admire?’

(35) a. Qui est-ce que Jean n’a pas vu qui?
   Who Q Jean not has seen
   ‘Who didn’t Jean see?’
   b. Qui est-ce que tous les étudiants ont rencontré qui?
   Who Q all the students have met
   ‘Who did all the students meet?’
   c. Qui est-ce qu’il admire toujours qui?
   Who Q he admires always
   ‘Who does he always admire?’

As argued in chapter 2, the ungrammaticality of the questions in (34) results from the type of movement by which these questions are derived. These questions involve feature movement. Typically, this type of movement is sensitive to the intervention effect.

The main question of experiment 4 is: how do French-speaking Broca patients repeat sentences of the type in (35)? Do they repeat these questions as wh-in-situ questions? If so, it can be argued that patients have lost some of their knowledge concerning the syntactic characteristics of wh-in-situ questions. Apparently, they no longer ‘know’ that the wh-word cannot remain in-situ in these constructions. Instead, their grammar now allows this option. This suggests that the syntactic representation of wh-in-situ questions in French-speaking Broca patients differs from that in non-brain-damaged speakers of French. If on the other hand, patients repeat sentences of the type in (35) correctly, i.e. with wh-movement, it follows that patients have retained their syntactic knowledge concerning wh-in-situ questions. Clearly, they still ‘know’ that in these conditions they cannot fall back on the simpler wh-in-situ question, since their grammar does not allow this construction here. In that case, it is reasonable to conclude that Broca patients have retained the syntactic structure of wh-in-situ questions as given in (29a). This line of reasoning is schematized below.

(36) Possible findings and following conclusions

<table>
<thead>
<tr>
<th>Target question</th>
<th>Repetition by patient</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qui est-ce que Jean n’a pas vu qui?</td>
<td>Jean n’a pas vu qui?</td>
<td>(29a) lost</td>
</tr>
<tr>
<td>Qui est-ce que Jean n’a pas vu qui?</td>
<td>Qui est-ce que Jean n’a pas vu qui?</td>
<td>(29a) retained</td>
</tr>
</tbody>
</table>

To recapitulate the logic behind experiment 4: French-speaking Broca patients are expected to repeat a wh-question involving optional wh-movement as a wh-in-situ question (cf. the pattern in (33)). If this expectation is met, the next step is to examine the way in which these patients repeat wh-questions in which the wh-word obligatorily moves (the examples in (35)). If these sentences too are repeated as a wh-in-situ question, this will be interpreted as indicating that patients have lost the syntactic structure of French wh-in-situ questions in (29a). If patients repeat
sentences of the type in (35) correctly, this will be interpreted as indicating that patients have retained the syntactic structure of wh-in-situ questions in (29a).

4.3. The repetition experiment

**Research questions**
Experiment 4 examines whether French-speaking Broca patients have retained the syntactic structure of wh-in-situ questions as given in (29a). As was explained above, the research question for this experiment can be subdivided into two questions.

(37) **Research questions**
   a. Do patients repeat wh-questions involving optional wh-movement as wh-in-situ questions?
   b. If so, how do they repeat wh-questions in which in non brain-damaged French the wh-word obligatorily moves?

**Participants**
All of the patients mentioned in table 2 participated in the first session. However, the test proved to be extremely difficult. Most of the patients were unable to repeat wh-questions at all. They showed a strong tendency to answer rather than repeat the target question. Although they realized that their task was not to give an answer, most of them were unable to repeat the question and only repeated one or two words. Most of the patients gave up after the first session. Still, three of them, namely CA, ST and SM, were able to complete the entire test.

**Materials and procedure**
Repetition of argument and adjunct questions was examined in three conditions: (1) wh-in-situ, (2) optional wh-movement, (3) obligatory wh-movement. This last condition consisted of wh-questions containing the quantifier *tous* (‘all’), the quantificational adverb *toujours* (‘always’), or negation. All of the argument questions were *who*-questions. The adjunct questions were *where*- or *when*-questions. Examples of these conditions are given in (38a) through (38f) below. Additionally, the test contained *what*-questions in two conditions, wh-in-situ and wh-movement (cf. the examples in (38g) and (38h)). Finally, yes/no questions were also included. An example is given in (38i). A complete list of the stimulus sentences is given in appendix 4.

(38) **Examples of the conditions**

**Argument questions**

a. L’homme admire qui?
   the man admires who
   ‘Who does the man admire?’
b. Qui est-ce que l’homme admire t\(_{qui}\)?  
\(\text{who Q}\) the man admires  
‘Who does the man admire?’

c. Qui est-ce que tous les hommes admirent t\(_{qui}\)?  
\(\text{who Q}\) all the men admire  
‘Who do all men admire?’

**Adjunct questions**

d. Pierre regarde la télé quand?  
Pierre watches the television when  
‘When does Pierre watch television?’

e. Quand est-ce que Pierre regarde la télé t\(_{quand}\)?  
When Q Pierre watches the television  
‘When does Pierre watch television?’

f. Quand est-ce que Pierre ne regarde pas la télé t\(_{quand}\)?  
When Q Pierre not watches NEG the television  
‘When doesn’t Pierre watch television?’

**Other**

g. L’homme mange quoi ce soir ?  
the man eats what this night  
‘What is the man eating tonight?’

h. Qu’est-ce que l’homme mange t\(_{que}\) ce soir?  
\(\text{what Q}\) the man eats this night  
‘What is the man eating tonight?’

i. Est-ce que l’auto coûte cher?  
\(\text{Q}\) the car costs expensive  
‘Is the car expensive?’

The test contained 12 items per condition. With respect to the restriction condition, there were 12 questions containing a negation (six argument questions and six adjunct questions), and 12 questions containing the quantifier \(\text{tous}\) (‘all’) or the adverb \(\text{toujours}\) (‘always’) (six argument questions and six adjunct questions). Thus, the total number of questions to be repeated was 108.

Each question was read out aloud by the experimenter. Patients were asked to listen carefully to the sentence and to repeat it after the experimenter was finished. Target questions were repeated on request, but never more than once. Before testing, two practice items were given. In these items, most of the patients showed a tendency to answer rather than to repeat the question. The instructions were therefore repeated. After the practice items, all of the patients understood the task, but as was said above, only three of them were able to complete it. Since the test was

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\(^{120}\) The question morpheme \(\text{est-ce que}\) is not obligatory in French yes/no questions. It is also possible to produce a question as (38i) without \(\text{est-ce que}\). The difference between \(\text{l’auto coûte cher}\) (‘the car is expensive’) as a question or a declarative is marked by the intonation pattern. The interrogative always has a rising intonation. All of the yes/no questions included in the test contained the question morpheme \(\text{est-ce que}\).
difficult and long, testing was done in three sessions of around 35 items per session. Patients were tested individually in a quiet room.

**Scoring**

Both a quantitative and a qualitative analysis were performed. Thus, I counted the number of correctly repeated questions per question type. Further, patients’ incorrect repetitions were classified according to the type of error the utterance contained. Since this experiment investigates the way in which wh-questions involving overt wh-movement are repeated, the focus is on errors with wh-movement. I distinguished six error types. The first two are errors in questions involving optional wh-movement (i.e. the examples (38b, 38e, 38h)). These errors are: producing a wh-in-situ question for a target wh-movement question (type I) and omission or substitution of the wh-word (II). Further, two other error types were distinguished in the obligatory movement condition (i.e. the examples in (38c) and (38f)): omitting the quantificational or the negative element, but producing the wh-word (type III), and omitting both the quantificational/negative element and the the wh-word (type IV). The first type is subdivided into two: (a) omitting the Q/N element, but moving the wh-word, and (b) omitting the Q/N element and producing a wh-in-situ question. Finally, two other error types were distinguished: omitting the verb and/or the subject (type V), and all other errors (type VI). This last category contained errors such as perseveration (repeating the previous instead of the target question), and omission of the question morpheme *est-ce que*. The different error types are illustrated in table 12 below.

---

121 Henceforth Q/N element.
Table 12
Error types in repeating wh-questions

<table>
<thead>
<tr>
<th>Error type</th>
<th>Description</th>
<th>Example</th>
<th>repetition by patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>wh-in-situ, instead of wh-movement</td>
<td>Qui est-ce que le garçon a vu? ‘Who did the boy see?’</td>
<td>Le garçon a vu qui? CA) the boy has seen who</td>
</tr>
<tr>
<td>II</td>
<td>omis./sub. wh-word</td>
<td>Quand est-ce que Pierre reçoit des cadeaux? ‘When does Peter receive presents?’</td>
<td>Pierre reçoit des cadeaux? (ST) Peter receives presents?</td>
</tr>
<tr>
<td>IIIa</td>
<td>omission of Q/N, moving the wh-word</td>
<td>Qui est-ce que tous les élèves aiment? ‘Who do all the students like?’</td>
<td>Qui est-ce que les élèves aiment? (ST) Who Q the students like</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Qui est-ce que Pierre n’invite pas à son anniversaire? Who does Peter not invite on his birthday party?</td>
<td>Pierre invite qui à la fête? (CA) Peter invites who on the party</td>
</tr>
<tr>
<td>IIIb</td>
<td>omission of Q/N, wh-in-situ question</td>
<td>Quand est-ce que les enfants ne regardent pas la télé? ‘When do the children not watch television?’</td>
<td>Les enfants gardent télévision ... ehm.. (ST) The children watch television</td>
</tr>
<tr>
<td>IV</td>
<td>omission of Q/N and the wh-word</td>
<td>Quand est-ce que les enfants ne regardent pas la télé? ‘When do the children not watch television?’</td>
<td>Les enfants gardent télévision ... ehm.. (ST) The children watch television</td>
</tr>
<tr>
<td>V</td>
<td>omis. verb and/or subject</td>
<td>Jean va à la messe quand? ‘When does John go to the service?’</td>
<td>Jean à la messe quand? (SM) John to the service when</td>
</tr>
<tr>
<td>VI</td>
<td>Other</td>
<td>Qui est-ce que la femme conduit à l’école? Who does the woman drive to school?</td>
<td>Qui elle va reconduire? (CA) Who she goes drive home</td>
</tr>
</tbody>
</table>

All remaining errors, such as omission of verbal inflection, omission or substitution of a preposition, semantic errors (e.g. woman for man) or phonological errors were not taken into account and counted as correct.

Results I: percentage correctly repeated wh-questions

Table 13 gives the percentage of correctly repeated questions per question type.
Table 13
Percentage correctly repeated question per question type

<table>
<thead>
<tr>
<th>Patient</th>
<th>Argument who-questions</th>
<th>Argument what-questions</th>
<th>Adjunct in-situ</th>
<th>Adjunct move wh-optional</th>
<th>Adjunct move wh-obligatory</th>
<th>Yes/no</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>58.3 0 0</td>
<td>75.0 8.3 0</td>
<td>66.7 33.3</td>
<td>8.3 0 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ST</td>
<td>100 83.3 33.3</td>
<td>100 25.0 58.3 8.3 0</td>
<td>50.0 100</td>
<td>58.3 41.7 25.0 0</td>
<td>33.3 25.0 0</td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td>75.0 91.7 33.3</td>
<td>75.0 44.4 61.1 27.8</td>
<td>11.1 11.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The data show that for who-questions, what-questions, and adjunct questions wh-in-situ questions are repeated significantly better than their counterparts involving wh-movement. A chi-square test gives the following values: $\chi^2=11.18, p=0.0008$ for who-questions; $\chi^2=5.77, p=0.016$ for what-questions and $\chi^2=16.92, p<0.0001$ for adjunct questions.\(^{122,123}\)

Discussion

The results in table 13 have shown that French-speaking Broca patients are better in repeating wh-in-situ questions than in their counterparts involving overt wh-movement. This suggests that wh-in-situ questions are easier to produce for these patients. However, the purpose of experiment 4 was not to examine whether wh-in-situ questions are easier to produce than wh-questions involving overt wh-movement. Instead, its goal was to examine the way in which French-speaking Broca patients repeat wh-questions involving wh-movement. Do they fall back on an easier question type and repeat these questions as wh-in-situ questions? And if so, how do they repeat wh-questions in which the wh-word obligatorily moves in the French of non brain-damaged speakers? Obviously, the results in table 13 do not provide an answer to these questions. Instead, an error analysis is needed. This will be done in the remainder of this section.

Before going in to the error analysis, there is one other observation in table 13 that has to be mentioned. The results in table 13 show that patients are almost unable to repeat yes/no questions. This is unexpected, since these questions do not involve wh-movement. However, a closer look at the data shows that here too, patients fall back on a simpler form. By far the most frequent error that is made (43.8% of the errors made on yes/no questions) is the omission of the question morpheme est-ce.

\(^{122}\) For who-questions and adjunct questions, the scores obtained in the optional and the obligatorily movement conditions have been combined.

\(^{123}\) Note also that there is a considerable amount of individual variation: patients CA and ST show a preference for wh-in-situ questions. Both patients repeat wh-in-situ questions better than questions involving overt wh-movement. However, patient SM shows the reversed pattern with better production of questions involving optional wh-movement than of wh-in-situ questions. Further, patient CA’s repetition of adjunct questions is better than that of argument questions: 50% correct versus 35.4% correct respectively. By contrast, both ST and SM show the reversed pattern. Their overall correct repetition of argument questions is 77.1% (ST) and 79.2% (SM), while that of adjunct questions is 33.3% (ST) and 50% (SM). I will not discuss all these individual differences. The error analysis will reveal another difference between patient CA on the one hand and patients ST and SM on the other. This difference will be discussed in detail.
que. Thus, the target question in (38i) is repeated as l’auto coûte cher? (‘the car is expensive?’). As was noted in footnote 120, such a question is a grammatical French yes/no question. The results on yes/no questions are consistent with earlier findings. Thompson et al. (1993) and Friedmann (2002) observed that respectively English and Hebrew-speaking Broca patients produce yes/no questions marked by rising intonation only.

**Results II: Error analysis**

As was explained in section 4.2, the first research question of experiment 4 was whether French-speaking Broca patients repeat wh-questions involving optional movement as wh-in-situ questions. Let us therefore consider the types of errors made in repeating argument questions and adjunct questions involving optional wh-movement (i.e. the examples in (38b), (38c), and (38h)). The tables 14 through 16 illustrate the types of errors per question type. See table 12 for an explanation and example of the different error types.

**Table 14**

Errors in repeating argument who-questions involving wh-movement (cf. 38b)

<table>
<thead>
<tr>
<th>patient</th>
<th>error type</th>
<th>I</th>
<th>II</th>
<th>V</th>
<th>VI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>wh-in-situ</td>
<td>omis./sub.wh-word</td>
<td>omis. verb/subject</td>
<td>other</td>
<td></td>
</tr>
<tr>
<td>CA</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>ST</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Table 15**

Errors in repeating argument what-questions involving wh-movement (cf. 38h)

<table>
<thead>
<tr>
<th>patient</th>
<th>error type</th>
<th>I</th>
<th>II</th>
<th>V</th>
<th>VI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>wh-in-situ</td>
<td>omis./sub.wh-word</td>
<td>omis. verb/subject</td>
<td>other</td>
<td></td>
</tr>
<tr>
<td>CA</td>
<td>7</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>ST</td>
<td>0</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Table 16**

Errors in repeating adjunct questions involving wh-movement (cf. 38e)

<table>
<thead>
<tr>
<th>patient</th>
<th>error type</th>
<th>I</th>
<th>II</th>
<th>V</th>
<th>VI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>wh-in-situ</td>
<td>omis./sub.wh-word</td>
<td>omis. verb/subject</td>
<td>other</td>
<td></td>
</tr>
<tr>
<td>CA</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ST</td>
<td>0</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
The results in these tables show that only CA tends to produce a wh-in-situ question when repeating a wh-question involving optional wh-movement. For all questions, she frequently produces type I errors. Surprisingly, patients ST and SM never make this kind of error. They both correctly repeat who-questions involving optional movement (cf. table 14). In repeating the other types of questions, different strategies can be observed. Thus, patient ST frequently omits the wh-word (i.e. error type II) in both what-questions and adjunct questions. Patient SM, by contrast, makes no errors in repeating what-questions involving optional wh-movement. However, as is shown in table 16, in repeating adjunct questions, she omits the verb or the subject (i.e. error type IV). At the end of this section, I will compare the results in the tables 14 through 16 with patients’ comprehension of wh-questions and examine whether the individual differences observed in patients’ repetition of wh-questions can be related to their comprehension of wh-questions. I will now first discuss the research questions of the present experiment, which were: (a) do patients repeat questions involving optional wh-movement as wh-in-situ questions? and (b) if so, how do they repeat wh-questions in which the wh-word obligatorily moves? Since the results of patient CA differ with those of patients ST and SM with respect to question (a), the results of CA will be discussed separately from those of ST and SM. I will start with the results of patient CA.

Patient CA

As was shown in tables 14 through 16, patient CA has a clear tendency to repeat wh-questions involving optional wh-movement as wh-in-situ questions. Some examples of her utterances are given below.

124 CA is also the only patient producing doubling errors. This means that she produces a question containing both a subject and an object wh-word. Thus, she repeats the question in (ia) as in (1b).

(i) a. Qui est-ce que l’homme embrasse?
   who Q the man kisses
   ‘Who does the man kiss?’

b. Qui qui embrasse qui?
   who who kisses who

Similar errors were observed by Thompson et al. (1996) and Friedmann (2002). Note that the doubling does not refer to the doubling of the subject wh-word. Subject questions in which the qui is repeated form a possible variant in québecois French (e.g. qui qui embrasse le garçon? ‘who kisses the boy?’). The doubling in (ib) refers to the fact that the question contains both a subject and an object wh-word. Here, these errors are counted as wh-in-situ errors (type I), since the target wh-word has not been moved, but is expressed in-situ.
(39) **Target sentence**

a. Qui est-ce que l’homme a rencontré?  
   Who Q the man has met  
   ‘Who did the man meet?’

b. Qu’est-ce que l’homme mange ce soir?  
   what Q the man eat this night  
   ‘What does the man eat tonight?’

c. Quand est-ce que Jean va à la mer?  
   When Q Jean goes to the see  
   ‘When does Jean go to the see?’

**Repetition by CA**  

....eh...l’homme a rencontré qui?  
....eh...the man has met who

L’homme...mange...quoi?  
the man...eat.....what

Jean...va à la mer quand?  
Jean...goes to the see when

The crucial question now is: how does this patient repeat wh-questions in which the wh-word obligatorily moves? Does she show the same wh-in-situ tendency for these questions? Table 17 illustrates the type of errors made by CA in repeating argument and adjunct questions in which the wh-word obligatorily moves (i.e. respectively (38c) and (38f)).

<table>
<thead>
<tr>
<th>error type</th>
<th>I wh-in-situ</th>
<th>II om/sub. wh-word</th>
<th>IIIa omis. Q/N, wh-moved</th>
<th>IIIb omis. Q/N, wh-in-situ</th>
<th>IV omis. Q/N &amp; wh-word</th>
<th>V omis. verb/subj</th>
<th>VI other</th>
</tr>
</thead>
<tbody>
<tr>
<td>argument</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>adjunct</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The results in table 17 show that patient CA does produce some wh-in-situ questions containing the quantifier or negation (error type I). In other words, she produces several questions that are ungrammatical in non brain-damaged French (cf. 34). All her utterances of this type are given below.

125 For argument questions, only who-questions were examined (cf. the examples given in (38)).
At first sight, these examples suggest that patient CA has lost some of the syntactic characteristics of French wh-in-situ questions. She no longer ‘knows’ that in questions of the type in (40) the wh-word has to move. As was schematized in (36) above, this leads to the conclusion that the grammar of CA assigns a different structure to wh-in-situ questions than the one argued for in non brain-damaged French. For convenience, the schema in (36) is repeated here.

(41) Possible findings and following conclusions

<table>
<thead>
<tr>
<th>Target question</th>
<th>Repetition by patient</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qui est-ce que Jean n’a pas vu qui? Jean n’a pas vu qui? (29a) lost</td>
<td>Qui est-ce que Jean n’a pas vu? (29a) retained</td>
<td></td>
</tr>
</tbody>
</table>

Based on the utterances in (40), it could thus be argued that the grammar of CA assigns a different structure to wh-in-situ questions than the structure in non brain-damaged French.

Note, however, that the situation is somewhat more complicated than presented in (41). It is possible that patients have retained the syntactic structure of French wh-in-situ questions, but that they are unable to use this knowledge due to a processing deficit and repeat questions involving obligatory wh-movement as wh-in-situ questions. In other words, if patients produce wh-in-situ questions in constructions where it is not allowed in the French of non brain-damaged speakers, it does not necessarily follow that they have lost the syntactic structure of wh-in-situ questions. In order to determine whether CA’s errors with questions of the type in (40) result from a processing or a representational deficit, her repetition of these questions will be compared with that of questions involving optional wh-movement. Thus, her errors will be assessed against the following criteria:

126 In colloquial French the item ne is often omitted. Negation is expressed by the item pas solely. Thus, in all these examples CA has not omitted the negation.
repetition of sentences of the type in (42) will be compared with that of questions of the type in (43).

(42) a. Qui est-ce que Jean a vu ?
   who Q Jean has seen
   ‘Who did Jean see?’

   b. Quand est-ce que Jean est venu ?
   when Q Jean has come
   ‘When did Jean come’

(43) a. Qui est-ce que Jean n’a pas vu ?
   who Q Jean not has NEG seen
   ‘Who didn’t Jean see?’

   b. Quand est-ce que Jean n’est pas venu ?
   when Q Jean not is NEG come
   ‘When didn’t Jean come?’

If CA has a general movement deficit, it is expected that in repeating both types of wh-questions in (42) and (43), she will avoid movement of the wh-word and produce a wh-in-situ question. However, if she has retained the syntactic structure of wh-in-situ questions, it is expected that she will use this wh-in-situ strategy more frequently in questions of the type in (42) than in those of the type in (43). If she ‘knows’ that questions of the type in (43) do not allow the wh-word to remain in-situ, she might also resort to other strategies avoiding wh-movement, such as to omit the wh-word.

Crucially, there is a clear difference in the error pattern of patient CA in repeating questions of the type in (42) versus those of the type in (43). In repeating questions of the type in (42), patient CA shows a clear wh-in-situ strategy: 61.3% of all her errors are wh-in-situ errors (cf. the tables 14 through 16). By contrast, she does not seem to use this strategy in repeating questions of the type in (43). As was shown in table 17, the error made most frequently is the omission of the element that blocks wh-in-situ licensing (i.e. the Q/N element): 56.6% of all the errors are of type III or IV. This suggests that CA is not using her in-situ strategy when repeating questions of the type in (43). It thus seems as if CA ‘knows’ that here she cannot fall back on the in-situ form. Therefore, she simplifies the target question in a different way, by leaving out the quantifier, the negation, and sometimes also the wh-word. Only when she forces herself to produce both the wh-word and the Q/N element, is she no longer able to also move the wh-word.127

127 Obviously, this is not a conscious process. I do not mean to say that CA makes a conscious decision as if she would like to repeat questions of the type in (43) as wh-in-situ questions, but she knows that this is not allowed and therefore she simplifies the target in a different way. Obviously, patients do not make such conscious decisions in a repetition task. What is meant here is that the contrast between the error patterns observed in repeating questions of the type in (42) and those in (43) suggests that CA has retained the syntactic structure of wh-in-situ questions. Her errors illustrated in (40) are the only examples in which the produces a wh-in-situ question in a context in which it is not allowed in non brain-damaged French. However, she is not always able to use her syntactic knowledge, which yields the occasional production of questions of the type in (40).
To conclude, the data of patient CA do not necessarily lead to the conclusion that this patient has lost the syntactic structure of French wh-in-situ questions. Rather, they suggest that this patient has retained the structure illustrated in (29a). Let us now move to the data of the patients ST and SM.

Patients ST and SM

As was shown in the tables 14 through 16, patients ST and SM do not use a wh-in-situ strategy. These patients do not repeat wh-questions involving optional wh-movement as wh-in-situ questions. Instead, in repeating these wh-questions, they either omit the wh-word (patient ST) or the verb (patient SM). Some examples of their utterances are given below. The utterance in (44a) is produced by patient ST, (44b) by patient SM.

(44) Target question Repetition by the patient
a. Qu’est-ce que le garçon a perdu dans la neige? Le garçon a perdu…la neige?
   what Q the boy has lost in the snow the boy….has lost….the snow?
   ‘What did the boy lose in the snow?’

b. Qui est-ce que Marie accompagne à la gare?
   Qui est-ce que Marie à la gare?
   who Q Marie accompanies to the station who Q Marie to the station?
   ‘Who does Mary accompany to the station?’

These patients thus do not meet the expectation in (33). They do no repeat wh-questions involving optional movement as wh-in-situ questions. Instead, they simplify the target question in a different way: by omitting the wh-word or the verb. The expectation pattern in (33) formed the premise for the examination of patients’ repetition of wh-questions involving obligatory wh-movement. If patients showed a wh-in-situ strategy in repeating wh-questions, the next step was to examine whether they also showed this strategy in question types where wh-in-situ is not allowed in non brain-damaged French. Since patients ST and SM do not show a wh-in-situ strategy in wh-question involving optional wh-movement, their repetition of questions involving obligatory wh-movement will not provide an answer to the question whether these patients have retained the syntactic structure of wh-in-situ questions. Still, I will briefly discuss their results on wh-questions involving obligatory wh-movement.

Table 18 illustrates the errors produced by patients ST and SM in repeating wh-questions involving obligatory wh-movement (cf. the condition (38c) and (38f)).

Incidentally, there is a relation between their use of a ‘simplification’ strategy and the type of question. The results of the comprehension experiments and the data in table 13 have shown that adjunct questions are more difficult for Broca patients than argument questions. Further, it was observed that within the argument questions, animate questions are easier than inanimate questions. Thus, there is a sort of complexity hierarchy. This is reflected in the error patterns of patients ST and SM. Both patients almost make no errors in repeating the easiest question, namely who-questions (cf. table 14). Patient ST has difficulties repeating what-questions. Patient SM does not show difficulties here (cf. table 15). Both patients are unable to repeat adjunct questions, which are the most difficult type of question. Here, both patients simplify the target question, although each in a different way.
Table 18

Errors produced by ST and SM in repeating wh-questions involving obligatory wh-movement (38c,f)

<table>
<thead>
<tr>
<th>patient</th>
<th>question type</th>
<th>I wh-in-situ</th>
<th>II omis/sub wh-word</th>
<th>IIIa omis. Q/N, moving wh</th>
<th>IIIb omis. Q/N, wh-in-situ</th>
<th>IV omis. Q/N &amp; wh-word</th>
<th>V omis. verb/sub</th>
<th>VI other</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST</td>
<td>argument</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>adjunct</td>
<td>0</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>SM</td>
<td>argument</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>adjunct</td>
<td>0</td>
<td>1</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The results in table 18 first show that ST and SM never make wh-in-situ errors. This is expected, since these patients do not have a wh-in-situ strategy when repeating wh-questions involving optional wh-movement (cf. table 17). The results further show that SM frequently omits the quantifier or the negation (type IIIa error). Patient ST does the same in argument questions. In repeating adjunct questions, this patient either omits the wh-word (type II error), or both the wh-word and the Q/N element (type IV error). Some examples of their utterances are given below.

(45) **Target question**

a. Qui est-ce que tous les hommes admirent?
   who Q all the men admire
   ‘Who do all the men admire?’

b. Où est-ce que tous les hommes lisent le journal?
   where Q all the men read the newspaper
   ‘Where do all the men read the newspaper?’

c. Qui est-ce que tous les élèves aiment?
   who Q all the students like
   ‘Who do all the students like?’

**Repetition by the patient**

Qui est-ce que les hommes admirent? (ST)
    who Q the men admire
Qui est-ce qui les élèves aiment? (SM)
    who Q the student like

Further, by comparing the results in table 18 with those in the tables 14 until 16 several observations can be made. For instance, in repeating adjunct questions involving optional wh-movement (42b), patient SM frequently omitted the verb. By contrast, in repeating adjunct questions involving obligatory wh-movement (43b), she does not show this tendency, but instead omits the Q/N element. This shows again that patients’ error patterns in repeating questions of the type in (42) versus those of the type in (43) differ. I will not further discuss these differences here, but instead focus on the differences between the results of patient CA on the one hand and those of patients ST and SM on the other. This will be done in the next section.

**Comparing the results of CA with those of ST and SM**

The results of the repetition experiment have shown that CA is the only patient repeating wh-questions involving overt wh-movement as wh-in-situ questions. Patients ST and SM do not show this strategy. The question now arises whether
there are any other differences between these patients that can be related to this difference. Let us therefore return to their comprehension of wh-questions.\(^{129}\) In table 19, all the results obtained for these patients in the experiments 1 through 3 have been combined.

**Table 19**

*Comprehension of wh-questions by patients CA, ST, and SM (percentages correct)*

<table>
<thead>
<tr>
<th>Patient</th>
<th>Argument</th>
<th>Adjunct</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>wh-in-situ</td>
<td>wh-moved</td>
</tr>
<tr>
<td>CA</td>
<td>75.0</td>
<td>61.5</td>
</tr>
<tr>
<td>ST</td>
<td>78.8</td>
<td>75.0</td>
</tr>
<tr>
<td>SM</td>
<td>71.2</td>
<td>71.2</td>
</tr>
</tbody>
</table>

The data in table 19 reveal a difference between patient CA on the one hand and patients ST and SM on the other. CA’s comprehension of wh-in-situ questions is better than that of questions involving overt wh-movement. This is only observed in argument questions. However, the absence of this effect in CA’s comprehension of adjunct questions might be a floor effect. In contrast to CA, patients ST and SM do not show a considerably better comprehension of wh-in-situ questions than of their counterparts involving overt wh-movement.

These data thus suggest that CA is more sensitive to wh-movement than ST and SM. In both the comprehension and the production of wh-questions, movement of the wh-word is difficult for her. Hence, she shows better comprehension of wh-in-situ questions. Similarly, in production she avoids wh-movement and prefers to produce wh-in-situ questions. By contrast, patients ST and SM have fewer difficulties with wh-movement. Although these patients show occasionally better comprehension of wh-in-situ questions (cf. the results of experiment 1, section 3.3), their overall performance reveals fewer difficulties with wh-movement than CA has. Hence, these patients do not avoid wh-movement in their production of wh-questions.

**Conclusion**

The purpose of experiment 4 was to examine whether French-speaking Broca patients have retained the syntactic structure of wh-in-situ questions. If so, they were expected to obey the restrictions on wh-in-situ questions, such as the intervention effect. Based on earlier findings on the performance of Broca patients on sentence repetition tasks, it was expected that French-speaking Broca patients repeat wh-questions involving optional wh-movement as wh-in-situ questions. If patients would indeed show such a tendency, the next step was be to examine their repetition of wh-questions involving obligatory wh-movement.

\(^{129}\) Alternatively, one might try to relate the observed difference to the characteristics of these patients mentioned in table 1. However, this does not work since these characteristics never contrast CA with ST and SM. For instance, CA is considerably younger than other patients, but so is SM. Further, CA also does not differ from ST and SM in nationality: both CA and ST are Canadian. Finally, these patients do not differ with respect to gender, employment, or lesion site and size (cf. table 1).
The results have shown that not all the French-speaking Broca patients exhibit the expected pattern. Only one out of three patients showed a clear tendency to produce wh-in-situ questions when repeating wh-questions involving overt wh-movement. This is patient CA. Crucially, a difference was observed between the type of errors this patient made in repeating wh-questions involving optional wh-movement versus those involving obligatory wh-movement. While the first type of questions were often repeated as wh-in-situ questions, the error made most frequently in the second type of questions was to omit the element blocking in-situ licensing of the wh-word. I have argued that this difference suggests that patient CA has indeed retained the syntactic structure of wh-in-situ questions. This conclusion is consistent with other findings in the neurolinguistic literature. Thus, it has been shown that Broca patients of a verb-second language, such as Dutch or German, still obey the syntactic restrictions of the verb movement rule (cf. Bastiaanse, Hugen, Kos & van Zonneveld 2002; Penke 2001; Platzack 2001).

Broca patients thus retain the syntactic structures and restrictions of linguistic constructions. Even though syntactic movement is difficult for them, they do not produce ungrammatical constructions without syntactic movement. French-speaking Broca patients have retained the syntactic structure of wh-in-situ questions. Hence, in proposing a new characterization of the comprehension deficit in Broca’s aphasia, it is allowed to assume that for French-speaking Broca-patients, wh-questions are derived in the same way as for non-brain damaged speakers of French.

5. General discussion

5.1. Summary

In this chapter, four experiments examining wh-questions in French-speaking Broca patients have been described. The first three experiments investigated patients’ comprehension of wh-questions. The results of these three experiments are summarized in the graphs in figures 7 and 8. In these graphs, the results obtained in all three comprehension experiments have been combined.
These results revealed three patterns. First, in both argument and adjunct questions, patients’ comprehension of wh-in-situ questions is better than that of wh-questions involving overt wh-movement (cf. figure 7). Secondly, argument questions are understood better than adjunct questions (cf. figures 7 and 8). Finally, for both argument and adjunct questions, patients’ comprehension of animate questions is better than that of inanimate questions (cf. figure 8).
Further, the results of the French-speaking Broca patients were compared to those obtained on English-speaking Broca patients. The results on subject and object who-questions for both groups of patients are illustrated in figure 9.130

![Fig. 9: Comprehension of subject and object questions in French and English-speaking Broca patients](image)

This comparison revealed an interesting crosslinguistic difference: French-speaking Broca patients, in contrast to English-speaking Broca patients, have severe difficulties comprehending subject who-questions.

Finally, the fourth experiment investigated patients’ repetition of several types of French wh-questions. It was observed that wh-in-situ questions were repeated better than their counterparts involving overt wh-movement. Thus, in both comprehension and production tasks, French-speaking Broca patients show better performance on wh-in-situ questions than on wh-questions involving overt wh-movement.

5.2. The effect of syntactic movement on patients’ comprehension

In chapter 2, it was shown that there are open questions concerning the effect of several types of movement on patient’s comprehension (cf. section 1.3). These questions are repeated below for convenience.

(46) a. Does wh-movement in wh-questions affect comprehension in Broca’s aphasia?
   b. Does head-movement affect comprehension in Broca’s aphasia?
   c. Does adjunct movement affect comprehension in Broca’s aphasia?
   d. Does covert movement affect comprehension in Broca’s aphasia?

130 For French, the scores on short and long subject questions have been combined. Further, for object questions, figure 9 illustrates only the scores on object questions involving overt wh-movement, since these questions are derived in the same way as English object wh-questions.
The purpose of the experiments discussed in the present chapter was to obtain more insight into the way in which syntactic movement affects comprehension in Broca’s aphasia. Let us therefore see whether the results obtained in these experiments provide an answer to the questions in (46).

Considering the question in (46a) first, the results obtained on French-speaking Broca patients suggest that the answer to this question is affirmative. These patients showed better comprehension of wh-in-situ questions than of their counterparts involving overt wh-movement (experiment 1 and 3). It thus follows that movement of the wh-movement does affect comprehension in Broca’s aphasia. As discussed in section 3.2, this also suggests that the TDH explanation of the findings on English object who-questions (cf. figure 9) has to be revised.

For the moment, it is impossible to answer the question in (46b). The results of experiment 2 showed that patients’ comprehension of wh-questions derived through head movement is impaired. However, it is unclear whether this deficit is related to syntactic movement or to animacy. I will return to this issue in the next chapter.

Patients’ comprehension of wh-questions involving adjunct movement was examined in experiment 3. It was observed that for adjunct questions too, patients’ comprehension of wh-in-situ questions is better than that of their counterparts in which the wh-adjunct has moved overtly. However, it was argued that, due to methodological shortcomings of the relevant experiment, this result does not allow strong conclusions concerning the effect of adjunct movement. The observation of a wh-movement effect in patients’ comprehension of adjunct questions can be taken as a first indication that Broca patients are at least sensitive to adjunct movement. Further research is required to determine whether adjunct movement affects patients’ comprehension in a way similar to argument movement.

Finally, a partial answer to the question in (46d) can be given. As was explained in chapter 2, section 2.2.3, French wh-in-situ questions are derived through feature movement, which is an instance of covert movement. Hence, patients’ better comprehension of wh-in-situ questions shows that one type of covert movement, namely feature movement, has less effect on patients’ comprehension than overt movement does.

5.3. Characterizing the comprehension deficit

As explained in chapter 2, it is generally assumed that the comprehension deficit of Broca patients is related to the position out of which movement has taken place, since patients show better comprehension of constructions involving movement out of the subject position (e.g. subject clefts and relative clauses) than of their object counterparts. Most models accounting for the comprehension deficit are based on this subject/object asymmetry.

In this chapter, I have argued that the findings on wh-questions show the need for a more fine-grained characterization of the comprehension deficit in Broca’s aphasia and the way in which it is related to syntactic movement. This new characterization will also lead to refinements in the accounts of the comprehension deficit of Broca patients. In the next chapter, I will propose a new characterization of
the comprehension deficit in Broca’s aphasia and show that this implies a new account of this deficit. Here, I will briefly repeat why a characterization of the comprehension deficit in terms of a subject/object asymmetry is too coarse.

First of all, both French and English-speaking Broca patients show a difference in their comprehension of wh-questions and that of other constructions involving syntactic movement: subject wh-questions are not better understood than object wh-questions. English-speaking Broca patients understand both subject and object who-questions equally well. This suggests that movement out of the object position does not always yield worse comprehension than movement out of the subject position. French-speaking Broca patients have severe difficulties with the comprehension of subject who-questions, indicating that constructions involving movement out of the subject position are not always better understood than their object counterparts (see experiment 1 and the discussion there).

Secondly, the crosslinguistic difference between the English and the French-speaking Broca patients concerning their comprehension of subject who-questions is unexpected under the standard characterization of the comprehension deficit. Moreover, it is difficult to explain under the existing accounts of the comprehension deficit discussed in chapter 2. If the poor performance on subject who-questions observed on French-speaking Broca patients is related to the wh-word, why does movement of a subject wh-word only affect comprehension in French-speaking Broca patients and not in English-speaking Broca patients?

Thirdly, French-speaking Broca patients show better comprehension of wh-in-situ object questions than of their counterparts involving overt movement of the wh-word (cf. experiment 1). This observation indicates that the comprehension deficit in Broca patients is not related to the position out of which movement has taken place. Indeed, as was argued in chapter 2, both types of French object questions involve movement out of the object position. The difference lies in the type of movement through which they are derived: feature movement or overt wh-movement. The difference in patients’ performance on these two types of object questions thus suggests that the comprehension deficit in Broca’s aphasia is not related to the position out of which movement has taken place, but rather to the type of movement through which sentences are derived.

Finally, the results obtained on French-speaking Broca patients have shown that the comprehension deficit in Broca’s aphasia is not restricted to moved arguments. Head-movement might also affect patients’ comprehension (cf. the discussion of experiment 2, section 3.3). Further, the results of experiment 3 have shown that adjunct movement too affects the comprehension abilities of these patients. Further research on both types of syntactic movement is required, since both experiments contained several factors influencing patients’ comprehension (e.g. animacy, the presence of a preposition). Therefore, the results of both experiments are difficult to interpret and cannot be related to syntactic movement only. Still, these results can be taken as a first indication that not only argument movement, but also other types of movement affect comprehension in Broca’s aphasia. This also suggests that the accounts of the comprehension deficit in Broca’s aphasia have to be refined, since they attribute the deficit to an inability to assign thematic roles to moved arguments.
5.4. Conclusion

Findings on the comprehension of wh-questions by Broca patients suggest that the standard characterization of the comprehension deficit of these patients is too coarse. In the next chapter, I will propose a new and more fine-grained characterization. In particular, it will be shown that the comprehension deficit in Broca’s aphasia is not related to the position out of which movement has taken place, but to the type of movement through which constructions are derived.
4 Syntactic movement and comprehension deficits in Broca's aphasia: a new characterization

1. Introduction

In the previous chapter, it was shown that patients’ comprehension of wh-questions differs from that of other constructions involving syntactic movement. In their comprehension of these latter constructions, Broca patients show a subject/object asymmetry. The pattern is repeated here for convenience.

(1) a. The girl kisses the boy. active
   b. I see the girl who kisses the boy. subject rel. above chance-level
   c. It is the girl who kisses the boy. subject cleft
   d. The boy is kissed by the girl. passive
   e. I see the boy who the girl kisses. object rel. chance-level
   f. It is the boy who the girl kisses. object cleft

This pattern does not extend to wh-questions. I have therefore argued that the data on wh-questions show the need for a new characterization of the comprehension deficit in Broca’s aphasia and the way in which this deficit is related to syntactic movement. Instead of the standard characterization in which the comprehension deficits are related to the position out of which movement has taken place (subject versus object), the data on wh-questions suggest that the comprehension deficits in Broca patients are related to the type of movement through which sentences are derived.

In this chapter, I will propose such a characterization. In doing so, I will make use of theoretical linguistic notions. Grodzinsky (1986b, 1990) showed that theoretical linguistics provides well-defined tools, useful for a proper description of the data obtained on Broca patients. Since then, this way of using theoretical linguistics has greatly increased the understanding of language impairment in aphasia (see Avrutin (2001) for an overview). In this chapter, I will use some of the recent ideas concerning syntactic movement and show that they allow for a new asymmetry characterizing the comprehension deficit in Broca’s aphasia. In particular, I will show that Broca patients have less difficulty comprehending constructions derived through feature movement, than those derived through overt category movement.

This new characterization also implies a new account of the comprehension deficit in Broca’s aphasia. The characterization proposed in this thesis will therefore be compared to two existing accounts of the comprehension deficit: the Trace Deletion Hypothesis and the Slowed down Syntax Hypothesis. It will be shown that the proposal made in this thesis captures more data than these two accounts.

The chapter is organized as follows. In each section, I compare patients’ comprehension of two types of constructions and show that the difference observed
in patients’ performance on these constructions is consonant with the claim that feature movement has less effect on patients’ comprehension abilities than overt movement does. Section 2 discusses the data on wh-questions. First, I will show that the observed difference between patients’ comprehension of in-situ object questions and that of object questions involving overt wh-movement suggests that French-speaking Broca patients have less difficulty with the comprehension of constructions involving feature movement than with those involving overt wh-movement. In the remainder of the section, this claim will be generalized and shown to capture other findings on wh-questions as well. In section 3, patients’ comprehension of subject clefts and relative clauses is compared to that of object clefts and relative clauses. Here, the line of reasoning is reversed. Instead of showing that the data are consistent with the newly proposed characterization, I examine the linguistic consequences of this characterization. If the new characterization of the comprehension deficit is on the right track, patients’ comprehension of clefts and relative clauses makes several predictions concerning the syntactic analyses of these constructions. I will argue that these predictions are correct and raise interesting new questions for the field of theoretical linguistics. In line with other studies (e.g. Grodzinsky et al. 1991; Ruigendijk, Vasić & Avrutin subm.), this section shows that the data obtained on Broca patients can be used in constraining the range of possible linguistic analyses and theories. In section 4, I compare patients’ comprehension of wh-questions with that of clefts and relative clauses and show that the resulting differences support the newly proposed characterization. Section 5 discusses this characterization in relation to the Trace Deletion Hypothesis and the Slowed down Syntax Hypothesis. Finally, section 6 summarizes all the findings and offers a conclusion.

The goal of this chapter is to show that there is a mutual relation between theoretical linguistics and neurolinguistics. Theoretical linguistic notions such as features and feature movement can be used in describing the data of Broca patients. It will be shown that these fine-grained notions provide a generalization of the data of Broca patients that at first sight seem rather unsystematic. At the same time, these data favor specific answers to open questions in the field of theoretical linguistics or constitute an argument in favor of one out of two competing analyses for a certain construction. Thus, theoretical linguistic notions can be used as a tool for neurolinguistic research, and the data obtained in neurolinguistic research can be used as an argument in theoretical linguistic research. In the present and the following chapter, I will show that such a mutual interaction between theoretical linguistics and neurolinguistics provides more insight and interesting new research questions in both disciplines.

2. Comprehension of wh-questions

2.1. Wh-in-situ versus wh-movement questions

The results of the experiments discussed in the previous chapter showed that for both argument and adjunct questions, French-speaking Broca patients comprehend
the wh-in-situ variant ((2a) and (3a)) better than the one involving overt wh-movement ((2b) and (3b)).

<table>
<thead>
<tr>
<th>Argument questions</th>
<th>Adjunct questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) a. La fille frappe qui? the girl hits who</td>
<td></td>
</tr>
<tr>
<td>‘Who does the girl hit?’</td>
<td></td>
</tr>
<tr>
<td>b. Qui est-ce que la fille frappe? who Q the girl hits</td>
<td></td>
</tr>
<tr>
<td>‘Who does the girl hit?’</td>
<td></td>
</tr>
<tr>
<td>(3) a. La fille dort sur qui? the girl sleeps on who</td>
<td></td>
</tr>
<tr>
<td>‘On who does the girl sleep?’</td>
<td></td>
</tr>
<tr>
<td>b. Sur qui est-ce que la fille dort? on who Q the girl sleep</td>
<td></td>
</tr>
<tr>
<td>‘On who does the girl sleep?’</td>
<td></td>
</tr>
</tbody>
</table>

In chapter 2, I argued that the syntactic difference between the two types of questions illustrated in (2a) and (2b) lies in the type of movement through which they are derived. In questions of the type in (2a) only the wh-features of the wh-word have been moved to C, while in (2b) the entire wh-word has been moved to Spec,CP. The syntactic analyses of these two questions are repeated below.

(4) a. [\[ CP C^0 \[ IP la fille frappe qui? \]]]

b. [\[ CP Qui est-ce que la fille frappe? \[ IP la fille frappe qui? \]]]

The same analysis can be applied to adjunct questions, illustrated in (3). Recall that I followed Pesetsky (2000) in using the intervention effect as a diagnostic for feature movement (cf. section 2.2.3, chapter 2). Crucially, wh-in-situ adjunct questions (3a) are similar to wh-in-situ argument questions (2a) in that both are sensitive to the intervention effect.

(5) a. * La fille ne frappe pas qui? the girl ne hits NEG who ‘Who doesn’t the girl hit?’

b. * La fille ne dort pas sur qui? the girl ne sleeps not on who ‘On who doesn’t the girl sleep?’

As is illustrated in (5), the intervention of negation creates an ungrammatical sentence for both wh-in-situ argument and adjunct questions. Based on the assumption that the intervention effect indicates the presence of feature movement, it follows that in wh-in-situ adjunct questions feature movement has taken place. Thus, in adjunct questions of the type in (3a) only the features of the wh-item move. By contrast, in adjunct questions of the type in (3b) the entire wh-adjunct moves.

Recall that what-questions formed an exception to this general finding (cf. experiment 2, discussed in section 3.3 of chapter 3). I will return to the findings on what-questions in section 2.3.3.
The observation that French-speaking Broca patients understand wh-in-situ questions better than the variants involving overt wh-movement suggests that the comprehension deficit in Broca’s aphasia is related to the type of syntactic movement by which these constructions are derived. Indeed, the only difference between the wh-in-situ questions in (2a, 3a) and those in (2b, 3b) concerns the type of movement underlying these questions. In wh-in-situ questions only the wh-features of the wh-word move. By contrast, in questions of the type in (2b, 3b) the entire wh-element moves. Apparently, feature movement has less effect on the comprehension abilities of Broca patients than does movement of the entire wh-word. I will take this suggestion as a first attempt towards a new characterization of the comprehension deficit in Broca’s aphasia.

(7) **Comprehension difficulties in Broca’s aphasia** (first version)

*Broca patients have less difficulty with the comprehension of sentences involving feature movement than with those involving movement of an entire category.*

In the remainder of this section, I will examine whether the other findings on patients’ comprehension of wh-questions are in line with this characterization. I will argue that the findings on wh-questions, unsystematic as they seem, can indeed be described by (7). I will first focus on the intriguing difference between French and English-speaking Broca patients with respect to their comprehension of subject questions.

2.2. **Subject questions: French versus English-speaking Broca patients**

One of the remarkable results of experiment 1 was the poor performance on subject questions by French-speaking Broca patients. These patients showed considerably more difficulties with the comprehension of subject questions than the English-speaking Broca patients did. The relevant data are repeated here for convenience.
Table 1

<table>
<thead>
<tr>
<th>Patients</th>
<th>Example of the examined construction</th>
<th>group score (% correct)</th>
</tr>
</thead>
<tbody>
<tr>
<td>French</td>
<td>Qui (est-ce qui) frappe la fille?</td>
<td>53.2% 132</td>
</tr>
<tr>
<td></td>
<td>who (Q) hits the girl?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>‘Who hits the girl?’</td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>Who hits the girl?</td>
<td>80%</td>
</tr>
</tbody>
</table>

The crosslinguistic difference illustrated in table 1 is unexpected in light of these patients’ comprehension of other movement derived constructions. As was shown before, all of these patients showed the typical Broca comprehension pattern (i.e the pattern exemplified in (1)). 133 The question thus arises why French-speaking Broca patients have so much difficulties with the comprehension of subject wh-questions, but not with that of other constructions involving movement out of the subject position, such as subject clefts. The difference between patients’ comprehension of subject wh-questions and subject clefts will be discussed later in this chapter (see section 3.2). Here, I focus on the difference between the French and English data.

Why do French-speaking Broca patients have more difficulties with the comprehension of subject wh-questions than English-speaking Broca patients do? Below, I will first discuss an explanation based on the assumption that Broca patients are unable to understand sentences in which the order of the arguments deviates from the canonical order. I will argue that this explanation is problematic. I will then show that the difficulties with subject questions, and especially the difference between French- and English-speaking Broca patients, can be understood in light of the characterization given in (7).

2.2.1. Canonicity

A possible way to explain the data in table 1 is to relate the observed difference to the underlying word order in both languages. It has been argued that the comprehension deficit in Broca’s aphasia is related to the order of the arguments. Thus, apart from the analyses discussed in chapter 2 it has also been argued that patients’ comprehension deficit does not result from syntactic movement per se, but rather from the noncanonical position of the arguments. On this view, patients’ impaired comprehension of passive sentences, object clefts and object relatives follows from the fact that in these constructions the order of the arguments deviates from the canonical order (cf. Hagiwara & Caplan 1990; Piñango 2000a,b; Bastiaanse et al. 2003). 134 Suppose now that French and English have different

132 The scores obtained on short and long subject questions (respectively (ia) and (ib)) have been combined, since there is no difference in patients’ comprehension of these two types of subject questions (cf. section 3.2 of the previous chapter).

(1) a. Qui frappe la fille? b. Qui est-ce qui frappe la fille?
who hits the girl who (Q) hits the girl
‘Who hits the girl?’ ‘Who hits the girl?’

133 See table 2, chapter 3 for the results of the French-speaking Broca patients and table 2, chapter 2 for those of the English-speaking Broca patients.

134 See however Grodzinsky (2000b) for some general problems encountered by these types of accounts.
underlying word orders and that French, in contrast to English, is not an SVO language. Suppose that French is a language in which the subject follows the object, i.e. an VOS or a OVS language. If this were true, the difficulties of French-speaking Broca patients with the comprehension of subject questions might be related to the order of the arguments in these questions. If French is indeed a VOS or OVS language, French subject questions are noncanonical sentences, since here the subject precedes rather than follows the object.

The literature on French contains one analysis claiming that French subjects are generated in a position following the object. This analysis has been proposed by Friedemann (1994). He argues that in French, the subject is generated at the right of V', yielding the underlying VOS structure illustrated in (8a) below. However, the order surfacing most frequently in French is the SVO order. Friedemann argues that this is due to Case requirements. The subject has to move to a higher position in the structure in order to obtain nominative Case. As is illustrated in (8b), this movement yields the surface SVO order.

\[
\begin{align*}
\text{(8) a. } & \begin{array}{c}
\text{VP} \\
\text{V'} & \text{S} \\
\text{V} & \text{O}
\end{array} \\
\text{(8) b. } & \begin{array}{c}
\text{IP} \\
\text{S} & \text{I'} \\
\text{V'} & \text{t}\text{s} \\
\text{V} & \text{O}
\end{array}
\end{align*}
\]

Friedemann further argues that the only construction in which the basic order in (8a) surfaces in adult French is the so-called stylistic inversion construction. Some examples of this construction are given below.

\[
\begin{align*}
\text{(9) a. } & \quad \text{Où a mangé Jean ?} \\
& \quad \text{where has eaten Jean} \\
& \quad \text{‘Where did John eat?’} \\
\text{b. } & \quad \text{L’homme à qui a téléphoné ton ami.} \\
& \quad \text{the man to whom has telephoned your friend} \\
& \quad \text{‘The man to whom your friend has telephoned.’} \\
\text{c. } & \quad \text{Je souhaiterais que téléphone ton ami.} \\
& \quad \text{I wish-SUBJ that telephones your friend} \\
& \quad \text{‘I would wish that your friend calls.’}
\end{align*}
\]

As is shown in the examples in (9), in stylistic inversion the subject occupies a postverbal position. The characteristics and precise syntactic structure of this construction is not important here (see for instance Kayne & Pollock 1978, 2000 for an extensive discussion). The only point relevant here is that the subject is located at
a position following the object and the verb. According to Friedemann (1994) these examples reflect the underlying basic order of French (i.e. the order in (8a)).\footnote{He claims that in these constructions the subject obtains its nominative Case through a specific mechanism. See Ferdinand (1996) for some problems with this mechanism.}

Friedemann’s analysis is based on language acquisition data. French children produce a considerable amount of utterances in which the subject occupies a postverbal position. Some examples (from Ferdinand (1996)) are given below.

\begin{enumerate}
\item \begin{tabular}{l}
\textit{pleure pas garçon} \\
cries not boy
\end{tabular} \quad ‘The boy is not crying.’
\item \begin{tabular}{l}
\textit{est à poupée le couteau} \\
is of the doll the knife
\end{tabular} \quad ‘The knife belongs to the doll.’
\end{enumerate}

Friedemann argues that by producing these sentences, French children use the basic word order of French. When children have acquired the case requirements triggering movement of the subject, the production of sentences of the type in (10) decreases and that of SVO sentences increases.

Adopting Friedemann’s analysis, the comprehension difficulties of French-speaking Broca patients with subject questions could result from the noncanonical order of the arguments. French subject questions display an SVO order. Thus, instead of the canonical order in which the subject follows the object (8a), the subject now precedes the object. If the comprehension deficit of Broca patients is related to the noncanonicity of the arguments, the comprehension difficulties of French-speaking Broca patients with subject questions follow naturally. By contrast, in English subject questions the canonical SVO order is preserved. As a consequence, English-speaking Broca patients are correctly predicted to have no difficulties comprehending subject questions.

This explanation is problematic for several reasons. First of all, although Friedemann’s analysis is based on language acquisition data, it cannot account for many aspects of these data. I will here mention only one example.\footnote{See Ferdinand (1996) for more problems with Friedemann’s account.} Friedemann assumes that children’s utterances containing postverbal subjects (i.e. the examples in (10)) are identical to the stylistic inversion construction illustrated in (9).

\begin{enumerate}
\item \begin{tabular}{l}
\textit{A qui donne le cadeau Marie?} \\
to who gives the present Marie
\end{tabular} \quad ‘To whom does Marie give the present?’
\item \begin{tabular}{l}
\textit{A qui le donne Marie?} \\
to who it gives Marie
\end{tabular} \quad ‘To whom does Marie give it?’
\end{enumerate}
As is illustrated in (11a), the object is not allowed to intervene between the verb and the postverbal subject. If the object is located in a position before the verb, as in (11b), the sentence is grammatical. Crucially, French children often produce sentences in which the object does occupy a position between the verb and the subject. The examples in (12) come from Ferdinand (1996).

(12) a. Fait pas du bruit la fille.
   makes NEG of-the noise the DIM-girl
   ‘The little girl makes no noise.’

b. Baisse la tête le hérisson
   lowers the head the hedgehog
   ‘The hedgehog lowers its head.’

c. Sort du garage la voiture.
   leaves of the garage the car
   ‘The car leaves the garage.’

Examples such as (12) contrast with the ungrammaticality of (11a), suggesting that the utterances produced by French children are not similar to stylistic inversion.

Secondly, it can easily be shown that any analysis assuming a basic order for French in which the object precedes the subject makes incorrect predictions with respect to patients’ comprehension. Following such an analysis, it is expected that French-speaking Broca patients will show better comprehension of all sentences in which the object precedes the subject than with those displaying the reversed order of the arguments. Consider now the order of the arguments in clefts.

(13) a. C’est la fille qui embrasse le garçon
   It is the girl that kisses the boy
   ‘It is the girl who kisses the boy.’

b. C’est le garçon que la fille embrasse.
   It is the boy that the girl kisses
   ‘It is the boy who the girl kisses.’

The examples above show that object clefts (13b) display the presumed canonical order in which the object precedes the subject. By contrast, subject clefts (13a) display the noncanonical order of the arguments. If patients’ comprehension deficits are related to the order of the arguments, it is predicted that French-speaking Broca patients will show better comprehension of object than of subject clefts. This prediction is not borne out. Instead, the reverse pattern has been observed: patients’ comprehension of subject clefts is better than that of object clefts.

A final argument against an explanation assuming different underlying word orders for French and English, is that English also allows postverbal subjects. Consider the examples in (14).

(14) a. Under the tree sits a woman.

b. Down the street walked a black dog.
The construction exemplified above is called stylistic or locative inversion (cf. Emonds 1976; Coopmans 1989; Culicover & Levine 2001). There are several differences between the English construction in (14) and the French stylistic inversion in (9). For instance, in English such a construction is only possible with a locative PP. These differences are, however, not important here. What is crucial is that the examples in (9) and (14) show that both English and French allow postverbal subjects in certain contexts. If the constructions in (9) reflect the underlying order of French, a similar argument could be made for English. Under such a view, English would also be a language in which the subject is generated postverbally. Consequently, English-speaking Broca patients are incorrectly predicted to have difficulties comprehending subject questions.

To conclude, an analysis in terms of the (non)canonical order of the arguments cannot explain why French-speaking Broca patients have more difficulties comprehending subject questions than English-speaking Broca patients do. In the next section, I will adopt a different approach. I will show that the data in table 1 are consistent with the characterization of the comprehension deficit in (7).

2.2.2. An alternative approach: feature movement versus category movement

In section 2.1, I have argued that the findings on object questions obtained on French-speaking Broca patients suggest that patients’ comprehension deficits with certain constructions are related to the type of syntactic movement involved in these constructions. Feature movement has less effect on patients’ comprehension abilities than category movement does. I argued that this would be an interesting new characterization of the comprehension deficit. In this section, I will show that this characterization does not only capture the findings on French object questions, but that it can also account for the difference between French and English-speaking Broca patients illustrated in table 1. If the comprehension deficit in Broca’s aphasia is indeed related to the type of movement, these data suggest that French and English subject questions are derived differently. More specifically, it follows that in French subject questions the entire wh-word has been moved, while in English subject questions only the features of the wh-word have. Below, I will put forward several arguments in favor of such an analysis. I will start with English subject questions and argue that in these questions only the features of the wh-word have been moved. In section 2.2.2.2., I will show that French subject questions have several characteristics that can only be explained by an analysis assuming full wh-movement to Spec,CP.

2.2.2.1. English subject questions

In the literature on English subject questions, two competing analyses can be found. Traditionally, it is assumed that the subject wh-word, just as all English wh-words, moves to Spec,CP (e.g. Chomsky 1977, Rizzi 1996). By contrast, according to the Vacuous Movement Hypothesis (Chomsky 1986, George 1980) the wh-subject in English remains in Spec,IP. The two analyses are illustrated below.

137 See also Gazdar (1981) for a similar analysis.
(15) a. [CP who C [IP who left?]]

b. [CP C [IP who left?]]

The analysis in (15a) is based on a theoretical requirement, namely feature checking. As explained in chapter 1, it is assumed that C in wh-questions carries a wh-feature specifying the sentence as a wh-question. This feature needs to be checked. In essence, this means that another element that also carries a wh-feature is needed within the CP-domain (cf. chapter 1, section 2.4). In English, the wh-word therefore moves into the specifier of CP.

However, there is some empirical evidence suggesting that in English subject wh-words do not move to Spec,CP, but remains in Spec,IP (i.e. the structure in (15b)). One piece of evidence comes from subject/object asymmetries in English wh-questions. Consider the examples in (16).


These examples show a contrast between subject and object wh-questions: object questions require do-insertion, but this is not allowed in subject questions. Crucially, such a difference is not expected under the analysis of subject questions in (15a). Under this analysis, English subject and object questions are derived similarly in that they both involve movement of the wh-word to Spec,CP. Hence, any subject/object asymmetries in English wh-questions are difficult to explain. However, if the subject wh-word has not been moved to Spec,CP as claimed by the Vacuous Movement Hypothesis (VMH), asymmetries of the type illustrated in (16) are expected and might also be explained. To see this, let me briefly explain some of the assumptions behind do-insertion.

Consider first the examples in (17). The subject-auxiliary inversion in (17b) is commonly taken as evidence that the auxiliary has been moved from the I into the C position. This structure is given in (17c).

(17) a. John has seen the mayor.

b. Has John seen the mayor?

c. [CP Has [IP John has [VP seen the mayor?]]]

The examples in (18) contrast with those in (17) in that the sentence does not contain an auxiliary. As shown by the ungrammaticality of (28b), the verb saw is not allowed to move to the C position.

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128 Note that the evidence presented here is not the evidence used in the literature to argue for the VMH. The arguments usually put forward to sustain the VMH are based on coordinated structures and parasitic gaps (c.f. George 1980 and Chomsky 1986). See Agbayani (1998) and Ishii (2004) for a review of these and other arguments in favor of the VMH.
In these sentences, a dummy auxiliary *do* is inserted in I. This dummy auxiliary moves to C, yielding the sentence in (19).

(19)  [CP Did [TP John tdo [VP see the mayor?]]]

The examples in (17) through (19) show that *do*-insertion occurs in constructions involving I-C movement, but lacking lexical material in I. Returning now to the examples in (16), the presence of *do*-insertion in object questions show that here too, I-C movement has taken place. Apparently, this construction required movement of an auxiliary to C. Since the question itself contained no auxiliary, a dummy auxiliary is inserted and moved to C. Following this reasoning, the absence of do-insertion in subject questions suggests that here no I-C movement has taken place. Suppose now that do-insertion is related to the movement of the wh-word to Spec,CP. For some reason, the movement of the wh-word triggers I-C movement. If this is true, the absence of do-insertion in subject questions follows naturally under the VMH. If the wh-subject does not move to Spec,CP (i.e. the structure in (15b)), there is no need for I-C movement and hence no need for do-insertion.

This is a puzzling situation. On the one hand, theoretical requirements force English subject wh-words to move to Spec, CP, yielding the structure in (15a). On the other hand, there is empirical evidence suggesting that English subject wh-words do not move to Spec,CP, but remain in Spec,IP (the structure in (15b)). Agbayani (1998, 1999) has proposed an analysis of English subject questions by which this puzzle can be solved. Following Chomsky (1995), he assumes that syntactic movement consists of two steps: feature movement and category movement. Feature movement always occurs, since it is triggered by the need for feature checking. Category movement is a repair strategy: the phonological system cannot pronounce an item whose features have been moved away. Therefore, the category and its features have to be recombined. As noted in chapter 1, however, Chomsky does not specify the conditions under which this recombination takes place (see section 2.4). Agbayani proposes that the need for category movement is determined by adjacency. He argues that a category can be recombined with its moved features if and only if the category and its moved features are adjacent. His definition of adjacency is given below.

(20) X and Y are adjacent if no elements that are visible at the interface intervene between X and Y.

Intervention is determined structurally: an element Z intervenes between X and Y if X dominates Z and Z dominates Y. To give an example, in the structure in (21), Z counts as an intervening element between X and Y, because X dominates Z and Z

---

139 See chapter 1, section 2.4 for a more detailed explanation of this view on syntactic movement.
140 See also Bobaljik (1996) for the role of adjacency in linguistic phenomena.
dominates Y. The element X dominates Z, because it is positioned higher in the syntactic tree. For the same reason, Z dominates Y.

(21)

Let us now turn to the derivation of English subject wh-questions. The structure in (22) illustrates an English subject wh-question after feature movement has taken place. The wh-features of the wh-word who have moved to C in order to check the wh-features of C. Agabayani assumes that this feature movement is adjunction to C. This yields the structure given in (22).

(22)

The question now arising is whether who in (22) has to move to Spec,CP. In other words, is there any need for category movement or can who and its moved features be recombined in (22)? Agabayani (1998) argues that they can, since who and its moved wh-features are still adjacent. In the structure in (22), there is no element intervening between the wh-word and its moved features. There is no element dominating the wh-word while at the same time being dominated by the moved wh-features. C is not an intervening element, since although it does dominate who, it is not dominated by the wh-features of who. Instead, C and the wh-features of who occupy a position at the same level of the syntactic tree. Hence, in (22) the wh-word can be recombined with its features without moving towards it. Following Chomsky (1995), Agabayani assumes that if there is no reason for the category to move, then, by economy, it does not move.

141 To be more precise, it is assumed that not only the wh-features but all the formal features of the wh-word move to C. The only features remaining behind are the phonological features of the wh-word, indicating how the wh-word should be pronounced. Since the other formal features are not relevant here, I will continue to speak only of wh-features. In section 3.2.1, I will return in more detail to the issue of formal features.
To summarize, Agbayani has proposed an analysis of English subject questions in which only the features of the wh-word move. This analysis obeys the theoretical requirement of feature checking in C, while at the same time accounting for the absence of *do* in English subject questions. I will therefore adopt his analysis and conclude that English subject questions involve only feature movement.

2.2.2.2. French subject questions

In the previous section, I have argued that in English subject questions only the wh-features of the wh-word move. In this section, I will argue that French subject questions differ from their English counterparts in that here the entire wh-word moves. This claim is based on two arguments. First of all, recall that the question morpheme *est-ce qui* is optional in French subject questions. This gives the following two possible subject questions.

(23) a. Qui embrasse le garçon?
   who kisses the boy
   ‘Who kisses the boy?’

   b. Qui est-ce qui embrasse le garçon?
   who Q kisses the boy
   ‘Who kisses the boy?’

In questions of the type in (23b), the wh-word has *visibly* moved to the specifier of CP. Question morphemes are base generated in C. Hence, *est-ce qui* occupies the C position. *Qui* in (23b) is located in a position before the question morpheme. The only available position above C is the Spec,CP position.

The second argument for full wh-movement in French subject questions has been put forward by Cheng and Rooryck (2003). Based on the distribution of the morpheme *-ça* (‘that’), they argue that in questions of the type in (23) the subject wh-word has been moved to Spec,CP. The argument runs as follows. In object questions, *-ça* can optionally be added to the wh-word, yielding a D-linked interpretation.

(24) a. Jean a vu qui?
   Jean has seen who
   ‘Who did John see?’

   b. Jean a vu qui-ça?
   Jean has seen who-that
   ‘Who precisely did John see?’

In questions of the type in (23b), the wh-word has visibly moved to the specifier of CP. However, as is illustrated in (25), *-ça* is not allowed as a suffix on moved wh-words.

(25) *Qui-ça est-ce que Jean a vu t*qui?  
   Who that Q Jean has seen
   ‘Who precisely did Jean see?’

The contrast between (24b) and (25) shows that the distribution of *-ça* correlates with syntactic movement: *-ça* can only occur on wh-words that have not been
moved. Consider now subject questions. Crucially, both types of subject questions in (23) form an illegitimate context for –ça suffixation.

(26)  a. *Qui-ça embrasse le garçon?
    ‘Who precisely kisses the boy?’

   b. *Qui-ça est-ce qui embrasse le garçon?
    ‘Who precisely kisses the boy?’

The ungrammaticality of (26) parallels that of (25). Since –ça can only occur on in-situ wh-words, the ungrammaticality of (26) indicates that the subject wh-word has been moved to Spec,CP.

Thus, in both types of subject questions in (23), the subject wh-word has been moved to Spec,CP. I therefore propose the following analysis for the French subject wh-questions.

(27)  CP
    qui C'
    C' (est-ce qui)
    IP
    qui VP
    embrasse le garçon

As is illustrated in (27), C in French subject questions can be optionally filled with the question morpheme est-ce qui. If this question morpheme is not present, the sentence in (23a) results. If it is present, (23b) results. Crucially, the presence or absence of est-ce qui is the only difference between the two types of subject questions in (23). As can be seen in (27), both types of questions involve movement of the subject wh-word to Spec,CP.

Note that this analysis of French subject questions raises a problem for the ideas on syntactic movement developed by Agbayani (1998). Recall that Agbayani assumed that the need for category movement is determined by adjacency. If the category and its moved features are still adjacent after feature movement, no further movement takes place. However, if feature movement results in a structure in which the category and its moved features are no longer adjacent, the category moves to a position where it can be recombined with its features. Following this line of reasoning, it is predicted that in French subject questions, just as in English subject questions, only the features of the wh-word move. To see this, consider the structures in (28).
The configuration in (28a) illustrates the structure of French subject questions before any movement has taken place. In this structure, the wh-features of C have to be checked. Therefore, the wh-features of qui move to C, yielding (28b). Under Agbayani’s analysis, the derivation is now finished. Indeed, (28b) is similar to the structure of English subject questions in (22) in that the wh-features of qui and qui itself are still adjacent. Hence, there is no need for qui to move. However, I have given two arguments showing that in French subject questions the wh-word does move to Spec,CP. Agbayani’s analysis cannot account for the evidence presented in (24) through (27). Moreover, his analysis excludes the existence of questions of the type in (23b). Based on (28), Agbayani’s analysis predicts that movement of the wh-word never takes place. Thus, subject questions containing the question morpheme est-ce qui are incorrectly predicted to have the word order given in (29).

(29) * Est-ce qui qui embrasse le garçon?

Q who kisses the boy
intended: ‘Who kisses the boy?’

French subject wh-questions thus show that adjacency is not the proper condition determining the need for category movement. In these questions, the subject wh-word moves to Spec,CP, even though adjacency does not force it to do so. This is the third construction encountered in this thesis indicating that the concepts of feature movement and category movement, as well as the way in which these movements are related have to be worked out in more detail.142 This is an issue for further research in the field of theoretical linguistics.

142 Other examples are partial movement in German (see chapter 1, section 2.4) and French object wh-in-situ questions (chapter 2, section 2.2.3). In all these conditions, only feature movement has taken place. However, the moved features and its category are not adjacent, as can be seen in (i) for German partial movement.

(i) Was glaubt Hans [mit wem] Jakob jetzt spricht?
what believes Hans with whom Jakob now talks

‘With whom does Hans think that Jakob is now talking?’

Thus, adjacency is neither a necessary nor a sufficient condition for category movement. The example in (i) shows that it is not a necessary condition: the wh-item mit wem (‘with whom’) is not adjacent to its moved features, but still allowed to remain in-situ. French subject questions show that adjacency is not a
To conclude, I have presented empirical evidence showing that French and English subject questions are derived differently. In English subject questions only the *wh*-features of the wh-word move. By contrast, in French subject questions the entire *wh*-word moves. The next section discusses how this difference can be related to the data obtained on French and English-speaking Broca patients.

### 2.2.3. Summary: subject questions in Broca’s aphasia

The starting point for the discussion concerning the analyses of English and French subject wh-questions was the observation of a crosslinguistic difference in the comprehension of these questions by French and English-speaking Broca patients. French-speaking Broca patients have considerably more difficulties comprehending subject wh-questions than English-speaking Broca patients do. In section 2.1, I have argued that the comprehension deficit in Broca patients is related to the type of movement through which constructions are derived. I have argued that feature movement has less effect on the comprehension abilities of Broca patients than category movement does. This new characterization was given in (7) and is repeated in (30) below.

(30) **Comprehension difficulties in Broca’s aphasia**

*Broca patients have less difficulty with the comprehension of sentences involving feature movement than with those involving movement of an entire category.*

If the comprehension difficulties of Broca patients are related to syntactic movement in the way expressed in (30), the observed difference in patients’ comprehension of subject questions can now be explained. The characterization in (30) states that all constructions derived through category movement are more difficult to understand for Broca patients than those derived through feature movement. In section 2.2.2.1, I argued that English subject wh-questions involve feature movement. By contrast, French subject wh-questions involve category movement. Hence, for Broca patients French subject wh-questions are more difficult to understand than English subject wh-questions. The findings on subject questions thus suggest that the characterization of the comprehension deficit proposed in (30) is on the right track. In the following section, I will examine whether the other findings concerning the comprehension of wh-questions in Broca’s aphasia are also consistent with this characterization.

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143 Notice that I adopt Agbayani’s analysis for English subject wh-questions, despite the incorrect predictions this analysis makes for French subject wh-questions. The reason why I do not reject his analysis is that I am unaware of other analyses of English subject wh-questions in which the theoretical requirement of feature checking is combined with the empirical evidence showing that English subject wh-words remain in-situ (i.e. the evidence presented in section 2.2.2.1). Agbayani’s claims concerning the role of adjacency are too strong, but a discussion on the proper condition determining category movement falls outside the scope of this thesis. Whenever this condition is found, it will also be possible to account for the evidence showing that English subject wh-words remain in-situ, while French subject wh-words move to Spec,CP.
2.3. Comprehension of wh-questions: remaining observations

In section 2.1, I discussed the observation that French-speaking Broca patients show better comprehension of wh-in-situ object questions than of those involving overt wh-movement. Section 2.2 dealt with the difference between French and English speaking Broca patients concerning their comprehension of subject questions. I have argued that both of these observations are captured by the proposed characterization in (30).

However, these were not the only observations on wh-questions requiring an explanation. In this section, I will discuss the other results obtained in the experiments on patients’ comprehension of wh-questions. The first concerns patients’ comprehension of subject and object wh-questions. As mentioned before, for both English and French-speaking Broca patients the comprehension of these constructions differs from that observed in other constructions involving syntactic movement. However, there are also important crosslinguistic differences between the English- and French data. I will therefore discuss the data obtained on English- and French-speaking Broca patients separately in sections 2.3.1 and 2.3.2, respectively. Secondly, I will discuss the difference observed between qui and quoi-questions for French-speaking Broca patients. I will examine whether these observations are in line with the characterization of the comprehension deficit as proposed in (30).

2.3.1. Subject and object questions in English-speaking Broca patients

As discussed in chapter 2, the comprehension of wh-questions by English-speaking Broca patients differs from that obtained on other constructions involving syntactic movement. In their comprehension of active sentences, passive sentences, clefts, and relative clauses, these patients show the typical comprehension pattern of Broca patients: better comprehension of constructions involving movement out of the subject position than of their object counterparts (i.e. the pattern illustrated in (1)). However, this pattern does not extend to wh-questions. The relevant data are repeated in table 2 below. In this table, only the scores of the group of Broca patients are given (see table 1, chapter 2 for the individual results).

<table>
<thead>
<tr>
<th>Question type</th>
<th>Example</th>
<th>group score (% correct)</th>
</tr>
</thead>
<tbody>
<tr>
<td>subject</td>
<td>Who kisses the boy?</td>
<td>80%</td>
</tr>
<tr>
<td>object</td>
<td>Who does the boy kiss?</td>
<td>79.1%</td>
</tr>
</tbody>
</table>

As can be seen in table 2, English-speaking Broca patients show no difference between their comprehension of subject and object wh-questions. Both are understood equally well. The difference between patients’ comprehension of wh-questions and that of other movement-derived construction will be discussed in detail in section 4 of this chapter. Here, I focus on the question how the high score on object wh-questions in table 2 can be explained.
As discussed before, this finding cannot be captured under the standard characterization of the comprehension deficit in Broca’s aphasia. According to this characterization, the comprehension deficit in Broca’s aphasia is related to the position out of which an element has been moved. Movement out of the object position yields impaired comprehension, while movement out of the subject position does not. Clearly, the data in table 2 do not show such a subject/object asymmetry. Unfortunately however, the new characterization proposed in this thesis (cf. (30)) also falls short in describing these data. The reason for this is that English object questions involve category movement. The derivation of English object questions was briefly discussed in chapter 1, and is illustrated below.

In (31a) the wh-features of the wh-word *who* have been moved into C in order to check the wh-features of C. The wh-features of *who* are now separated from their originating lexical item. Therefore, *who* moves to Spec,CP in order to be recombined with its features. This is illustrated in (31b).

As discussed in section 2.2.1, English subject wh-questions are derived through feature movement (cf. the structure in (22)). English object wh-questions, by contrast, involve feature movement (31a) followed by category movement (31b). Based on (30), it is thus expected that English-speaking Broca patients will have more difficulties with the comprehension of object questions than with that of subject questions. Indeed, English object questions involve a type of movement that is supposed to yield more comprehension difficulties than the type involved in English subject questions. The data in table 2 show that this prediction is not borne out. Before concluding, however, that the characterization in (30) is incorrect, I will first examine the other findings on wh-questions.

2.3.2. Subject and object questions in French-speaking Broca patients

As discussed in chapter 3, in their comprehension of wh-questions, French-speaking Broca patients show a pattern that is the reverse of the pattern observed in other constructions involving syntactic movement. These patients understand object wh-questions better than subject wh-questions. The difference between patients’ performance on wh-questions and that on other movement-derived constructions will be discussed in section 4. In this section, the focus is on patients’
A NEW CHARACTERIZATION

comprehension of wh-questions. In table 3, the group scores on these constructions are repeated (see table 5, chapter 3 for the individual results).

Table 3
Comprehension of wh-questions by French-speaking Broca patients

<table>
<thead>
<tr>
<th>Question type</th>
<th>Example</th>
<th>group score (% correct)</th>
</tr>
</thead>
<tbody>
<tr>
<td>subject</td>
<td>Qui (est-ce qui) embrasse la fille ?</td>
<td>53.2%</td>
</tr>
<tr>
<td></td>
<td>‘Who kisses the girl ?’</td>
<td></td>
</tr>
<tr>
<td>object (wh-in-situ)</td>
<td>La fille embrasse qui?</td>
<td>84.6%</td>
</tr>
<tr>
<td></td>
<td>the girl kisses who</td>
<td></td>
</tr>
<tr>
<td></td>
<td>‘Who does the girl kiss?’</td>
<td></td>
</tr>
<tr>
<td>object (wh-movement)</td>
<td>Qui est-ce que la fille embrasse?</td>
<td>72.2%</td>
</tr>
<tr>
<td></td>
<td>‘Who does the girl kiss?’</td>
<td></td>
</tr>
</tbody>
</table>

The data summarized in table 3 cannot be captured by the standard characterization of the comprehension deficit. Contrary to this characterization, patients’ comprehension of subject questions is worse than that of object questions. Let us therefore examine whether the new characterization given in (30) can describe these data.

The syntactic analyses of the questions illustrated in table 3 have been discussed, before. In section 2.2.2.2, I argued that French subject questions involve movement of the entire wh-word to Spec,CP. Further, I argued in chapter 2 that French in-situ object questions are derived through feature movement (cf. section 2.2.3). Finally, in the second type of French object questions, the entire wh-word moves to Spec,CP (cf. section 2.3, chapter 2). The resulting structures as well as the types of movement involved are indicated below.

(32) a. \[
\text{CP} \quad \begin{array}{c}
\text{Qui} \\
\text{est-ce qui}
\end{array} \quad \begin{array}{c}
\text{IP} \\
\text{tqui embrasse la fille?}
\end{array}
\] \hspace{1cm} \text{category movement}

b. \[
\text{CP} \quad C \quad \begin{array}{c}
\text{IP} \\
\text{la fille embrasse qui?}
\end{array} \\
\begin{array}{c}
\text{wh} \\
\text{thr}
\end{array}
\] \hspace{1cm} \text{feature movement}

c. \[
\text{CP} \quad \begin{array}{c}
\text{Qui} \\
\text{est-ce que}
\end{array} \quad \begin{array}{c}
\text{IP} \\
\text{la fille embrasse tqui?}
\end{array}
\] \hspace{1cm} \text{category movement}

If the comprehension of Broca patients is affected by the type of syntactic movement in the way proposed in (30), two predictions follow. First of all, it is expected that French-speaking Broca patients will show better comprehension of wh-in-situ object questions (32b) than of subject questions (32a). Secondly, it is predicted that there is no difference between patients’ comprehension of subject questions (32a) and that of object questions of the type in (32c).\(^{144}\)

\(^{144}\) It is also predicted that French-speaking Broca patients show better comprehension of wh-in-situ object questions (32b) than of their counterparts involving overt wh-movement (32c). This is indeed the case, as was discussed in section 2.1. of this chapter.
The first prediction is borne out. Wh-in-situ object questions are understood significantly better than subject questions (see chapter 3, section 3.2 for the statistics). The second prediction is also confirmed by the data. Although patients score higher on object questions of the type in (32c) than on subject questions, this difference is not significant (see chapter 3, section 3.2 for the statistics). Thus, the data obtained on French-speaking Boca patients concerning their comprehension of subject and object wh-questions are in line with the characterization in (30). These patients show better comprehension of constructions involving feature movement than of those involving category movement. The characterization in (30) can thus describe data that cannot be accounted for under the standard characterization. Obviously, this is a strong argument in favor for the characterization proposed in this thesis.

2.3.3. Object what-questions in French-speaking Broca patients

The results obtained on French-speaking Broca patients have shown a striking difference between who- and what-questions. For who-questions, patients showed better comprehension of wh-in-situ questions than of those involving overt wh-movement. For what-questions however, such a difference has not been observed (cf. experiment 2, discussed in section 3.3 of the previous chapter). The group results on these questions are repeated in table 4 below.

<table>
<thead>
<tr>
<th>question type</th>
<th>example</th>
<th>group score (%) correct</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>who-question</strong></td>
<td>Le garçon tire qui?</td>
<td>83.3%</td>
</tr>
<tr>
<td>(wh-in-situ)</td>
<td>Qui est-ce que le garçon tire?</td>
<td>69.4%</td>
</tr>
<tr>
<td>(wh-movement)</td>
<td>‘Who does the boy pull?’</td>
<td></td>
</tr>
<tr>
<td><strong>what-question</strong></td>
<td>La voiture tire quoi?</td>
<td>64.6%</td>
</tr>
<tr>
<td>(wh-in-situ)</td>
<td>Qu’est-ce que la voiture tire?</td>
<td>65.6%</td>
</tr>
<tr>
<td>(wh-movement)</td>
<td>‘What does the car pull?’</td>
<td></td>
</tr>
</tbody>
</table>

At first sight, the data in table 4 raise the question why French-speaking Broca patients show such a poor performance on wh-in-situ what-questions. Why is there such a difference between their comprehension of wh-in-situ who-questions (83.3% correct) and that of wh-in-situ what-questions (64.6% correct)? Indeed, both types of questions are derived through the same type of movement, namely feature movement. As is shown in the examples in (33) below, both qui (‘who’) and quoi (‘what’) cannot remain in-situ in constructions containing a negation or a quantifier.

(33) a. *Tu n’as pas vu qui/quoi?*
You have not seen who/what
‘Who/what haven’t you seen?’
The ungrammaticality in (33) is called the intervention effect. As was explained in chapter 2, section 2.2.3, this effect can be used as a diagnostic for feature movement. The intervention of scope-bearing elements such as negation blocks the separation of the moved features and their originating lexical element. Thus, both French wh-in-situ who and what-questions are derived through feature movement.

Patients’ poorer comprehension of what-in-situ questions versus that of who-in-situ questions can, however, be understood in light of the animacy effect, discussed in the previous chapter. There it was shown several times that syntactic movement is not the only factor underlying the comprehension deficit in Broca’s aphasia. Instead, these patients are also sensitive to animacy, to the extent that their comprehension of inanimate wh-questions is worse than that of animate wh-questions. This was observed for both English-speaking Broca patients (cf. section 3.3 of chapter 3) and French-speaking Broca patients (cf. the results of the experiments 2 and 3). Given this animacy effect, the difference between patients’ comprehension of the two types of wh-in-situ questions is expected. Patients have more difficulties comprehending questions of the type in (34b) than those in (34a), since (34b) is inanimate.  

(34) a. Le garçon tire qui?
   the boy pulls who
   ‘Who does the boy pull?’
 b. La voiture tire quoi?
   the car pulls what
   ‘What does the car pull?’

However, this explanation gives rise to a new question: why is there no difference between patients’ comprehension of animate and inanimate wh-questions involving movement of the wh-word? As can be seen in table 4, patients’ performance on questions of the type in (35a) is similar to that of the type in (35b), despite the fact that (35b) is inanimate.

(35) a. Qui est-ce que le garçon tire t qui?
   who Q the boy pulls
   ‘Who does the boy pull?’
 b. Qu’est-ce que la voiture tire t quoi?
   what Q the car pulls
   ‘What does the car pull?’

145 See section 3.3, chapter 3 for the statistics of these and the following comparisons.
I propose that the absence of the animacy effect in patients’ comprehension of sentences of the type in (35) is due to an interaction of syntactic movement and animacy. To see this, I will first discuss patients’ performance on inanimate wh-questions, i.e. the questions exemplified in (34b) and (35b). These questions only differ in the type of movement through which they are derived. As argued above, wh-in-situ what-questions involve feature movement. By contrast, questions of the type in (35b) are derived through head movement (cf. section 3.3 of the previous chapter). The structures of both types of questions are illustrated below.

(36) a. \[ CP \quad C^0 \quad [IP \quad \text{la voiture tire quoi?}] \quad \text{feature movement} \]
\[ \quad [\text{wh}] \quad [t_{\text{wh}}] \]

b. \[ CP \quad \text{Qu’ est-ce que} \quad [IP \quad \text{la voiture tire } t_{\text{QO}}?] \quad \text{head movement} \]

The two types of French what-questions in (34b) and (35b) are thus derived differently. However, this difference is not reflected in patients’ performance on these two constructions. As can be seen in table 4, there is no difference in patients’ comprehension of these two constructions. This suggests that feature movement and head movement affect patients’ comprehension in a similar way. Hence, the characterization of the comprehension deficit in Broca’s aphasia proposed in (30) needs to be more refined. Head movement is an instance of overt category movement and thus similar to XP-movement. However, it does not have the same effect on patients’ comprehension as XP-movement does. Instead, it patterns with feature movement. I therefore propose the following characterization of the comprehension deficit in Broca’s aphasia.

(37) Comprehension deficits in Broca’s aphasia (final version)

Broca patients have more difficulties with the comprehension of constructions involving XP-movement than with those involving feature movement or head movement.

Returning now to the questions exemplified in (35), I propose the following explanation for patients’ performance on these questions. Questions of the type in (35b) are both easier and more difficult to understand for Broca patients than those of the type in (35a). Questions of the type in (35a) are derived through XP-movement, which is a type of movement that affects patients’ comprehension more severely than the type of movement underlying the derivation of questions in (35b). Hence, it is expected that patients have more difficulties comprehending questions of the type in (35a) than those of the type in (35b). At the same time, however, the question in (35b) is inanimate and as such more difficult to understand for Broca patients than its animate counterpart in (35a). As a result, there is no difference between patients’ performance on these two types of questions.
To sum up, I have argued that the results on what-questions obtained on French-speaking Broca patients suggest a refinement of the characterization of the comprehension deficit in Broca’s aphasia. Head movement and feature movement affect patients’ comprehension similarly. These two types of movement have less effect on patients’ comprehension than XP-movement does. This leads to the characterization in (37). The distinction made in (37) between XP-movement on the one hand and feature movement and head movement on the other hand might seem counterintuitive to the extent that both XP-movement and head movement are instances of overt category movement. Hence, it seems strange that head movement patterns with feature movement and not with XP-movement. In chapter 5, I will, however, put forward some theoretical arguments showing that feature movement is an instance of head movement. Under such a view, (37) can be better understood.

2.4. Summary

In this section, I have discussed the comprehension of wh-questions by French and English-speaking Broca patients. In each subsection I focused on two types of wh-questions and compared patients’ comprehension of these two types of questions relative to each other. This has led to the following observations.

(38) Observations on the comprehension of wh-questions in Broca’s aphasia

a. Except for what-questions, French-speaking Broca patients understand wh-in-situ questions better than their counterparts involving overt wh-movement (section 2.1).
b. French-speaking Broca patients have more difficulties comprehending subject questions than English-speaking Broca patients do (section 2.2).
c. English-speaking Broca patients show no difference between their comprehension of subject and object who-questions (section 2.3.1).
d. French-speaking Broca patients understand in-situ object who-questions better than subject who-questions (section 2.3.2).

146 This characterization might also be able to capture the findings on English object who-questions, discussed in section 2.3.1. If it can be argued that English object who-questions are derived through head movement, patients’ performance on these types of questions is in line with (37). This would be reminiscent to Thompson et al. (1999), who suggested that patients’ relatively performance on object who-questions might indicate that who is a head and that head movement is intact in Broca’s aphasia. There are several reasons why I will not adopt this idea here. First of all, to my knowledge, it is difficult to prove that who is a head. Clearly, who is a bare wh-item, in contrast to more complex wh-items such as which N (cf. Chomsky 1995), but from this does not follow that who is a head. Moreover, who in constrast to the French que (‘what’) does not behave as a head. Que clearly is a clitic, but who is not. More importantly, if who is a head because it is a bare wh-item, qui (‘who’) also has to be a head. Consequently, the observations on French wh-questions can no longer be explained. For instance, if qui is a head, object questions involving movement of qui would be derived through head movement. Hence, patients’ better comprehension of wh-in-situ qui-questions versus that of their counterparts involving movement of qui can no longer be explained. I will therefore not adopt the suggestion that who is a head. The observations on English object who-questions thus remain problematic for the characterization proposed in (37). However, these observations are also problematic for the standard characterization. In contrast to the standard characterization, the characterization in (37) is able to account for many other observations on patients’ comprehension of wh-questions (see section 2.4).
e. French-speaking Broca patients show no difference between their comprehension of subject who-questions and object who-questions involving overt wh-movement (section 2.3.2).

f. There is no difference between patients’ score on in-situ what-questions and what-questions involving overt wh-movement (section 2.3.3).

I have argued that the standard characterization of the comprehension deficit in Broca’s aphasia does not capture these findings. According to this characterization, patients’ comprehension of sentences involving movement out of the subject position is intact, but that of their object counterparts is impaired. This characterization cannot describe any of the findings on wh-questions summarized in (38). First, neither English nor French-speaking Broca patients understand subject questions better than object questions (cf. (38c) through (38e)). Secondly, this characterization does not discriminate between several types of object movement and hence does not capture (38a). Finally, the crosslinguistic difference in (38b) is unexpected if Broca patients in general are able to understand sentences involving subject movement.

In this section, I have proposed a new characterization of the comprehension deficit stating that Broca patients have more difficulties with the comprehension of sentences derived through XP-movement than with those derived through feature movement or head movement do (cf. (37)). I have shown that this characterization can capture all the findings in (38), except those on English object wh-questions (cf. 38d). Thus, the relation between syntactic movement and patients’ comprehension difficulties is not determined by the position out of which movement has taken place (subject/object), but by the type of movement through which constructions are derived. Several types of movement, such as feature movement and head movement, have less effect on the comprehension of Broca patients than other types of movement, such as XP movement.147

This section shows that the use of the theoretical linguistics tools provides better insight in the comprehension deficit of Broca patients. These tools are fruitful in the analysis and generalization of the data obtained on Broca patients. In theoretical linguistics, several types of syntactic movement are distinguished. By using these types of syntactic movement, the data of Broca patients can be generalized in a very straightforward way. In the next section, it will be shown that there is a mutual relation between theoretical linguistics and neurolinguistics. Theoretical linguistics provides tools analyzing the data of Broca patients. These data, in turn, lead to new linguistic analyses of several constructions. This will be illustrated below for clefts and relative clauses.

147 Recall that syntactic movement is not the only factor affecting comprehension in Broca’s aphasia. These patients are also sensitive to animacy in that animate wh-questions are better understood than their inanimate counterparts. Further research is required to determine the precise influence of animacy on patients’ comprehension as well as the relation between animacy and syntactic movement.
3. Comprehension of clefts and relative clauses

So far I have shown that the findings on wh-questions can be described by the characterization in (37). The goal of this section is to show that this characterization can also capture the data on clefts and relative clauses. In doing so, I reverse my line of reasoning. In the previous sections, I have described patients’ performance on wh-questions by a characterization based on the linguistic analyses of these questions. I will now turn the argument around and start with the characterization in (37). If patients’ comprehension deficits are described in the way proposed in (37), several predictions with respect to the linguistic analysis of clefts and relative clauses follow. In this section, I will discuss these predictions for English and French. I will show that there are independent arguments in favor of the analysis of clefts and relative clauses as suggested by the data of Broca patients.

3.1. The analysis of clefts and relative clauses

The analysis of clefts and relative clauses was briefly explained in chapter 2, section 1.1.1.2. Here, it will be discussed in more detail. I will use English examples to illustrate the standard analysis of clefts and relative clauses.

In English object relative clauses, the presence of the relative pronoun who as well as that of the complementizer that is optional. This yields the following possibilities for English object relative clauses.

(39) a. I see the man [ CP who Mary loves]
b. I see the man [ CP Mary loves]
c. I see the man [ CP that Mary loves]

In theoretical linguistics, the relative pronoun who is referred to as the wh-operator. This operator is overtly realized in (39a). It is standardly assumed that relative clauses of the types in (39b) and (39c) also contain a wh-operator. The only difference is that in these sentences, the wh-operator is phonologically null, whereas it is expressed as who in (39a). According to the standard analysis of relative clauses, the wh-operator is generated in the embedded IP and subsequently moved to the specifier of the embedded CP (cf. Browning 1987; Chomsky 1977). Thus, for all sentences in (39) the wh-operator is generated at the object position and moved to Spec,CP. This is illustrated below.

(40) a. I see the man [ CP who C0 [ IP Mary loves twho]]
b. I see the man [ CP OpWH (that) [ IP Mary loves tOp]]

148 See further De Vries (2002) for more references.
The structure in (40a) illustrates the underlying structure of (39a). In (40b) the derivation of (39b) and (39c) is given. In this structure, C can be empty or filled with the complementizer that, yielding respectively (39b) and (39c). In both (40a) and (40b) the wh-operator (either the overt who or the empty operator) moves to Spec,CP.\textsuperscript{149}

It is further assumed that there is a predication relation between the head noun, base-generated in the matrix sentence, and the embedded CP. Leaving technical details aside, this means that the embedded CP in (40) is the predicate of the head noun the man in the sense that it is a property of this head noun. The wh-operator plays an important role in this relation, which can for instance be seen from the fact that the head noun and the wh-operator agree in animacy.

\begin{itemize}
  \item \textbf{a.} the book \[ CP \text{ which/*who Mary read } t \]
  \item \textbf{b.} the man \[ CP \text{ *which/who Mary loves } t \]
\end{itemize}

In this thesis, I illustrate the predication relation between the head noun and the embedded clause through a dotted line connecting the head noun and the wh-operator. Thus, the structure of English relative clauses is as is illustrated in (42).

\begin{itemize}
  \item \textbf{a.} I see the man \[ CP \text{ who } C^0 \ [IP \text{ Mary loves } t] \]
  \item \textbf{b.} I see the man \[ CP \text{ OpWH(that) } [IP \text{ Mary loves } t] \]
\end{itemize}

The analysis of clefts is similar to that of relative clauses. As is illustrated in (43), in clefts the head noun is base generated in the matrix clause and related to the embedded CP.

\begin{itemize}
  \item \textbf{a.} I see the man \[ CP \text{ who } C^0 \ [IP \text{ Mary loves } t] \]
  \item \textbf{b.} I see the man \[ CP \text{ who Mary loves } t \]
\end{itemize}

\textsuperscript{149} The analysis of relative clauses is heavily debated. Roughly speaking, there are two types of analyses. The first is the one I referred to as the ‘standard analysis’. According to this analysis, the head noun of relative clauses is base generated in the matrix clause. The only movement that has taken place is that of the wh-operator. Alternatively, it has been argued that the head noun in relative clauses is generated in the embedded CP and subsequently moved to the matrix clause. This analysis, called raising analysis, has been proposed and defended by Vergnaud (1974, 1985) and Kayne (1994) amongst others. The structures in (i) illustrate the derivations of object relative clauses assumed in both analyses.

(i) \begin{itemize}
  \item \textbf{a.} I see the man \[ CP \text{ who Mary loves } t \]
  \item \textbf{b.} I see the man \[ CP \text{ who Mary loves } t \]
\end{itemize}

The contrast in (i) shows that the analyses differ with respect to the question which element moves. According to the standard analysis, it is the wh-operator who. The raising analysis claims that it is the head noun the man that has moved. I will not go into this debate here (see De Vries (2002) for a comprehensive review of the discussion concerning these and other analyses), but explain only the analysis illustrated in (ia). I will continue to refer to this analysis as the standard analysis.
In the remainder of this section, I will no longer give the analyses of both clefts and relative clauses, but concentrate on one of these two constructions. Every argument based on the analysis on one of these constructions also applies to the other construction.

The standard analysis assumes no difference between subject and object clefts and relative clauses. In both, the wh-operator can be either realized as who or phonologically empty. Further, both involve movement of the wh-operator to the specifier of CP. This is illustrated below.

(44) Standard analysis of clefts and relative clauses

a. It is/I see the man[CP who C³ [IP t₁ who loves Mary]] subject

b. It is/I see the man[CP who/OpWH C³ [IP Mary loves t₁ who/Op]] object

However, in contrast to the analysis in (44), the data of Broca patients suggest that there is a difference between the derivation of subject and object relative clauses and clefts. These patients show better comprehension of subject clefts and relative clauses than of their object counterparts. In the previous sections, I argued that the comprehension deficit of Broca patients is related to the type of movement through which constructions are derived. Some types of movement have less effect on patients’ comprehension than others do. The data of Broca patients thus suggest that, contrary to (44), subject and object relative clauses are derived differently. Subject relative clauses should be derived by a type of movement that has less effect on patients’ comprehension than the one involved in object clefts and relative clauses. More specifically, if the characterization in (37) is correct, the data of Broca patients suggest that subject clefts and relative clauses are derived through head movement or feature movement. By contrast, object clefts and relative clauses should be derived through XP-movement. The question thus arises whether there is any evidence showing that this prediction is correct. In the following sections, I will show that the analysis of clefts and relative clauses suggested by the data of Broca patients is a possible and perhaps even better analysis than the standard analysis. I will first do so for French.

3.2. French clefts and relative clauses

The examples in (45) illustrate the standard analysis of French clefts and relative clauses. As can be seen in these examples, in French clefts and relative clauses, the wh-operator is never phonologically realized.¹⁵⁰

¹⁵⁰ Note further that the complementizer que (‘that’) has been changed to qui (‘that’) in subject clefts and relative clauses. This will be discussed in the next section.
(45) standard analysis of French clefts and relative clauses

a. C’est/Je vois l’homme [CP  \textit{Op}_{\text{SN}} \textit{qui} [IP \textit{to}_{\text{Op}} \text{aime Marie}]] \textit{subject}
   
it is/I see the man that loves Mary
   ‘It is/I see the man who loves Mary.’

b. C’est/Je vois l’homme [CP  \textit{Op}_{\text{SN}} (que) [IP Marie aime \textit{to}_{\text{Op}}]] \textit{object}
   
it is/I see the man that Marie loves
   ‘It is/I see the man who Mary loves.’

As is illustrated in (45), the standard analysis assumes that subject and object clefts and relative clauses are derived similarly. Both involve movement of the wh-operator to Spec,CP. Further, in both constructions this operator is related to the head noun ‘l’homme’ (‘the man’) in the matrix clause.

The data from French-speaking Broca patients predict an analysis of French clefts and relative clauses differing from the one in (45). These patients show better comprehension of subject clefts than of their object counterparts (cf. table 2, chapter 3). If the characterization of the comprehension deficit I proposed in (37) is correct, these data predict that French subject clefts and relative clauses are derived through a different type of movement than the one underlying object clefts and relative clauses. More specifically, it is predicted that French subject clefts and relative clauses involve feature movement or head movement, whereas French object clefts and relative clauses involve XP-movement. It is hard to see how an analysis assuming head-movement in French subject clefts and relative clauses could be argued for. Indeed, wh-operators are XPs and not X0s. Moreover, even if it could be argued that French wh-operators are heads, it is unclear why this only holds for wh-operators in subject clefts and relative clauses and not for those in object clefts and relative clauses. Thus, the assumption of head-movement in French subject clefts and relative clauses can be ruled out. It is, however, possible to assume that French subject clefts and relative clauses are derived through feature movement. On this view, only the features of the wh-operator have been moved and the wh-operator itself has remained in Spec,IP. Hence, in contrast to the standard analysis of French clefts and relative clauses given in (45), the data of French-speaking Broca patients suggest the following analysis.

(46) Analysis suggested by the data of French-speaking Broca patients

a. C’est/Je vois l’homme [CP [\textit{FF}] \textit{qui} [IP \textit{Op}_{\text{SN}} \text{aime Marie}]] \textit{subject}
   
it is/I see the man [\textit{to}_{\text{FF}}] that loves Mary
   ‘It is/I see the man who loves Mary.’

---

\textsuperscript{151} Comprehension of relative clauses was not examined. It is, however, reasonable to assume that patients show the same pattern on these constructions, since Broca patients in general show no difference between their comprehension of clefts and that of relative clauses (see also chapter 2).
b. C’est/Je vois l’homme \[ \text{CP } \text{OpWH} \text{(que)} \left[ \text{IP Marie aime t}_{\text{op}} \right] \text{object} \]

\[ \text{it is/I see the man that Marie loves} \]

‘It is/I see the man who Mary loves.’

Comparing (45) and (46), it is clear that both analyses assume that in object clefts and relative clauses the entire wh-operator has been moved. However, the analyses differ with respect to the type of movement proposed for subject clefts and relative clauses. In contrast to the analysis in (45a), the data from Broca patients suggest that in subject clefts and relative clauses only the features of the wh-operator have been moved.\(^{152}\) Below, I will present two arguments sustaining this analysis.

### 3.2.1. French subject clefts and relative clauses: the que-qui rule

The first argument in favor of the claim that French subject clefts and relative clauses involve only feature movement is based on a morphological difference between subject and object clefts and relative clauses. This difference is illustrated below.

\begin{align*}
(47) & \text{ a. C’est/Je vois la fille \[ \text{CP qui embrasse le garçon} \] subject} \\
& \text{It is/I see the girl that kisses the boy} \\
& \text{‘It is/It is the girl who kisses the boy.’} \\
& \text{ b. C’est/Je vois la fille \[ \text{CP que le garçon embrasse} \] object} \\
& \text{It is/I see the girl that the boy kisses} \\
& \text{‘It is/It is the girl who the boy kisses.’}
\end{align*}

The examples above display a contrast between subject clefts and relative clauses on the one hand (47a) and object clefts and relative clauses on the other (47b). Object clefts and relative clauses are introduced by the complementizer que. By contrast, subject clefts and relative clauses are introduced by qui. This is called the que-qui rule (Pesetsky 1982). According to this rule, the complementizer que is changed into qui if it governs a trace in subject position.\(^{153},^{154}\) It is commonly assumed that this

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\(^{152}\) For the moment I will refer to these features as formal features (FF). In the following section, I will discuss the set of features out of which the operator is constructed as well as the question which of the features move in subject clefts and relative clauses.

\(^{153}\) Note that qui in (47a) is not an instance of the wh-operator qui (‘who’), despite the fact that it is homophonous to the wh-item qui used in wh-questions. The most important reason for this assumption is that there are several differences between the qui in these constructions and the qui used in wh-questions (cf. Moreau 1971; Kayne 1976; Pesetsky 1982; Labelle 1990; Rizzi 1990; Rooryck 2000). There is therefore general agreement that qui in subject clefts and relative clauses is not a wh-item, but an allomorph of the complementizer que.

\(^{154}\) Note that this que-qui change also occurs in wh-questions in which the wh-word is moved out of the embedded CP. In (ib) the object wh-word is moved out of the embedded CP into the matrix clause. The same movement has taken place in (ia). Crucially, however, here the moved wh-word was the subject of the embedded clause. As a result of this movement, the complementizer que changes into qui.

(i)a. Qui penses-tu \[ \text{CP qui t}_{\text{op}} \text{a frappé le garçon ?} \]  
who think you that has hit the boy  
‘Who do you think that has hit the boy?’

(b) Qui penses-tu \[ \text{CP que le garçon a frappé t}_{\text{op}} ? \]  
who think you that the boy has hit  
‘Who do you think that the boy has hit?’
change from *que* into *qui* is related to the movement of the wh-operator out of Spec,IP (cf. Kayne 1976; Pesetsky 1982; Rizzi 1990). The tree in (48) illustrates the structure of the embedded CP in (53a) under the standard analysis of clefts and relative clauses.

(48)

In this structure, the wh-operator moves to Spec,CP. As a result of this movement, *que* is changed into *qui*. Rizzi (1990) proposed the following implementation of this *que-qui* rule. He argues that it is a morphological reflex of Spec-Head agreement in C⁰. The wh-operator in Spec, IP agrees with I¹. I contains the verb *embrasse* (‘kiss’) which has been moved from V to I in order to obtain features such as Person and Number. Before movement, the wh-operator in Spec,IP agrees with the verb in I in that they are specified for the same Person and Number features. Thus, in (54) both are 3rd person singular. Rizzi (1990) argues that if the operator moves to Spec,CP, it agrees with C⁰. He further claims that therefore C⁰ agrees with I⁰. This agreement is spelled out by the change from *que* into *qui*.

As was noted by Rooryck (2000), a problem of this analysis is that it does not explain why agreement is spelled out in precisely this way. He argues that the complementizer *qui* in constructions such as in (47a) is a morphological compound consisting of *que* and –*i*. He further convincingly shows that this morpheme –*i* is derived from the nominative pronoun *il* (‘he’) and hence bears the Case feature ‘nominative’. Under the analysis in (48), it is, however, unclear why the agreement between C and I is spelled out by a Case feature on C. As was argued by Van der Meulen and Rooryck (2004), this is even impossible under the definition of Agree as proposed by Chomsky (2001). Note finally that there are no other agreement phenomena in natural languages in which case is expressed on a head. Instead, Case is always expressed on an XP. The nominative nature of complementizer *qui* thus remains problematic for the standard analysis of French subject clefts and relative clauses.

Crucially, the nominative nature of *qui* can be explained if we adopt the analysis of French subject clefts and relative clauses suggested by the data of French-speaking Broca patients. As was noted above, these data suggest that in French
subject clefts and relative clauses only the features of the wh-operator have been moved. This is illustrated below.

(49)  

In the structure in (49), the features of the wh-operator have been adjoined to C. The operator itself remains in Spec,IP. Let us consider this operator in more detail. It consists of a set of formal features. First, being an operator, it contains the operator feature, commonly indicated as Q. Second, as explained above, it agrees with the verb in I and therefore bears the same features of Person and Number (i.e. 3rd person singular). Finally, since it is a nominal element in Spec,IP, it will receive nominative Case from the verb in I. This is illustrated in (50).

(50)  

Following Chomsky (1995), feature movement entails movement of the entire set of formal features. Thus, if in (50) the features of the wh-operator move to C, C obtains a Q-feature, features of Person and Number and a nominative Case feature. The derivation is illustrated in (51).155

(51)  

a.  

b. 

155 The position of the verb is not important here. Therefore, the movement of the verb to I is not indicated.
The structure in (51a) shows the embedded clause of subject relative clauses (47a) before movement has taken place. In (51b), the formal features of the wh-operator have moved to C. As a result, C bears the nominative feature. This nominative feature is spelled out as –i and the complementizer therefore changes from que into qui. In other words, under the analysis in (49), the nominative nature of qui can be explained. It is a direct consequence of the movement of the features.

To sum up, the data of French-speaking Broca patients suggest that, in contrast to the standard analysis of French subject clefts and relatives clauses (cf. 45a), these constructions involve only feature movement (cf. 46a). This analysis provides an explanation for the que-qui change, a phenomenon that is not fully explained under the standard analysis. This is a strong argument in favor of the analysis in (46). Further evidence sustaining this analysis comes from a subject/object asymmetry in French relative clauses. This evidence is discussed below.

3.2.2. French subject clefts and relative clauses: idioms

The second argument corroborating the analysis in (46) is based on the behavior of a certain class of idioms consisting of a noun and a verb. This class is formed by idioms such as prendre part à (‘to participate in’), and tirer parti de (‘to take advantage of’). Some examples are given below.

(52) a. Jean a pris part aux débats.
   Jean has taken part at the debates
   ‘Jean has participated in the debate.’

b. Max a tiré parti de cette situation.
   Max has taken advantage of that situation
   ‘Max has taken advantage of that situation.’

Vergnaud (1985) observed that these idioms allow the noun to appear out of their so-called canonical context (i.e. the position between the verb and the preposition). Thus, apart from the constructions in (52), the nouns of these idioms can be separated from their verbal part. This can be done by means of passivization, or a wh-question. The examples in (53), from Vergnaud (1985), illustrate these constructions for the idiom prendre part.

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156 Note that there is also a class of V NP idioms that do not allow the noun to be separated from the verb. According to Vergnaud (1985), idioms such as casser la croûte (‘to have a bite’) and faire le malade (‘to pretend to be ill’) belong to this second class. The examples in (i) show that la croûte in casser la croûte can only appear in its canonical context (i), and can not be separated from the verb through passivization (iia) or relativization (iib).

(i) Ils ont cassé la croûte.
   The have broken the crust
   ‘They have taken a bite.’

(ii) a. *La croûte a été cassée à l’heure prévue.
    the crust has been broken at the hour fixed
    ‘The bite has been taken at the fixed moment.’

b. *La croûte qu’ils ont cassée nous a surpris.
    the crust that they have broken us has surprised
    ‘The bite that they had surprised us.’
A NEW CHARACTERIZATION

(53)a. Quelle part a-t-il prise aux débats?
   which part has-CL-he taken in the debate
   ‘How did he participate in the debate?’
   b. Une part active semble avoir été prise aux débats par les délégués C.U.T.
   a part active seems have been taken in-the debate by the representatives C.U.T.
   ‘The C.U.T. representatives seem to have participated actively in the debate.’

Relative clauses form the third construction in which the nouns of these idioms are separated from the verb. This is illustrated in (54) for the idioms prendre part and tirer parti.157

(54) a. La part [CP que Jean a prise aux débats] nous a surpris.
   the part that Jean has taken in the debate us has surprised
   ‘The way he participated in the debate surprised us.’
   b. Le parti [CP que Max a tiré de cette situation] a soulevé de l’inquiétude.
   the advantage that Max has taken of that situation has raised of uneasiness
   ‘The advantage Max took out of that situation has raised uneasiness.’

A final characteristic of these idioms is that they show a subject/object asymmetry in relative clauses. It is this characteristic that is important to the present discussion and on which I will focus in the remainder of this section. The reason for this is that the standard analysis of relative clauses does not predict any differences between subject and object relative clauses, since both are derived in the same way. In both types of sentences, the wh-operator has been moved from its base position to Spec,CP (cf. 45). However, under the analysis of relative clauses suggested by the data of Broca patients (cf. 46) subject/object asymmetries are expected. According to this analysis, subject relative clauses involve a different type of movement than the one involved in object relative clauses. Based on this underlying syntactic difference, other differences between subject and object relative clauses might be expected. Thus, any subject/object asymmetry in French relative clauses forms a strong argument in favor of the analysis suggested by the data of Broca patients and against the standard analysis. Let us therefore look in more detail to the

157 Note that Vergnaud uses the examples in (53) and (54) to argue for a raising analysis of relative clauses (see also Kayne 1994). As was discussed in footnote 149, this analysis assumes that the head noun in relative clauses is base-generated within the embedded clause and subsequently moved to the matrix clause. On this view, the derivation of (54a) is as in (i).

(i) [DP la part [CP que Jean a prise aux débats]] nous a surpris
   In this structure, la part is generated in the embedded clause at the right of the verb prendre. Vergnaud claims that this is the only possible analysis, since la part can only receive an interpretation within the idiom chunk prendre part. Thus, in both (53) and (54) part starts out in the idiom chunk, i.e. in its canonical context, and can than be moved.
   However, examples such as (53) and (54) can also be explained under the standard analysis of relative clauses, in which the head noun is not moved but base generated in the matrix clause. Under this analysis, the structure of (54a) is as in (ii).

(ii) [CP [la part [CP que Jean a prise aux débats]] nous a surpris]
   In this structure, la part is not generated in the embedded CP. However, as I will show later, it can be interpreted within the CP and hence within its idiom chunk via the operator. Thus, contrary to Vergnauds claim, these idioms do not necessarily lead to a raising analysis of relative clauses.
subject/object asymmetry in clauses relativized over idioms. Vergnaud (1985) observed the following contrast.

(55) a. Il a pris à ce congrès une part [CP qui nous a surpris].
    he has taken at that conference a part that us has surprised
    ‘The way he participated in that conference surprised us.’
   
b.*Elle a pris à ce congrès une part [CP que Max a critiquée].
   she has taken at that conference a part that Max has criticized
   ‘Max has critized the way she participated in that conference.’

(56) a. Il a tiré des difficultés économiques un parti
    [CP qui a soulevé beaucoup d’inquiétude].
    he has taken out of the difficulties economical a party
    that has raised a lot of uneasiness
    ‘The advantage he took of the economical difficulties has raised a lot of uneasiness.’
   
b.*Il a tiré de cette situation un parti [CP qu’on a fortement critiqué].
   he has taken out of that situation a party that one has severely criticized
   ‘The advantage he took of the economical difficulties has been severely criticized.’

The examples in (55a) and (56a) show that idioms such as prendre part and tirer parti allow a construction in which both the verb and the noun are located in the matrix clause, followed by a relative clause. As is shown by the contrast between the a- and the b-examples, this construction is only possible if the noun is the subject of the relative clause.

As was explained above, this subject/object asymmetry is difficult to explain under the standard analysis of relative clauses. In contrast, the analysis of relative clauses suggested by the data of Broca patients predicts the occurrence of subject/object asymmetries. Obviously, this makes the latter analysis a preferable analysis. It would, however, be even better, if this analysis does not only predict the existence of subject/object asymmetries in relative clauses, but can also account for them. Let me therefore show that the contrast in (55) and (56) can indeed be explained under an analysis claiming XP-movement in object relatives and feature movement in subject relatives.

First, consider the question why the b-examples (i.e. the object relatives) are ungrammatical. To see this, consider an object relative clause such as in (57).

(57) I see the man [CP who C0 [IP Mary loves twho]]

In this example, the noun man is both the theme of the matrix verb see and the theme of the embedded verb love. In other words, the man in (57) seems to be present at two positions: in the matrix clause and within the embedded sentence at the trace position of the moved operator. Studies examining the processing of these types of sentences have shown that listeners do indeed reactivate the head noun at the trace position in the embedded sentence (cf. Swinney, Ford, Frauenfelder & Bresnan 1987; Garnsey et al. 1989; Love & Swinney 1996. See also Swinney et al. 2000 for an overview). Thus, (57) can be represented as (58).
As was shown from the results of the processing experiments, this reactivation is an automatic and structurally driven (i.e. based on the underlying syntactic structure) process in comprehension.

Similar to (58), the object relative clauses in (55b) and (56b) thus also involve reactivation of the head noun within the embedded clause. The example in (59) illustrates the resulting construction of this reactivation for the sentence in (55b).

(59) *Elle a pris à ce congrès une part [CP Op WH que [IP Max a critiqué une part]].

Crucially, in contrast to the IP ‘Mary loves the man’ in (58), the IP ‘Max a critiqué un part’ in (59) is ungrammatical. In this latter IP there is a conflict of semantic selection. The verb *critiquer* (‘to criticize’) selects NPs of a specific semantic type as its theme, namely objects or persons that can be criticized. This is illustrated in (60) below. The sentence in (60a) meets the selection restrictions of the verb. Books are typically objects that can be criticized. However, abstract nouns such as joy in (60b) cannot.

(60) a. Max a critiqué le livre.
   Max has criticized the book
   ‘Max has criticized the book.’

b. *Max a critiqué la joie.
   Max has criticized the joy
   ‘Max has criticized the joy.’

Nouns in idioms do not have a meaning of their own. Instead, they acquire their meaning solely within the idiom (i.e. in combination with the specific verb that they are stored with in the lexicon). Hence, the ungrammaticality of the IP in (59) given here in (61) is akin to that in (60b).

(61) * [IP Max a critiqué une part]
   Max has criticized a part

In (61) as in (60b), the selection restrictions of the verb are not met. Both the NPs la joie (‘the joy’) and une part (‘a part’) cannot be criticized. La joie cannot be criticized since it does not refer to a specific object or person. Une part in (61) cannot be criticized, since it has no meaning here. It only receives a meaning in combination with the verb prendre.

The ungrammaticality of the object examples in (55) and (56) thus results from the recativation of the head noun within the embedded IP. In the standard analysis of

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158 Sentences of the type in (61) are possible if the object NP is made specific, as in (i) below.

(i) Max a critiqué la joie de Marie.
   ‘Max has criticized the joy of Marie.’
relative clauses, this recatvation has to be related to the movement of the wh-operator. Indeed, the head noun is reactivated at the trace position of this moved operator. In a sense, the ungrammaticality of the object examples in (55b) and (56b) is thus related to the movement of the operator.

Consider now subject relative clauses. The grammaticality of the sentences in the a-examples in (55) and (56) suggests that in these constructions the head noun is not interpreted in the embedded clause. If it were, these sentences would have been ungrammatical for the same reason as just explained for object relatives. Reactivation of la part in (55a) within the embedded clause would yield (62).

(62) * Il a pris à ce congrès une part [CP qui [IP une part nous a surpris]].

Again, the IP une part nous a surpris (‘a part surprised us’) in (62) is ungrammatical because of a conflict of semantic selection. The NP une part does not have a meaning of its own. The verb surprendre (‘surprise’) selects NPs as its subject that can surprise someone. Thus, if subject relatives are derived in the same way as object relatives, the a-examples in (55) and (56) are predicted to be ungrammatical. However, in contrast to the object examples in (55) and (56), the subject examples are perfectly well-formed sentences. This can only be explained if in these cases the head noun is not reactivated within the embedded clause. In other words, the grammaticality of (55a) and (56a) suggests that the structure in (62) is not formed and hence that reactivation does not take place here. As was explained above, reactivation of the head noun is related to the movement of the operator. The head noun is reactivated at the base position of the moved operator. The grammaticality of the a-examples in (55) and (56) thus suggests that in these cases the operator has not been moved. Crucially, this conclusion accords with the analysis of subject relative clauses following from the data of French-speaking Broca patients. These data predict that French subject relative clauses involve only feature movement (cf. (46a)). Under this analysis, the structure of a subject relative clause as in (55a) is as illustrated below.

(63) Il a pris à ce congrès une part [CP [C [FF] [qui]] [IP OpWH nous a surpris]]

In this construction, the features of the wh-operator have moved to C, resulting in the change from que into qui. The operator itself has remained in Spec,IP. The difference between this structure and the structure of the object relative in (59) is that here the head noun une part is not related to the operator, but only to the features of the operator. I suggest that it is this difference that explains the difference in grammaticality illustrated in (55) and (56). The idea is as follows. In subject relative clauses the head noun is only related to a part of the operator, namely its features. Therefore, in subject relative clauses, in contrast to object relative clauses, there is only a partial relation between the head noun and the
operator. As a consequence, the head noun *une part* in (62) is not reactivated within the embedded IP. Thus, the embedded IP of (55a) is not as is illustrated in (64a), but as is illustrated in (64b).

(64) a. ... * [IP une part nous a surpris]  
(64b) a part us has surprised

b. ... [IP OpWH nous a surpris]  
us has surprised

The contrast between the subject and object relative clauses in (55) and (56) thus follows from the movement of the operator. In object relatives, the operator moves, yielding the IP in (65b). This IP is ungrammatical because of a conflict of semantic selection. In subject relatives, by contrast, the operator does not move. Hence, the head noun is not reactivated within the embedded IP. As a result, in this IP no conflict of semantic selection arises and the sentence is grammatical. Both IPs are illustrated again below.

(65) a.  [IP OpWH nous a surpris]  
IP of the subject relative in (55a)
us has surprised

b.  * [IP Max a critiqué une part]  
Max has criticized a part

To sum up, there is a subject/object asymmetry in French relative clauses predicated over idioms. I have shown that this asymmetry is unexpected under the standard analysis of relative clauses. Further, I have shown that this asymmetry can be explained under the analysis suggested by the data of French-speaking Broca patients.

3.3. English clefts and relative clauses

In the previous section I have argued that the comprehension data of French-speaking Broca patients favor an analysis of French clefts and relative clauses differing from the standard analysis. These patients show better comprehension of subject clefts and relative clauses than of their object counterparts. Based on the claim that patients’ comprehension of constructions involving feature movement is better than that of constructions involving XP-movement, this implies that French subject clefts and relative clauses are derived through feature movement, whereas their object counterparts involve category movement. I have presented two arguments showing that such an analysis has several advantages over the standard analysis of French clefts and relative clauses.

159 Obviously, it should be worked out in more detail what this partial relation is. How exactly are the head noun and the embedded CP related in subject relative clauses? This is a question that might be examined in theoretical linguistics. What is relevant here is that the data of Broca patients show that there is a difference in the type of movement underlying the derivation of subject and object relative clauses. This is favored by the two phenomena discussed in the sections 3.3.2 and 3.3.3. It is a task of the theoretical linguists to work out the technical consequences of these findings.
In chapter 2 it was shown that English-speaking Broca patients also understand subject clefts and relative clauses better than their object counterparts. Following the same reasoning as above, this implies that the subject and object variants of these constructions are derived differently. English subject clefts and relative clauses are predicted to involve feature movement or head movement. As was shown in section 2.3, an analysis in terms of head movement can be ruled out on independent grounds. Hence, the data of English-speaking Broca patients predict that subject clefts and relative clauses are derived through feature movement. Object clefts and relative clauses, by contrast, are predicted to involve XP-movement. Again, the data of Broca patients thus suggest a different analysis for subject clefts and relative clauses than the standard analysis. The contrast between both analyses is illustrated below.

(66) *standard analysis of English clefts and relative clauses*

a. It is/I see the man[^CP who C\(^0\) [IP who loves Mary]] subject

b. It is/I see the man[^CP who C\(^0\) [IP Mary loves t\(\text{loves}\)]] object

(67) *analysis suggested by the data of Broca patients*

a. It is/I see the man[^CP FF [IP who loves Mary]] subject

b. It is/I see the man[^CP who C\(^0\) [IP Mary loves t\(\text{loves}\)]] object

Both analyses in (66) and (67) assume that in object clefts and relative clauses the wh-operator is moved to Spec,CP. However, the analyses differ with respect to the derivation of subject clefts and relative clauses. In contrast to the standard analysis in (67a), the data of Broca patients suggest that in subject clefts and relative clauses only the features of the wh-operator have been moved. Interestingly, the analysis suggested by the data of Broca patients is identical to the one proposed by Agbayani (1998). He argues that his analysis of English subject wh-questions (see section 2.2.2.1) extends to clefts and relative clauses. Using again adjacency as the trigger for category movement, he claims that in English subject clefts and relative clauses only the features of the wh-operator have been moved. By contrast, in the object variants of these constructions the entire wh-operator moves. It is, of course, interesting that the analysis of English clefts and relative clauses suggested by the data of Broca patients is identical to an analysis arrived at on the basis of theoretical arguments. It would, however, be even better if independent, empirical arguments in favor of this analysis could be found. In the following two sections, I present two such arguments. As was done for French, all arguments based on relative clauses are also valid for clefts and vice versa.
3.3.1. English subject clefts and relative clauses: that-trace effect

The first argument in favor of the claim that English subject clefts and relative clauses involve only feature movement can be derived from a phenomenon known as the that-trace effect. This phenomenon is best illustrated in embedded wh-questions. Examples of embedded wh-questions are given below.

\[(68)\]
\[
\begin{align*}
&\text{a. } \text{Who do you think } t_{\text{wh}} \text{ saw Bill?} & \text{subject question} \\
&\text{b. Who do you think } t_{\text{wh}} \text{ saw } t_{\text{who}}? & \text{object question}
\end{align*}
\]

In the examples in (68), the wh-word has been extracted out of the embedded clause to the matrix clause. As such, it obtains matrix scope. The examples show that this can be done with a subject as well as with an object wh-word. Consider now the examples in (69). These sentences differ from the ones in (68) in that the embedded clause now contains the complementizer that.

\[(69)\]
\[
\begin{align*}
&\text{a. } * \text{Who do you think that } & t_{\text{who}} \text{ saw Bill?} & \text{subject question} \\
&\text{b. Who do you think that } & t_{\text{who}} \text{ saw } t_{\text{wh}}? & \text{object question}
\end{align*}
\]

The examples in (69a) display a contrast with those in (68a). In (69a), extraction of the subject wh-word out of the embedded clause is not allowed. The contrast between (68a) and (69a) suggest that this is due to the presence of the complementizer that. The ungrammaticality of (69a) has been dubbed the that-trace effect (Chomsky & Lasnik 1977) and has been observed in many other languages. It states that the sequence ‘that-trace’ is ungrammatical. In other words, the complementizer that cannot be followed immediately by a trace. I will not discuss the reason for this ungrammaticality (see Chomsky 1986; Rizzi 1990; Lasnik & Saito 1992). Interesting for the present discussion, is the observation of Browning (1987) that the that-trace effect does not show up in English subject clefts and relative clauses. Thus, in contrast to (69a), the sentences in (70), from Browning (1987), are fully grammatical.

\[(70)\]
\[
\begin{align*}
&\text{a. The woman that won the race.} & \text{subject relative clause} \\
&\text{b. It is Jane that won the race.} & \text{subject cleft}
\end{align*}
\]

Crucially, under the standard analysis of subject clefts and relative clauses in (66a), a that-trace effect in these constructions is expected. Indeed, according to this analysis, the wh-operator has been moved to Spec,CP. As a consequence, the complementizer that is followed by a trace. This is illustrated below for the example in (70a).

\[(71)\]
\[
\text{The woman } [\text{CP Op}_\text{wh} \text{ that } t_{\text{op}} \text{ won the race}]
\]

Following the standard analysis of English subject clefts and relative clauses, (71) is similar to (69a). Hence, contrary to fact, it is expected that these sentences are ungrammatical. Several explanations have been put forward to explain the absence

\[160\] The que-qui rule in French (cf. section 3.2.1) is also seen as an instance of the that-trace effect.
of the that-trace effect in English subject clefts and relative clauses (see for instance Browning 1987). I will not discuss these proposals here. What is important here, is that the contrast between (69a) and (71) can be taken to mean that there is no trace in the subject position of the embedded CP in subject clefts and relative clauses. In other words, the grammaticality of (71) suggests that in these constructions the operator has not been moved. This is consistent with the analysis of clefts and relative clauses suggested by the data of Broca patients. These data predict that in subject clefts and relative clauses only the features of the wh-operator have been moved. Thus, in contrast to (71), the structure of (70a) is as in (72).

(72) The woman [CP [FF] that OpWH won the race]

In this construction, only the features of the wh-operator have been moved. Therefore, there is no trace in the subject position. Hence, no that-trace effect is expected. In other words, under the analysis of subject clefts and relative clauses suggested by the data of English-speaking Broca patients, the absence of the that-trace effect follows naturally. In contrast, the standard analysis of English subject clefts and relative clauses requires extra assumptions to account for the grammaticality of the constructions in (70). The analysis of English subject clefts and relative clauses suggested by the data of Broca patients has thus an advantage over the standard analysis.

3.3.2. English subject clefts and relative clauses: idioms

The second argument in favor of the analysis in (68) is based on a subject/object asymmetry similar to the one discussed above for French. Recall that French has a certain class of Verb Noun idioms, such as prendre part ('participate') and tirer parti ('take advantage'). These idioms can be followed by a relative clause, but only if the noun of the idiom functions as the subject of the relative clause. The relevant examples are repeated below.

(73) a. Il a pris à ce congrès une part [CP qui nous a surpris].
   he has taken at that conference a part that us has surprised
   ‘The way he participated in that conference surprised us.’

b. *Elle a pris à ce congrès une part [CP que Max a critiquée].
   she has taken at that conference a part that Max has criticized
   ‘Max has critized the way she participated in that conference.’

(74) a. Il a tiré des difficultés économiques un parti
   [CP qui a soulevé beaucoup d’inquiétude].
   he has taken out of the difficulties economical a party
   that has raised a lot of uneasiness
   ‘The advantage he took of the economical difficulties has raised a lot of uneasiness.’

b. *Il a tiré de cette situation un parti [CP qu’on a fortement critiqué].
   he has taken out of that situation a party that one has severely criticized
   ‘The advantage he took of the economical difficulties has been severely criticized.’
As explained in section 3.2.2, the subject/object asymmetry illustrated in (73) and (74) cannot be accounted for under the standard analysis of French relative clauses. Indeed, this analysis holds that subject and object relative clauses are derived in the same way, namely through movement of the wh-operator. By contrast, the data obtained on French-speaking Broca patients suggest that subject and object relative clauses are derived differently: subject relative clauses involve movement of only the features of the wh-operator, whereas in object relative clauses the entire wh-operator moves. I have argued that this analysis predicts the existence of subject/object asymmetries and that it can account for the data in (73) and (74).

The analysis of English relative clauses suggested by the data of English-speaking Broca patients is similar to the French one: feature movement in subject relative clauses versus wh-operator movement in object relative clauses (cf. 67). It is therefore interesting to examine whether there are any English idioms displaying the same subject/object asymmetry as illustrated above for French. The data on English idioms are not as clear as those on French idioms. However, there seems to be a contrast between the (a) and the (b) sentences in the examples below.

(75)  
a. The Bush administration gave North Korea the kind of leeway that surprised many observers.  
b. ? The Bush administration gave North Korea the kind of leeway that many European observers criticized.

The sentence in (75b) is judged more marked and less grammatical than its counterparts in (75a). These data thus suggest that English has a class of idioms showing similar behavior as the French idioms. As discussed before, this subject/object asymmetry can only be captured under an analysis assuming different underlying movement operations for subject and object relative clauses. The data of Broca patients suggest such an analysis (cf. 67). The contrast in (75) is thus an argument in favor of this analysis.

3.4. Conclusion  
In this section, I have argued that the data obtained on Broca patients favor a new analysis of clefts and relative clauses. These patients show better comprehension of subject clefts and relative clauses than of their object counterparts. Based on the characterization of the comprehension deficit proposed in this thesis, this suggest that subject and object clefts and relative clauses are derived differently. I have argued that the data of Broca patients suggest that subject clefts and relative clauses are derived through feature movement, while their object counterparts involve category movement. This analysis differs from the standard analysis of clefts and relative clauses, which holds that both subject and object clefts and relative clauses involve movement of the wh-operator (i.e. XP-movement). I have presented empirical evidence from French and English showing that the analysis of clefts and relative clauses suggested by the data of Broca patients can account for several phenomena that remain unexplained under the standard analysis.
In section 2 of this chapter, I have shown that theoretical linguistics provides well-defined tools useful for a proper description of the data of Broca patients. In other words, neurolinguistic research can profit from the knowledge obtained in theoretical linguistics. The present section illustrated that the interaction between neurolinguistics and theoretical linguistics is mutual. The data of obtained in neurolinguistic research may lead to a new analysis of linguistic constructions, such as clefts and relative clauses. As was shown in this section, this is not only a possible, but even a preferable analysis.

I have thus discussed the comprehension deficit in Broca’s aphasia from two points of view. In section 2 of this chapter, I compared patients’ comprehension of several types of wh-questions. I argued that the observed differences in patients’ performance on these constructions should be related to the type of syntactic movement underlying these constructions. In particular, I argued that patients have less difficulty with the comprehension of structures involving head or feature movement than with those involving XP-movement (cf. 37). In section 3 the argument was turned around. It was shown that this characterization of the relation between patients’ comprehension and syntactic movement leads to a new analysis of clefts and relative clauses. In the last section of this chapter, I will return to the point of view taken in section 2. Patients’ comprehension of wh-questions will be compared with that obtained on clefts and relative clauses. It will be examined whether the differences in patients’ comprehension of these constructions are in line with the characterization in (37). Further, it will be shown that the data of Broca patients raise several research questions for the field of theoretical linguistics. These questions will only be mentioned and not examined in detail.

4. Wh-questions versus clefts and relative clauses

In this section, I will compare patients’ comprehension of wh-questions with that of clefts and relative clauses. As was explained in chapter 2, it is generally assumed that wh-questions, clefts, and relative clauses are derived in the same way. All these constructions involve wh-movement. However, patients’ comprehension of wh-questions differs from that obtained on clefts and relative clauses. In this section, I will discuss these differences, and argue that they are consistent with the claim that feature movement and head movement have less effect on patients’ comprehension than does XP-movement.

4.1. Subject wh-questions versus subject clefts and relative clauses

In table 5, the group scores obtained by English-and French-speaking Broca patients on subject wh-questions, clefts, and relative clauses are given. The individual data on these constructions can be found in chapter 2 for the English-speaking Broca patients (tables 1 and 2) and chapter 3 for the French-speaking Broca patients (tables 2 and 4). The scores on clefts and relative clauses have been combined, since patients’ performance on these constructions does not differ.
Table 5
Comprehension of subject wh-questions, clefts, and relative clauses in % correct

<table>
<thead>
<tr>
<th>Patients</th>
<th>subject wh-question</th>
<th>subject cleft/rel. clause</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>80%</td>
<td>85.5%</td>
</tr>
<tr>
<td>French</td>
<td>53.2%</td>
<td>73.6%</td>
</tr>
</tbody>
</table>

As can be seen in table 5, English-speaking Broca patients show no difference between their comprehension of subject wh-questions and that of subject clefts and relative clauses. Instead, they score around 80% correct on all these constructions. Using a Wilcoxon signed ranks test, it can be concluded that there is no significant difference between patients’ score on these constructions ($z=-0.52$, $p=0.6$).

However, the results of the French-speaking Broca patients differ from those obtained on English-speaking Broca patients. For these patients, comprehension of subject wh-questions is significantly worse than that of subject clefts and relative clauses (Wilcoxon: $z=-2.37$, $p=0.018$). This crosslinguistic difference is exactly as expected under the characterization of the comprehension deficit proposed in this thesis. Consider first the findings on English-speaking Broca patients. In the previous sections, I have argued that English subject wh-questions as well as English subject clefts and relative clause are derived through feature movement (cf. sections 2.2.2.1 and 3.3 respectively). Further, I have argued that Broca patients are sensitive to the type of movement underlying the derivation of constructions to the extent that constructions involving XP-movement are more difficult to understand for them than those involving feature movement or head movement. Since English subject wh-questions, clefts, and relative clauses are all derived through feature movement, no difference in patients’ comprehension of these constructions is expected. As can be seen in table 5, this prediction is confirmed by the data.

The story is different for French. In section 2.2.2.2, I have argued that in French subject questions the entire wh-word moves to Spec,CP. In contrast, French subject clefts and relative clauses involve movement of only the features of the wh-operator (see section 3.2). The derivations of both constructions are repeated in (76a) and (76b) respectively.

(76) a. $[CP\ Qui (est-ce qui) \ [IP t_{wh} embrasse la fille?]]$

who (Q)           kisses        the girl

‘Who kisses the girl?’

b. C’est/Je vois le garçon $[CP\ [FF\ qui \ [IP Op_{wh} embrasse la fille]]$

it is/I see the boy that           kisses  the girl

‘It is the boy who kisses the girl.’

The structures in (76) show that French subject questions and French subject clefts are derived differently. French subject questions (76a) involve XP-movement of the wh-word. By contrast, French subject clefts and relative clauses (76b) involve feature movement. If the characterization of the comprehension deficit proposed in
this thesis is correct, it follows that French-speaking Broca patients will have more difficulties with the comprehension of subject wh-questions than with that of subject clefts. This prediction seems to be confirmed by the data. As can be seen in table 5, patients’ score on subject wh-questions is considerably worse than that on subject clefts and relative clauses. However, the difference between patients’ scores on these constructions does not reach significance (Wilcoxon: $z=-1.86$, $p=0.063$). The absence of a significant effect might be due to the small number of patients.\textsuperscript{161} If a less detailed statistical test, such as the chi-square test, is used the difference between patients’ score on the two conditions does become significant: $\chi^2=5.49$, $p=0.019$. I will therefore conclude that the data of French-speaking Broca patients illustrated in table 5 are consistent with the characterization of the comprehension deficit proposed in this thesis. Patients show better comprehension of subject clefts than of subject wh-questions, since the former involve a type of movement that has less effect on patients’ comprehension than the type of movement involved in subject wh-questions.

The data of French-speaking Broca patients thus suggest that wh-questions, clefts, and relative clauses are not derived in the same way. They show that French subject clefts and relative clauses involve a different type of movement than the one underlying French subject wh-questions. The question now arises how to account for this difference. Why are French subject wh-questions derived differently from French subject clefts and relative clauses? This question requires further research in the field of theoretical linguistics. It is, for instance, interesting to examine whether the arguments traditionally advanced for a unified analysis of these constructions do not hold for French. Further, it should be explained why the wh-operator can remain in its base position in subject clefts and relative clauses, whereas the wh-word in subject questions has to move to Spec,CP. This question is directly related to the more general question concerning the trigger for category movement. As has been mentioned several times throughout this thesis, the conditions determining the need for category movement are still unclear. Obviously, it is therefore at present impossible to explain why the category has to move in French subject wh-questions, but not in French subject clefts and relative clauses. I will leave this issue for further research. What is important here is that the data of French-speaking Broca patients show that there is a difference between French subject wh-questions and French clefts. Moreover, this difference is in line with the claim that patients’ comprehension of constructions involving feature movement is less impaired than that of constructions involving XP-movement.

4.2. Object wh-questions versus object clefts and relative clauses

In this section I will compare patients’ comprehension of object who-questions with that of object clefts and relative clauses. The relevant data are repeated in table 6.

\textsuperscript{161} The Wilcoxon signed rank test has been computed over the scores of only seven out of the nine patients participating in the experiments discussed in the previous chapter. The reason for this is that two patients, JD and AM, were not tested on subject wh-questions (see also footnote 96, chapter 3). The Wilcoxon examines for each individual patient whether there is a difference between his or her scores on two conditions. Since results from JD and AM on subject wh-questions are lacking, the Wilcoxon cannot compute whether there is a difference between their scores on subject questions and that on subject clefts.
For French, only the results on object questions involving overt wh-movement are given, since these types of object questions are derived through the same type of movement as the one involved in English object questions.

<table>
<thead>
<tr>
<th>Patients</th>
<th>object wh-question</th>
<th>object cleft/rel. clause</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>79.1%</td>
<td>39.3%</td>
</tr>
<tr>
<td>French</td>
<td>72.2%</td>
<td>43.1%</td>
</tr>
</tbody>
</table>

As can be seen in table 6, both English- and French-speaking Broca patients show a difference between their comprehension of object wh-questions on the one hand and that of object clefts and relative clauses on the other. Both groups of patients score considerably better on object wh-questions than on object clefts and relative clauses. The Wilcoxon signed ranks test shows that this difference is significant for English ($z=-2.2$, $p=0.028$) and for French ($z=-1.96$, $p=0.051$).

This is a striking difference in light of the standard characterization of the comprehension deficit in Broca’s aphasia. According to this characterization, patients show better comprehension of constructions involving movement out of the subject position than of their object counterparts. Hence, differences within two types of constructions involving movement out of the object position are unexpected. To my knowledge, the difference illustrated in table 6 has not been discussed before in the neurolinguistic literature. In discussing the English findings, both Hickok and Avrutin (1996) and Thompson et al. (1999) focus on different aspects of the data obtained on English-speaking Broca patients. They do not discuss the question why patients’ comprehension of object clefts is worse than that of object wh-questions. Still, this is an important question. It becomes all the more important in view of the fact that the French data show the same pattern. This suggests that patients’ better comprehension of object wh-questions is not a characteristic of English-speaking Broca patients only. Instead, it might be a characteristic of Broca patients in general. If this is true, the contrast illustrated in table 6 has to be explained.

Unfortunately, this contrast is also unexpected under the characterization of the comprehension deficit proposed in this thesis. I have argued that this deficit is related to the type of movement in that patients’ comprehension of constructions involving XP-movement is more impaired than that of constructions involving feature movement or head movement. However, all the constructions illustrated in table 6 involve XP-movement. The derivations of these constructions are repeated here.

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162 They concentrate on the difference between patients’ comprehension of D-linked and non D-linked questions.
163 Preliminary data of Hebrew-speaking Broca patients point in the same direction (cf. Biran & Friedmann (to appear). These patients too show a better comprehension of object wh-questions than of object clefts.
(77) Derivation of English object wh-questions and object clefts/rel.clauses
a. \[ CP \textit{Who does [IP the boy kiss t_{\text{boy}}}?] } \quad \text{XP-movement}

b. \[ \text{It is/I see the girl [CP who C^{\text{CP}} [IP the boy kisses t_{\text{boy}}]]} \quad \text{XP-movement} \]

(79) Derivation of French object wh-questions and object clefts/rel.clauses
a. \[ CP \textit{Qui est-ce que [IP le garçon embrasse t_{\text{boy}}?]} \quad \text{XP-movement} \]
\[ \text{who Q the boy kisses} \]
'Who does the boy kiss?'

b. \[ \text{C’est/Je vois la fille [CP qui que [IP le garçon embrasse t_{\text{boy}}]]} \quad \text{XP-movement} \]
\[ \text{it is/I see the girl that the boy kisses} \]
'It is/I see the girl who the boy kisses.'

As is illustrated in (77) and (78), English and French object wh-questions, clefts and relative clauses are all derived through XP-movement. Thus, the difference observed in patients’ comprehension of these constructions cannot be related to syntactic movement. Apparently, apart from movement, there are also other factors influencing comprehension in Broca’s aphasia.

I suggest that the difference between patients’ comprehension of object clefts and relative clauses on the one hand versus that of object wh-questions on the other hand is due to the complexity of these constructions. Object clefts and relative clauses are in a sense more complex than object wh-questions, since they involve embedding. As can be seen in (77b) and (78b), in object clefts and relative clauses, wh-movement occurs in an embedded CP.

There is an interesting link between the difference illustrated in table 6 and the data obtained in treatment studies performed by Thompson and colleagues (cf. Thompson & Shapiro 1995; Thompson et al. 1993; Thompson, Lange, Schneider & Shapiro 1997). In these studies, Broca patients were trained to produce sentences derived through syntactic movement. The treatment program was based on the underlying linguistic structure of these constructions. Thus, training of wh-questions involved training of the operations necessary to derive these constructions (i.e. subject-aux inversion and wh-movement). The results of these studies were that patients showed improved production of the trained constructions, but also of untrained constructions derived through the same type of movement. For instance, training patients on who-questions resulted in better production of who-questions and of what-questions, but not in better production of NP-movement derived constructions, such as passives (Thompson et al. 1993, 1997b). Of interest for the present discussion is that Thompson and colleagues observed a difference between patients’ production of object wh-questions and that of object clefts. It was observed that training object clefts resulted in generalization to object wh-questions. By contrast, training of object wh-questions resulted in better production of wh-questions, but no generalization to object clefts was found (Thompson, Ballard &
Thompson and colleagues argue that this contrast shows that successful generalization to untrained constructions depends on the complexity of the trained constructions and the direction of the treatment. It has been observed before that treatment of more complex constructions results in generalization to less complex constructions (cf. Thompson et al. 1993). Thompson et al. (1998) argue that the same effect occurs in the treatment of object clefts. Object clefts are more complex than object wh-questions, in that they involve movement in an embedded CP. Hence, training the production of object clefts improves patients’ production of object clefts and that of less complex constructions derived through the same type of movement: object wh-questions. Treatment of the less complex constructions does not result in better production of the more complex constructions.

These findings thus show that Broca patients are sensitive to embedding to the extent that constructions involving embedding are more difficult to produce for them than constructions without embedding. The data illustrated in table 6 might be taken to indicate that this is not only the case in patients’ production, but also in patients’ comprehension. Broca patients have more difficulties with the comprehension of object clefts and relative clauses than with that of object wh-questions, since the former constructions involve embedding.

The data illustrated in table 6 are a second indication that syntactic movement is not the only factor affecting comprehension in Broca’s aphasia. At several times in this thesis, it was shown that animacy also plays a role in patients’ comprehension difficulties. Broca patients have more difficulties interpreting constructions containing inanimate arguments than with those containing animate arguments. Here, we see a similar example of the influence of non-movement related factors. Apparently, the complexity of the constructions, in terms of embedding, also affects patients’ comprehension. Obviously, the influence of these and possibly other factors should be examined in more detail. Since this thesis focuses on the influence of syntactic movement, I will leave this issue for further research.

4.3. Conclusion

In this section, I have compared patients’ comprehension of wh-questions with that of clefts and relative clauses. I have argued that the results on the object variants of these constructions revealed that syntactic movement is not the only factor determining comprehension difficulties in Broca’s aphasia. Complexity in terms of embedding also plays a role. Secondly, patients’ comprehension of subject wh-questions, clefts and relative clauses was shown to be consistent with the characterization of the comprehension deficit proposed in this thesis. English-speaking Broca patients show no difference between their comprehension of subject wh-questions and that of subject clefts and relative clauses, because both involve feature movement. In contrast, French subject wh-questions and French subject clefts are derived differently. The former involves XP-movement, the latter only feature movement. This explains why French-speaking Broca patients have more difficulties with the comprehension of subject wh-questions than with that of subject clefts. I have thus discussed several findings sustaining my claim that the
comprehension difficulties in Broca’s aphasia are related to the type of syntactic movement that has taken place.

5. Accounts of the comprehension deficit

In chapter 2, section 1.2, I have discussed several accounts of the comprehension deficit in Broca’s aphasia. I have argued that it is too early to evaluate these accounts, since data concerning patients’ comprehension of many constructions involving syntactic movement are still lacking. An explanation of the comprehension deficit can only be proposed if there is a complete and detailed picture of the way in which Broca patients understand sentences derived through syntactic movement.

The accounts of the comprehension deficit discussed in chapter 2 were all based on the assumption that patients’ comprehension of sentences involving movement out of the subject position is intact, while that of their object counterparts is impaired. In the chapters 3 and 4, I have shown that this is not a proper characterization of the comprehension deficit in Broca’s aphasia, since it does not capture the data on wh-questions. I have therefore proposed a new characterization holding that patients’ comprehension of sentences derived through feature movement or head movement is less impaired than that of sentences derived through XP-movement (cf. (37)). This characterization also implies a new account of the comprehension deficit. In this section, I will develop this account and compare it to two existing accounts, namely the Trace Deletion Hypothesis and the Slowed Syntax Hypothesis.

5.1. The types of movement hypothesis

Data on wh-questions suggest that the comprehension deficit in Broca’s aphasia is related to the type of movement through which sentences are derived. The characterization of the comprehension deficit proposed in this thesis implies an account of this deficit in which the level of impairment is determined by the type of syntactic movement. Under this account, there is a complexity hierarchy which stipulates that XP-movement yields worse comprehension than feature movement or head movement. I will call this hypothesis the Types of Movement Hypothesis (TMH).

(79) Types of Movement Hypothesis

1. In Broca’s aphasia the syntactic relation between a moved item and its original position is impaired.
2. The level of impairment depends on the type of syntactic movement: XP-movement affects patients’ comprehension more severely than head movement or feature movement.

This hypothesis thus claims that syntactic movement is the crucial factor underlying the comprehension deficit in Broca’s aphasia. Patients’ comprehension of all
constructions derived through syntactic movement is impaired, but some types of syntactic movement are more impaired than others. XP-movement (80a) is more impaired than head movement (80b) or feature movement (80c).

\[(80) \begin{align*}
\text{a. } & \text{XP} \\
\text{b. } & \text{X} \\
\text{c. } & \text{FF XP/X} \\
\end{align*}\]

Recall that there are two types of accounts, structural deficit and processing accounts (cf. section 1.2, chapter 2). The difference between these two types of accounts lies in their claim concerning the grammar of the patients. Structural deficit accounts claim that patients’ grammar is impaired in the sense that the syntactic representation of a sentence derived by the grammar of Broca patients is lacking grammatical elements, such as traces. Processing accounts assume that patients’ grammar is still intact, but that patients lack the amount of processing resources needed to implement grammatical knowledge in real time. The TMH is compatible with both approaches. The TMH claims that patients have difficulties connecting a moved item to its trace position. This can either be due to a loss of traces or to a difficulty establishing the connection between the trace and the moved item. Thus, the nature of the comprehension deficit (representational or processing) remains for the moment an open question. I will return to this issue in the next chapter. In the remainder of this section, I will compare the TMH to the Trace Deletion Hypothesis (TDH) and to the Slowed Syntax Hypothesis (SSH).

5.2. Comparing the TMH and the TDH

The TDH was discussed in chapter 2, section 1.2.1. According to this hypothesis, traces of moved arguments are deleted from Broca patients’ representation of a sentence. Further, it is claimed that these patients use a heuristic, the Default Principle, to interpret sentences in which an argument has been moved. This principle assigns the Agent role to the first argument in the sentence. As a result, patients correctly assign the Agent role to arguments moved out of the subject position. This results in an above chance-level performance in sentences involving movement out of the subject position (e.g. subject clefts and relative clauses). However, arguments moved out of the object position are also assigned the Agent role. As a consequence, patients’ representation of sentences involving movement out of the object position contains two Agents. Broca patients thus have a representation in which there are two Agents. This results in a chance-level score. Below the similarities and differences of the TDH and the TMH will be discussed.

5.2.1. Interpretation of the data

The first difference between the TMH and the TDH is that the relative difficulty of several constructions distinguished by the TMH cannot be captured by the TDH.
Under the TDH, patients’ comprehension of a certain construction is either intact (above chance-level score) or impaired (at or below chance-level score). I have argued that this is too coarse a view of patients’ comprehension. French-speaking Broca patients always differ significantly from non brain-damaged speakers of French in their comprehension of wh-questions. Still, their comprehension of some wh-questions (e.g. wh-in-situ questions) is considerably better than that of other wh-questions (e.g. subject questions).

This difference follows from a different way of interpreting the data obtained on Broca patients. As mentioned before, patients’ scores on a certain construction are usually related to chance-level. This results in three levels of performance: above chance-level, chance-level, and below chance-level. This is also the interpretation on which the TDH is based, accounting for the observed levels of performance on a large variety of constructions. However, the TDH cannot explain a significant difference between two above chance-level scores. This is precisely what has been found for French object wh-questions. French-speaking Broca patients score above chance-level on both types of object wh-questions in (81), but their comprehension of questions of the type in (81a) is significantly better than that of the type in (81b).

(81) a. Le garçon arrose qui?
   the boy splashes who
   ‘Who does the boy splash?’

b. Qui est-ce que le garçon arrose?
   who Q the boy splashes
   ‘Who does the boy splash?’

The TDH only distinguishes three levels of performance and is thus not fine-grained enough to capture the difference observed on French object questions. By contrast, the TMH is based on a different way of interpreting the data, namely on the relative difficulty of two constructions compared to each other. This hypothesis can account for the observation that questions of the type in (81a) are understood better than those in (81b). Indeed, questions of the type in (81b) are derived through XP-movement, which is the type of movement affecting patients’ comprehension most severely.

5.2.2. French subject questions
In order to insightfully compare predictions made by both accounts, it is necessary to adopt the same interpretation of data. I will therefore relate the scores obtained in experiment 1 to chance-level. This yields the following results (see experiment 1 for the scores).

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164 See the results section of experiment 1 (section 3.2, chapter 3).
165 See experiment 1 for the statistics.
(82) **Results on wh-questions by French-speaking Broca patients**

<table>
<thead>
<tr>
<th>Construction</th>
<th>Performance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Qui (est-ce qui) t qui arrose le garçon?</td>
<td>chance</td>
</tr>
<tr>
<td>who (Q) splashes the boy</td>
<td>‘Who splashes the boy?’</td>
</tr>
<tr>
<td>b. Le garçon arrose qui?</td>
<td>above chance</td>
</tr>
<tr>
<td>the boy splashes who</td>
<td>‘Who does the boy splash?’</td>
</tr>
<tr>
<td>c. Qui est-ce que le garçon arrose t qui?</td>
<td>above chance</td>
</tr>
<tr>
<td>who Q the boy splashes</td>
<td>‘Who does the boy splash?’</td>
</tr>
</tbody>
</table>

The results on object questions (82b, 82c) were discussed in the previous section. Here, I concentrate on the results on subject questions, since these data show crucial differences in the predictions of the TDH as compared to the TMH. Crucially, the TDH incorrectly predicts above chance-level performance on these types of subject questions. To see this, the TDH is repeated below:

(83) **Trace Deletion Hypothesis**

a. Traces in Θ-positions are deleted from Broca patients’ representation.

b. Assign a referential NP a role by its position if it has no Θ-role.

According to this hypothesis, patients’ representation of subject questions is as illustrated in (84). In this representation, qui (‘who’) is lacking a thematic role. Thematic roles are assigned to arguments in their base position. Since traces are lacking in Broca’s representation, the moved qui is not connected to its original position and hence does not obtain a thematic role.

(84) Qui (est-ce qui) arrose le garçon?

Theme

The Default Principle (83b) does not assign a thematic role to qui, since qui is non-referential and the Default Principle only applies to referential arguments. It is therefore assumed that Broca patients infer the thematic role of qui on the basis of their available syntactic knowledge: since the role of Theme is already attributed to le garçon (‘the boy’), the only other thematic role of the verb arroser (‘splash’), i.e. the Agent role, is attributed to qui. Hence, French-speaking Broca patients are predicted to score above chance-level on subject questions. However, contrary to this prediction, chance-level score is observed.

This chance-level score can be explained by the TMH. As was explained in section 2.2.2.2 of the present chapter, French subject questions are derived through XP-movement of the wh-word. The TMH holds that this type of movement affects patients’ comprehension most severely. Suppose that this means that for this type of
movement, patients can no longer connect a moved item to its trace.\textsuperscript{167} Similar to the assumptions of the TDH, it follows that patients’ representation of sentences of the type in (82a) is as in (84). Contrary to the TDH, I do not assume that patients use their available syntactic knowledge to assign a thematic role to \textit{qui}. Instead, I propose that an incomplete representation, such as (84), causes the derivation to crash. As a result, patients cannot interpret these sentences. Therefore, they guess and score at chance-level.

Note that my interpretation of chance-level performance differs considerably from the one used in the context of the TDH. Under the TDH, chance-level performance is supposed to arise from a conflicting situation (namely a representation containing two Agents). The interpretation of chance-level I adopt here was proposed by Hickok et al. (1993). They showed that in constructions yielding chance-level performance (such as object clefts), patients did not construct any representation at all. Instead, these sentences appeared to be completely infelicitous constructions for Broca patients. Their suggestion that the linguistic system does not provide an interpretable analysis for these types of constructions is in line with my suggestion that the derivation crashes. If this happens, patients cannot interpret the sentence and will resort to guessing in a forced-choice task.

To conclude, the TMH, in contrast to the TDH, can account for the chance-level performance on subject questions observed on French-speaking Broca patients.

\textbf{5.2.3. French object questions}

The TMH and the TDH also make different predictions with respects to patients’ comprehension of object questions. Following the same reasoning as explained above for subject questions, the TDH predicts that patients score above chance-level on these constructions. \textit{Qui} in (82b) has no thematic role, but patients correctly assign it the role of theme since \textit{le garçon} (‘the boy’) bears the Agent role.

Contrary to the TDH, the TMH predicts chance-level scores for object questions of the type in (82c). These questions are derived through XP-movement. Patients are thus unable to connect to moved wh-word to its trace, resulting the derivation to crash. As explained above, this predicts a chance-level performance on object wh-questions of the type in (82c). Thus, the TDH and not the TMH makes the correct prediction for object questions of the type in (82c).

In sum, the results on French object questions are problematic for both accounts. The TMH cannot explain the above chance-level performance on object questions of the type in (82c), while the TDH can. By contrast, the TDH cannot account for the patients’ better comprehension of object questions of the type in (82b) versus those of the type in (82c), whereas this can be captured by the TMH (cf. section 5.2.1).

\textsuperscript{167} Following this assumption, it has to be assumed that patients are able to connect moved heads and features to their traces, but that this connecting is no longer established automatically and is therefore sometimes not done correctly. This results in errors in comprehension tasks. This is very similar to assumptions of processing accounts, to which I will turn in section 5.2.
5.2.4. Clefts and relative clauses
Both the TDH and the TMH can account for the observed pattern on clefts and relative clauses: above chance-level comprehension of subject clefts and relative clauses and chance-level comprehension of their object counterparts. For the TDH, this was explained in section 1.2.1 of chapter 2. The TMH explains the pattern as follows. In section 3 of the present chapter, it was argued that subject clefts and relative clauses involve feature movement, i.e. the type of movement schematized in (80c). Patients are able to construct this relation, but it does no longer take place automatically. As a result, patients sometimes select the wrong picture and score lower than non brain-damaged speakers. However, their linguistic system does assign an interpretation to these constructions, yielding the above chance-level score. By contrast, object clefts and relative clauses involve XP-movement of the wh-operator and are thus derived through the type of movement in (80a). As explained above, the TMH predicts chance-level score in constructions involving XP-movement. In these cases, the derivation crashes and no interpretation is assigned to these structures.

5.2.5. Head movement
The data concerning the effect of head movement on patients' comprehension show an intricate picture. On the one hand, findings from French and Hebrew-speaking Broca patients suggest that patients' comprehension of sentences derived through head movement is impaired (cf. respectively section 2.3.3 and Friedman et al. (to appear)). On the other hand, it has been observed that patients correctly judge the (un)grammaticality of sentences derived through head movement (cf. Grodzinsky & Finkel (1998)).

This difference can be captured by the TMH. This hypothesis holds that patients are able to relate a moved head to its trace, but that this connection is no longer established automatically. The effort patients have to make in order to create the connection in (80b) results in errors in comprehension tasks. However, since this connection is not disrupted, patients are still sensitive to violations of head movement. This explains the findings obtained in grammaticality judgment tasks.

By contrast, the difference in patients' performance on comprehension tasks versus that on grammaticality judgment tasks, is difficult to account for under the TDH. According to the TDH, only traces of moved arguments are deleted. Hence, head movement is claimed to be intact in Broca's aphasia. This is in line with the findings observed in grammaticality judgment tasks, but not with those observed in comprehension tasks.

5.2.6. Adjunct movement
According to the TDH, the movement deficit in Broca's aphasia is restricted to moved arguments. As a result, the TDH cannot account for the observation that patients' comprehension of sentences of the type in (85b) is worse than that of the type in (85a).
(85) a. La fille dort sur qui?
the girl sleeps on who
‘On who does the girl sleep?’
b. Sur qui est-ce que la fille dort?
on who Q the girl sleeps
‘On who does the girl sleep?’

This difference can be explained by the TMH, because questions of the type in (85b) are derived through a type of movement that affects patients’ comprehension more severely than the type of movement underlying questions of the type in (85a).

5.3. Comparing the TMH and the SSH

The Slowed Syntax Hypothesis (SSH) is a processing account: it assumes that patients’ grammar is intact, but that a processing deficit prevents patients from implementing their grammatical knowledge in real time. As explained in chapter 2, the SSH is based on the observation that parsing is slowed down in Broca’s aphasia (cf. section 1.2.2.2). It claims that this slowing down prevents syntactic structure from being built in real time, allowing other mechanisms to intervene which yield alternative interpretations. For instance, in sentences involving movement out of the object position, patients rely on a strategy assigning the Agent role to the first NP in the sentence. Hence, the moved object is interpreted as the Agent. When at a later stage syntactic structure becomes available, this yields a different interpretation in which the moved object is given the role of Theme. These two interpretations compete, resulting in chance-level performance. If syntactic structure and non-syntactic mechanisms converge towards the same interpretation, patients are predicted to score above chance-level. Below I will discuss differences and similarities between this hypothesis and the TMH.

5.3.1. Data on French wh-questions

The data obtained on French-speaking Broca patients have been discussed in sections 5.2.1 through 5.2.3. In explaining these data the SSH runs into some of the same problems as the TDH. I can therefore discuss these problems more briefly here.

The SSH is similar to the TDH in that it is based on a different interpretation of the data than the one adopted in this thesis. The SSH accounts for chance-level and above chance-level performance. It is unable to distinguish between scores within each of these levels of performance. As a result, the SSH, like the TDH, cannot explain why French-speaking Broca patients show better comprehension of wh-in-situ object questions than of their counterparts involving overt wh-movement (see section 5.2.1). By contrast, the TMH can account for this finding.

Turning now to French subject questions, the SSH at first sight seems to make the same prediction as the TDH, namely above chance-level performance. Syntactic structure assigns the role of Agent to the moved qui in (86). Similarly, a strategy assigning the Agent role to the first argument in the sentence also yields to an interpretation in which qui is the Agent and le garçon the Theme of the verb.
Qui (est-ce qui) arrose le garçon?

Who splashes the boy

‘Who splashes the boy?’

The SSH thus seems to be unable to account for the chance-level performance observed for these constructions (cf (82a)). However, as was pointed out to me by Avrutin (p.c.), the results on French subject questions can be argued to be in line with the SSH. The reasoning is as follows. Recall that French allows a construction called stylistic inversion in which subjects appear in a postverbal position. The relevant examples were given in (9) and repeated here as (87).

(87) a. Où a mangé Jean?

where has eaten Jean

‘Where did John eat?’

b. L’homme à qui a téléphoné ton ami.

the man to whom has telephoned your friend.

‘The man to whom your friend has telephoned.’

c. Je souhaiterais que téléphone ton ami.

I wish- subj that telephones your friend

‘I would wish that your friend calls.’

Suppose that for French-speaking Broca patients the use of postverbal subjects is no longer restricted to the stylistic inversion construction, but is allowed in other contexts as well. In that case, patients could interpret le garçon in (86) as the Agent of the action. Later, syntactic structure assigns the role of Theme to this argument. Patients thus have two different interpretations for sentences of the type in (86), which results in a chance-level score.

The chance-level score observed on French subject wh-questions can thus be explained by the SSH. However, this explanation runs into problems with respect to patients’ performance of subject relative clauses. As can be seen in (87b), stylistic inversion is also allowed in relative clauses. Hence, patients are predicted to have two interpretations for the sentence in (88), one in which le garçon is the Agent and one based on syntactic structure in which le garçon is the Theme. Contrary to the above chance-level observed for this construction168, the SSH thus predicts that patients score at chance-level on sentences of the type in (88).

(88) Je vois la fille qui frappe le garçon.

I see the girl that hits the boy

‘I see the girl that hits the boy.’

Under the SSH extra assumptions are needed to explain why patients assign the Agent role to postverbal NPs in wh-questions, but not in relative clauses.

Finally, as was explained in section 5.2.3, the TMH cannot account for the above chance-level performance obtained on French object questions of the type in (82c).

168 See table 2, chapter 3.
This observation is also problematic for the SSH. Indeed, the SSH predicts that patients score at chance-level on these constructions, since there is a competition between two interpretations. Syntactic structure yields the correct interpretation in which *qui* is the Theme and *le garçon* the Agent. Alternative mechanisms yield an interpretation in which *qui* is the Agent and *le garçon* the Theme.

(98) Qui est-ce que le garçon arrose?
who Q the boy splashes
‘Who does the boy splash?’

Avrutin (2000) has argued, however, that in comprehending constructions involving movement of non D-linked items, such as *qui*, patients solely rely on the syntactic structure. Under this assumption, the above chance-level performance on constructions such as (89) is expected.

To sum up, the SSH cannot explain some of the data obtained on French-speaking Broca patients that can be captured under the TMH. The TMH, but not the SSH, accounts for patients’ better comprehension of wh-in-situ object questions versus that of object questions involving overt wh-movement as well as for the chance-level performance on French subject questions. By contrast, the TMH cannot explain the above chance-level performance observed on French object questions of the type in (89). Under the SSH, this finding might be accounted for. I will now discuss the data on other constructions involving syntactic movement and on other types of syntactic movement.

5.3.2. Clefts and relative clauses
In section 5.2.4, it was shown that the TMH can account for the subject/object asymmetry observed in patients’ comprehension of clefts and relative clauses. This pattern is also straightforwardly explained under the SSH (see Avrutin 2004). Patients score at chance-level on object clefts and relative clauses, because there is a competition between two different interpretations of these constructions. Nonsyntactic mechanisms yield an interpretation in which the moved object bears the Agent role. Syntactic structure yields the correct interpretation in which the moved object is the Theme of the action. For subject clefts and relative clauses, syntactic structure and non-syntactic mechanisms derive the same interpretation. Hence, patients score above chance-level on these constructions.

5.3.3. Head movement and adjunct movement
In sections 5.2.5 and 5.2.6, it was argued that the TMH can account for the observations on head movement and for those on adjunct movement. The supporters of the SSH, Piñango (2003) and Avrutin (2004), do not discuss these types of movement. It is therefore difficult to examine whether the SSH can capture the findings discussed in the sections 5.2.5 and 5.2.6. I will leave this as a question for further research.
5.4. Conclusion

The characterization of the comprehension deficit proposed in this thesis implies an account of this deficit according to which the level of impairment is determined by the type of syntactic movement through which sentences are derived. I have argued that this account is compatible with both a structural deficit and a processing deficit hypothesis. Broca patients are unable to connect moved XPs to their traces, either because this trace is no longer present or because this connection requires more processing resources than these patients can use in real time.

I have shown that the account proposed in this thesis is more fine-grained than accounts explaining patients’ performance in terms of chance-level, such as the TDH or the SSH. As a result, the TMH is the only account capable of explaining patients’ better comprehension of object wh-in-situ questions versus that of object wh-questions involving overt movement of the wh-word.

Further, the TMH explains several findings that cannot be accounted for under the TDH or the SSH. The TMH offers a straightforward explanation of the chance-level score observed on French subject questions. Secondly, the TMH is not restricted to moved arguments and as such also captures the findings observed on constructions involving head movement or adjunct movement.

Finally, it was argued that the TMH does not only capture the findings on wh-questions, but also those on clefts and relative clauses. Thus, the TMH can account for the same findings as those explained by the TDH and the SSH (the pattern observed on clefts and relative clauses), but it can also account for findings that remain unexplained under the TDH and the SSH (i.e. some of the findings concerning wh-questions). The approach taken in this thesis has thus led to both a more fine-grained characterization and a new account of the comprehension deficit in Broca’s aphasia.

6. Summary and conclusion

6.1. The relation between syntactic movement and comprehension deficits

In this chapter, I have compared and discussed patients’ comprehension of several constructions involving syntactic movement, namely wh-questions, clefts, and relative clauses. I have focused on the data obtained on French- and English-speaking Broca patients. The following findings were discussed.

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\[169 \text{I have deliberately excluded the data on active and passive sentences from this discussion. As was noted in chapter 2, these sentences involve a different type of movement: NP-movement. By contrast, the category moving in wh-questions, clefts, and relative clauses is not an NP, but a wh-element. Since the data on these constructions are already highly complicated, I did not want to add another set of data (actives and passives). Clearly, these data have to be discussed at some point in the future. Ultimately, one hopes to find a characterization of patients’ comprehension of all the constructions involving syntactic movement.}\]
Syntactic movement and comprehension difficulties in Broca’s aphasia

Wh-questions
- English-speaking Broca patients comprehend subject and object wh-questions equally well (section 2.3.1).
- French-speaking Broca patients comprehend object wh-questions better than subject questions (section 2.3.2).
- With the exception of what-questions, French-speaking Broca patients comprehend wh-in-situ object questions better than their counterparts involving overt wh-movement (section 2.1).
- French-speaking Broca patients show no difference between their comprehension of in-situ what-questions and what-questions involving overt wh-movement (section 2.3.3).
- French-speaking Broca patients have more difficulties with the comprehension of subject wh-questions than English-speaking Broca patients do (section 2.2).

Clefts and relative clauses
- Both English- and French-speaking Broca patients show better comprehension of subject clefts and relative clauses than of their object counterparts (section 3).

Wh-questions versus clefts/relative clauses
- English-speaking Broca patients comprehend subject wh-questions, clefts and relative clauses equally well (section 4.1).
- French-speaking Broca patients show better comprehension of subject clefts/relative clauses than of subject wh-questions (section 4.1).
- Both English- and French-speaking Broca patients show better comprehension of object wh-questions than of object clefts and relative clauses (section 4.2)

I have argued that many of these findings cannot be captured under the standard characterization of the comprehension deficit in Broca’s aphasia or on accounts based on this characterization. According to this characterization, patients’ comprehension of constructions involving subject movement is better than that of constructions involving object movement. This does describe the findings on clefts and relative clauses in (90b), but not those summarized in (90a) and (90c). Based on these findings I have therefore argued that the relation between syntactic movement and patients’ comprehension difficulties is not determined by the position out of which an element has moved, but by the type of movement that has taken place. This resulted in a new characterization of the comprehension deficit, given in (37) and repeated here as (91).

Syntactic movement and comprehension in Broca’s aphasia
Patients have more difficulties with the comprehension of constructions involving XP-movement than with those involving feature movement or head movement.

I have shown that this characterization covers almost all of the findings in (90). The only observation that remains unexplained concerns the comprehension of wh-
questions by English-speaking Broca patients (cf. the first bullet in (90a)). These patients show no difference in their comprehension of subject and object wh-questions. Still, English subject questions involve only feature movement, whereas object questions involve XP-movement. Under the characterization in (91), it is thus expected that English-speaking Broca patients show better comprehension of subject than of object wh-questions. Note however, that this observation is also problematic for the standard characterization of the comprehension deficit in Broca’s aphasia. Thus, although the characterization in (91) does not cover all data concerning comprehension in Broca’s aphasia, it does at least capture more data than the standard characterization did.

It was further observed that syntactic movement is not the only factor underlying the comprehension difficulties of Broca patients. Syntactic complexity, in terms of embedding also seems to affect patients’ comprehension. This explained why patients’ comprehension of object wh-questions is considerably better than that of object clefts and relative clauses (i.e. the last bullet in 90c).

It is, of course, possible that future research will show that syntactic movement and patients’ comprehension are related in yet another way. For now, it is sufficient to conclude that the characterization in (91) covers more data than the standard characterization. Adopting this characterization has important consequences for the accounts of the comprehension difficulties of Broca patients. The accounts discussed in chapter 2, section 1.2 all tried to explain why constructions involving movement out of the subject position are better understood than their object counterparts. If (91) is correct, this is no longer the question to answer. Instead, the question becomes: why is category movement more difficult than feature movement or head movement? This question will be discussed briefly in the next chapter.

Before doing so, there is one other issue that came up frequently in this chapter and with which I would like to conclude this chapter.

6.2. The relation between neurolinguistics and theoretical linguistics

It has been shown several times in this chapter that the relation between neurolinguistics and theoretical linguistics is of a mutual kind. Theoretical linguistics provides well-defined tools for a fine-grained description of the data obtained on Broca patients. This has led to the characterization in (91). At the same time, the data of Broca patients, in combination with (91), provide new input for research in the field of theoretical linguistics. For instance, it favors a new analysis for clefts and relative clauses in English and French. I have shown that this analysis has several advantages over the standard analysis of clefts and relative clauses. Thus, it shed new light on the que-qui change in French subject clefts and on the absence of the that-trace effect in the English ones. Further, it accounted for the subject/object asymmetry clauses relativized over V NP idioms.

Apart from suggesting alternative syntactic analyses, the data of Broca patients can also be used in research on open issues in theoretical linguistics. One of these issues concerns the relation between feature movement and category movement. It is still unclear whether movement always consists of two steps, namely feature movement followed by category movement. It might also be that feature movement
is a phenomenon in its own right. Further, the conditions determining the need for category movement should be worked out in more detail. The data of Broca patients have shown that adjacency is clearly not the proper condition.

It has been shown more often that the knowledge acquired in theoretical linguistics and the tools used in this field are useful for neurolinguistics research (cf. Avrutin 2001 for a comprehensive overview). With this chapter, I hope to have shown that this relation is mutual. Neurolinguistics does not only profit from theoretical linguistics, but also gives new input to this discipline by suggesting alternative analyses and new research questions.
5 Further research and conclusion

In this thesis, it was shown that patients’ comprehension of wh-questions differs from that of other constructions involving syntactic movement. I have proposed a new characterization of the comprehension deficit in Broca’s aphasia and the way in which this deficit is related to syntactic movement. In particular, I have argued that XP-movement affects patients’ comprehension more severely than feature movement or head movement do. This characterization gives rise to a number of questions requiring further research. In this last chapter of the thesis, I will discuss some of these questions. This will be done in section 1. Section 2 places the research performed for this thesis in a broader perspective. It examines whether other language difficulties of Broca patients, such as their production difficulties and their difficulties with non-movement derived constructions, are related to the observations discussed in this thesis. Finally, section 3 offers a summary and conclusion of the research results of this thesis.

1. Further research

In the previous chapter, I have argued that the comprehension deficit in Broca’s aphasia is related to the type of movement through which sentences are derived. Patients’ comprehension of constructions involving feature movement or head movement is less impaired than that of constructions involving XP-movement. Obviously, the question now arises why this would be the case. This question can be subdivided into two questions, given in (1).

(1) a. Why do feature movement and head movement have less effect on the comprehension of Broca patients than XP-movement?
    b. Why is there no difference between patients’ comprehension of constructions involving feature movement and those involving head movement?

These questions have theoretical linguistic and neurolinguistic aspects. I will discuss these aspects separately in sections 1.1 and 1.2, respectively. For both domains, I will also briefly point out other questions for further research arising from the research discussed in this thesis.

1.1. Future research: theoretical linguistics

The questions in (1) both center around the nature of feature movement. In order to answer the questions in (1), it is necessary to know what feature movement is. Crucially, this is currently a topic of research in theoretical linguistics. The notion of
feature movement is relatively new and many of its aspects are still unknown.\textsuperscript{170} It is unclear, for instance, whether feature movement is a subtype of a familiar movement process (e.g. head movement) or whether it is a truly distinct type of movement. In discussing the questions in (1), I will therefore also examine whether the data of Broca patients shed any new light to the nature of feature movement. Do these data provide an answer to open questions concerning feature movement?

1.1.1. Feature movement: the notion of economy

Let me start out with the question why feature movement is apparently an easier type of movement for Broca patients than XP-movement. When Chomsky (1993, 1995) introduced the notion of feature movement, he claimed that this was the most economical type of movement. Recall that in his Minimalist Program, movement is triggered by the need for feature checking. A head has certain features that need to be checked. Hence, this head ‘looks’ into the sentence to find another element bearing the same type of features. Chomsky assumed that instead of attracting this entire element, the head attracts only the smallest possible unit, i.e. the features of the element.

The idea behind this assumption is that words consisting of several parts are complex items and hence more difficult to move. I will illustrate this by means of the French wh-word \textit{qui} (‘who’). It is assumed that this wh-word is composed of several units, called \textit{features}. There are two types of features: formal features and phonological features. Formal features indicate morpho-syntactic aspects of the lexical item. Phonological features indicate the pronunciation of the item. In (2) both types of features for \textit{qui} are illustrated.

\begin{equation}
\begin{array}{c}
\text{WH} \\
\text{3rd PERS SING} \\
\text{CASE} \\
\hline
\text{[ki]} \\
\hline
\end{array}
\end{equation}

Feature movement involves movement of the formal features, while the phonological features remain behind. Chomsky (1995) assumed that it is easier to move one set of features (e.g. the set of formal features) than to move two sets of features (e.g. the formal features and the phonological features). This idea is very plausible. Obviously, one box weighs less than two boxes. Hence, moving one box (e.g. the box of formal features) is easier than moving two boxes. In other words, feature movement is easier than XP-movement, which involves movement of both the formal and the phonological features.

\textsuperscript{170} Recall the discussion in chapter 1, section 2.4 concerning the question whether feature movement is the first step of the two-step movement operation as proposed by Chomsky (1995) or whether it is a phenomenon in its own right.
However, although this assumption is plausible, it is unclear whether it is correct. In fact, there is no empirical evidence showing that it is. Moreover, the opposite idea could be equally true. Thus, as argued by Brody (1997) and Pesetsky (2000), it can also be claimed that movement of the entire word is an easier operation than feature movement. Consider what feature movement is: extraction of a box out of a larger constituent and movement of this box to somewhere else. It is not unthinkable that such an operation is more difficult than simply moving an entire category.

Linguists thus do not agree on the question whether feature movement is the most economical movement operation or not. Interestingly, the data of Broca patients might shed light on this issue. These patients are sensitive to computational complexity to the extent that easier constructions are better produced and understood. The more complex a construction, the more Broca patients suffer in producing and comprehending this construction. Thus, the observation that Broca patients comprehend constructions involving feature movement better than those involving XP-movement suggests that feature movement is indeed an easier type of movement. In other words, the data of Broca patients accord with Chomsky’s ideas on feature movement. This type of movement is the most economical type of movement. It involves movement of a ‘lighter’ element than the element moved in XP-movement.

Note, however, that such a conclusion can only be drawn if there is empirical evidence showing that constructions involving feature movement are indeed easier to parse than those involving XP-movement. Only if this is the case, can we safely assume that Chomsky’s notion of economy is related to computational complexity to the extent that the most economical operation (i.e. feature movement) requires the least amount of processing resources. In order to obtain this type of evidence, well-designed psycholinguistic experiments are needed. I will discuss some of these experiments in section 1.2.1. For now, it is sufficient to conclude that a possible answer to the question in (1a) might be: feature movement has less effect on patients’ comprehension because feature movement is an easier type of movement.

1.1.2. Feature movement and head movement
In this thesis, I have argued that patients’ comprehension of constructions involving head movement or feature movement is better than that of constructions involving XP-movement. The preceding section discussed the question why feature movement would have less effect on patients’ comprehension than XP-movement. Here, I address the second question following from the proposed characterization (i.e. question (1b)): why is there no difference between patients’ comprehension of constructions involving feature movement and those involving head movement?

A possible answer to this question is that feature movement is an instance of head movement. This assumption is not as strange as it might seem at first sight, since feature movement and head movement involve the same type of operation. Both involve movement of an element to a head position. This is illustrated in (3), where the structure of French wh-in-situ questions is repeated.

\[171\] Recall for instance the discussion in chapter 3, section 4, in which it was shown that in repetition tasks Broca patients tend to produce a more simple sentence when asked to repeat a complex one.
As can be seen in (3), the wh-features of the wh-word have moved into C and not into Spec,CP. Since only heads can move into head positions, it might be argued that features are heads and hence that feature movement is head movement. If this is true, the proposed characterization of the comprehension deficit can be simplified. It would then become: patients’ comprehension of constructions involving head movement is better than that of constructions involving XP-movement. The observations concerning feature movement would be subsumed under head movement. Thus, this new version still accurately describes the difference between feature movement and XP-movement and it also captures the absence of a difference between feature movement and head movement.

Such a simplification of the characterization would obviously be a desirable goal. However, there are at least two arguments against the claim that feature movement is head movement, given by Simpson (2000). First of all, features and heads differ with respect to their categorical status. Heads are syntactic categories, such as V or N. Features, by contrast, occur inside a category. Features are not syntactic categories, but properties of a syntactic category. Hence, despite the fact that feature movement and head movement have similar landing sites (namely head positions), the two involve different types of moving elements. Secondly, feature movement and head movement have different characteristics. As argued in chapter 2, feature movement is subject to the intervention effect. The intervention of a quantifier blocks in-situ licensing of the wh-word.

(4) a. L’enfant aime qui?
   the child loves who
   ‘Who does the child love?’

b. * Tous les enfants aiment qui?
   all the children love who
   ‘Who do all the children love?’

The structure of (4b) is illustrated in (5) below. In this structure, the wh-features of the wh-word have to move to C in order to check the wh-features of C. However, this movement is not possible. As can be seen in this structure, feature movement is not allowed to cross intervening elements such as quantifiers.
Head movement, by contrast, is not sensitive to the intervention effect. This can be seen in the example in (6). In English yes/no questions, the auxiliary moves from the I-position into the C-position. As is illustrated below, this head movement is not blocked by the presence of the quantifier *all*.

(6) \[ \text{CP Did } \text{[IP all the children did [VP eat their breakfast?]]} \]

On the one hand, there is thus evidence suggesting that feature movement is an instance of head movement. Both operations involve movement into a head position. Since only heads can move into head positions, it follows that feature movement must be a specific case of head movement. On the other hand, there are several differences between feature movement and head movement. Some linguists use these differences as an argument against the claim that feature movement is the equivalent of head movement.

The data of Broca patients might again shed light into this theoretical debate. Since there is no difference between the effects of both types of movement on patients’ comprehension, it might be argued that they are indeed similar operations. The data of Broca patients show that these types of movement are both easier than XP-movement. Thus, despite the fact that head movement and feature movement show several syntactic differences, they apparently require both less processing resources than XP-movement does. As was explained in the previous section, any claim concerning the parsing complexity of different types of movement can only be adopted if there is empirical evidence sustaining it. The question thus becomes whether there is any evidence suggesting that constructions involving head movement are as easy to parse as those involving feature movement? This is a question for research in the field of psycholinguistics, to which I will turn in section 1.2.2. Before going there, there is one other topic of debate in theoretical linguistics that is relevant to our discussion here. This concerns the question whether features do really move. This question will be addressed in the next section.

1.1.3. *Is feature movement really movement?*

Currently, there is a debate in the linguistic literature concerning the question whether feature movement is indeed a *movement* operation. Do features really move? Chomsky (2000, 2001) has argued that they do not and that feature movement should be replaced by *Agree*.\(^{172}\) Leaving technical details aside, Agree merely establishes a link between an attracting head and the features it seeks, but

\(^{172}\) I will not discuss the arguments against the assumptions of movement in “feature movement”. See Chomsky (2000), Simpson (2000), and Pesetsky (2000) for a discussion.
nothing moves. For French wh-in-situ this means that Agree ensures a relation between C and the in-situ wh-word, but that the wh-features of the wh-word remain inside their lexical item and do not move to C. This is illustrated below. The construction in (7) differs from the one in (3) in that the wh-features of qui (‘who’) have not been moved to C.

(7) [CP C [IP l’enfant aime qui?]]

The consequence of the Agree relation in (7) is that the wh-features of C can be checked. Under Agree, feature checking thus does not involve feature movement. In any technical implementation of this idea, phenomena that were previously seen as restrictions on feature movement, such as the intervention effect, are now seen as locality conditions. It is claimed that the Agree relation, although long-distance, is not free, but bound to a certain local domain (see for instance Simpson 2000).

Others argue, however, that feature movement cannot be replaced by Agree. This position is for instance taken by Cheng and Rooryck (2003). They note that Agree forms the basis for every movement operation. Indeed, in Chomsky (2001) movement is seen as Agree plus Move. Thus, every movement operation starts out with an Agree relation, followed by movement of the relevant element. Hence, if Agree is the basis for every movement operation, it is predicted that every movement operation bears at least the characteristics of Agree. If movement consists of two steps, Agree plus Move, every movement operation is subject to the same restrictions as Agree plus potentially other restrictions related to Move. Now, if the phenomenon previously called feature movement should be replaced by Agree, it follows that Agree bears the characteristics of this phenomenon. Hence, Agree is sensitive to the intervention effect. Following the reasoning explained above, it is thus predicted that every movement operation is also subject to the intervention effect. However, it can easily be shown that this prediction does not hold. XP-movement is clearly not subject to the intervention effect. This is illustrated by the contrast in (8).

(8) a. * Tous les enfants aiment qui?
all the children love who
‘Who do all the children love?’
b. Qui est-ce que tous les enfants aiment t qui?
who Q all the children love
‘Who do all the children love?’

The grammaticality of (8b) shows that French XP-movement is allowed to cross quantifiers. If the wh-in-situ question in (8a) does not involve feature movement, but Agree, the contrast between (8a) and (8b) cannot be explained. If both (8a) and (8b) involve Agree, both are expected to be ungrammatical. The contrast between (8a) and (8b) thus shows that the process underlying (8a) differs from that underlying
Cheng and Rooryck (2003) conclude that feature movement is a phenomenon in its own right, with its own characteristics, and involving movement (see also Lasnik 2002).

The debate summarized above is important for the data of Broca patients discussed in this thesis. If the phenomenon called ‘feature movement’ is actually not a movement operation, the characterization of the comprehension deficit proposed in this thesis should be completely revised. Indeed, it is based on many data which on this view do not involve movement. If feature movement should be replaced by Agree, constructions such as French wh-in-situ questions and English subject questions do no longer involve movement. Hence, the data on these constructions should no longer be taken into account in any study aiming to characterize the relation between syntactic movement and patients’ comprehension deficits. Thus, under any approach replacing feature movement by Agree, the characterization proposed in this thesis can no longer be maintained. Instead, we should exclude all the data on constructions involving feature movement and propose a new characterization of the remaining data. Further, it should be examined in what way Agree affects comprehension in Broca’s aphasia. To my knowledge, there is no empirical evidence bearing on this issue.

Alternatively, if we adopt the claim that feature movement does involve movement, the characterization proposed in this thesis can be maintained. Under this approach feature movement is a movement operation distinct from other movement operations, such as XP-movement. The data of Broca patients then show that this difference is not only a theoretical difference. Broca patients are sensitive to the type of movement by which constructions are derived. Feature movement has less effect on patients’ comprehension than XP-movement.

In this thesis, I have taken the second approach. I have shown that this view on feature movement sheds new light on the relation between syntactic movement and the comprehension deficit in Broca’s aphasia. However, the alternative view on feature movement cannot be excluded. As yet, there is no clear-cut evidence showing that feature movement is an operation in which the features of a certain element really move to a higher position. As long as this evidence is lacking, it is impossible to make a well-grounded choice between both alternatives. Future research on feature movement will hopefully show whether the approach taken in this thesis was correct.

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173 See Ochi (1999) for an examination of the characteristics of feature movement and those of XP-movement.
174 See however Gavarró (2002) for some comments concerning the status of Agree in Broca’s aphasia.
175 The argument presented by Cheng and Rooryck (2003) is a strong argument against the idea that feature movement can be replaced by Agree. However, it is not necessarily an argument in favor of the idea that features do really move. The intervention effect could be related to semantic rather than syntactic aspects of the clause. Alternatively, it might be argued that Agree is indeed sensitive to the intervention effect, but that the effects of Agree are in some sense overruled by those of Move. Thus, movement operations do not necessarily show the same characteristics as Agree.
1.2. Future research: neurolinguistics

The characterization of the comprehension deficit in Broca patients proposed in this thesis gave rise to two questions. These questions were given in (1) and are repeated below for convenience.

(9) a. Why do feature movement and head movement have less effect on the comprehension of Broca patients than XP-movement?
b. Why is there no difference between patients’ comprehension of constructions involving feature movement and those involving head movement?

In the previous section, I have discussed these questions from a theoretical linguistic point of view. I have shown that theoretical arguments might be put forward to propose the following answers to these questions: (a) feature movement is the most economical and hence the easiest type of movement; (b) feature movement is an instance of head movement. Hence, there might be no difference between the processing resources needed to parse both operations. I have also argued that evidence from psycho- and neurolinguistic experiments is required to verify these answers. The questions in (9) can thus now be rephrased as follows.

(10) a. Do constructions involving XP-movement require more processing resources than constructions involving feature or head movement?
b. Do constructions involving feature movement and those involving head movement require the same amount of processing resources?

These questions will be discussed in sections 1.2.1 and 1.2.2. In sections 1.2.3 and 1.2.4, I will discuss two other questions for further neurolinguistic research.

1.2.1. Processing: feature movement versus XP-movement

In section 1.1.1, it was argued that feature movement is an easier type of movement than XP-movement. Hence, it is expected that feature movement requires less processing load than XP-movement. How can we verify this assumption? In psycholinguistics, the relative complexity of a certain construction is usually determined by on-line experiments on non brain-damaged adults. For instance, de Vincenzi (1996) compared the processing complexity of several types of Italian wh-questions by means of a self-paced reading task. Non brain-damaged speakers of Italian were asked to read a wh-question on a computer screen. By pressing a button a new question appeared. Each question was followed by a comprehension task to examine whether subjects correctly understood the question. One of the results of this experiment was that Italian who-questions are read faster than Italian which-questions. This suggests that which-questions require more processing resources than who-questions (see also Avrutin 2000; Shapiro 2000).

If feature movement is an easier type of movement than XP-movement, a processing difference between the two types of operations is expected. In other words, non brain-damaged adults should parse constructions involving feature
movement quicker than those involving XP-movement. This prediction can be examined using a self-paced reading task. For instance, it would be interesting to compare reading times of non brain-damaged speakers of French on the two types of object questions illustrated in (11).

(11)  
   a. La fille embrasse qui?  
       the girl kisses who  
       ‘Who does the girl kiss?’  
   b. Qui est-ce que la fille embrasse?  
       who Q the girl kisses  
       ‘Who does the girl kiss?’

If questions of the type in (11a) are read faster than those of the type in (11b), this shows that constructions involving feature movement are indeed easier to parse. This in turn, would allow us to conclude that Broca patients show better comprehension of constructions involving feature movement than of those involving XP-movement, because the former type of movement requires less processing resources. I hope to perform such an experiment in the future.

1.2.2. Processing: feature movement and head movement

Following the same reasoning as explained above, it is necessary to set up experiments comparing the processing of constructions involving head movement and those involving feature movement. If no difference is observed, it can be concluded that both types of movement belong to a class of easier movement operations. This would explain why there is no difference between the effects of both types of movement on the comprehension abilities of Broca patients.

I have argued that French wh-in-situ what-questions (12a) are derived through feature movement. Their counterparts of the type in (12b) involve head movement (see chapter 3, section 3.3).

(12)  
   a. Tu as acheté quoi?  
       you have bought what  
       ‘What did you buy?’  
   b. Qu’est-ce que tu as acheté?  
       what Q you have bought  
       ‘What did you buy?’

If feature movement and head movement are both easier types of movement, no processing difference between the two types of questions in (12) is expected. To my knowledge, there is no empirical evidence bearing on this issue. Further research is thus required to show whether the above-mentioned prediction is correct.

In this and the preceding section, I have argued that the comprehension deficit of Broca patients might be explained in terms of a processing deficit. On this view, these patients have less difficulty comprehending constructions involving feature or head movement than those involving XP-movement because the former types of movement require fewer processing resources. However, empirical evidence
sustaining this assumption is still lacking. Further psycholinguistic experiments will hopefully make clear whether this conclusion on the nature of the comprehension deficit in Broca patients can indeed be drawn. In the following two sections, I will briefly point out two other questions for further research that arise from the research done for this thesis.

1.2.3. Comprehension of other constructions involving feature movement

The observation that patients’ comprehension of questions of the type in (11a) is better than that of the type in (11b) was one of the reasons for assuming that feature movement has less effect on patients’ comprehension than XP-movement (cf. section 2.1 chapter 4). The question arises whether there are other constructions similar to French object wh-questions in (11). If so, it would be interesting to examine whether patients’ comprehension of these constructions patterns with that observed on French object wh-questions. In other words, are there other constructions allowing two variants that do not differ in meaning, but that do differ in the type of movement underlying them? One of these variants should involve feature movement, the other overt XP-movement. If these constructions exist, do Broca patients show better comprehension of the variant derived through feature movement than of that derived through overt XP-movement?

It is hard to find constructions paralleling the French object wh-questions in (11). However, there is one construction that is very similar to the sentences in (11): partial movement in German. This construction has been mentioned in chapter 1, section 2.4. The relevant examples are repeated here.

(13) a.  
[[Mit wem] glaubt Hans [CP t_{mit wem} dass Jakob jetzt t_{mit wem} spricht]?]  
\[ \text{move XP} \quad \text{move XP} \]
\begin{align*}
\text{with whom} & \quad \text{thinks Hans} \\
\text{that Jacob now} & \quad \text{talks}
\end{align*}

‘With whom does Hans think that Jacob is now talking?’

b.  
Was glaubt Hans [CP [mit wem] Jakob jetzt t_{mit wem} spricht]?  
\[ \text{move wh-features} \quad \text{move XP} \]
\begin{align*}
\text{WH} & \quad \text{thinks Hans} \\
\text{with whom} & \quad \text{Jacob now} \\
\text{talks}
\end{align*}

‘With whom does Hans think that Jacob is now talking?’

As was mentioned in chapter 1, Cheng (2000) has argued that the construction in (13b) is derived through feature movement. Both types of questions involve two movement steps. First, in both (13a) and (13b) the wh-word mit wem (‘with whom’) moves from its base position to the specifier of the embedded CP. The questions differ with respect to the second movement step: in (13a) the entire wh-word moves to the beginning of the matrix clause, while in (13b) only its features move. Thus, (13a) involves two times XP-movement, (13b) involves XP-movement followed by feature movement. The feature movement analysis for (13b) is confirmed by its sensitivity to the intervention effect. As noted before, Pesetsky (2000) has argued that the intervention effect can be used as a diagnostics for feature movement (cf.
Crucially, questions of the type in (13b), in contrast to those of the type in (13a), are sensitive to the intervention effect.

\[(14)\]

\[\begin{align*}
\text{a. } & \text{Mit wem glaubt Hans nicht dass Jakob jetzt spricht?} \\
& \text{with whom believes Hans not that Jacob now talks} \\
& \text{‘With whom does Hans not believe that Jacob is now talking?’} \\
\text{b. } & \text{* Was glaubt Hans nicht mit wem Jakob jetzt spricht?} \\
& \text{WH believes Hans not with whom Jacob now talks} \\
& \text{‘With whom does Hans not believe that Jacob is now talking?’}
\end{align*}\]

The constructions in (13) are thus similar to the French object wh-questions in (11) in that they display a contrast between the type of movement through which they are derived. Partial wh-movement in German, as well as French wh-in-situ questions involve feature movement. Both languages also allow a variant of the relevant construction involving XP-movement. It would thus be interesting to examine whether patients’ comprehension of the constructions in (13) patterns with that observed for the constructions in (11). In other words, do German-speaking Broca patients also show better comprehension of constructions derived through feature movement (i.e. (13b)) than of their counterparts involving overt XP-movement (i.e. (13a))? I doubt however, whether any difference will be found. The reason for this is that the effects of a secondary movement step on patients’ comprehension are unclear. There is some evidence suggesting that a secondary movement step does not yield worse comprehension (cf. Friedmann & Shapiro 2003). Thus, both types of questions in (13) might be equally difficult since they both first involve XP-movement of the wh-word to the specifier of the embedded CP.

**1.2.4. The influence of other factors on patients’ comprehension**

It has been mentioned several times throughout this thesis that patients’ comprehension is not only affected by syntactic movement, but also by other factors, such as animacy and syntactic embedding. Patients have more difficulties comprehending inanimate wh-questions than animate wh-questions (see sections 3.3 and 3.4 of chapter 3). Further, constructions containing embedded CPs are more difficult to understand for Broca patients than constructions without embedding. This explains why these patients have more difficulties with the comprehension of object clefts and relative clauses than with that of object wh-questions. In this light, it is also important to recall the difference between patients’ comprehension of D-linked versus that of non D-linked wh-questions, observed by Hickok and Avrutin (1996).\(^{176}\) It is necessary to examine in more detail how these factors affect patients’ comprehension and in what way they interact with syntactic movement.

**1.3. Summary**

In this section, I have discussed several questions arising from the research performed for this thesis. First, I have discussed the question why the

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\(^{176}\) See chapter 2, section 1.1.4.1
comprehension deficit in Broca’s aphasia should be characterized in the way proposed in this thesis. Why do Broca patients have less difficulty with the comprehension of structures involving feature or head movement than with those involving XP-movement? I have suggested that this might be explained in terms of a processing deficit: feature movement and head movement require less processing resources than XP-movement does. However, further research in both the theoretical linguistic and the neurolinguistic field is needed before such a conclusion can be drawn. The specific questions underlying this research are enumerated in (15a,b) and (16a,b). I have also discussed several other questions requiring further research. These questions are repeated in (15c) and (16c,d).

**Questions for further research**

(15) *Theoretical linguistics*

a. Is feature movement the most economical type of movement? Why?
b. Is feature movement an instance of head-movement?
c. Does feature movement involve movement of the features?

(16) *Psycho/neuro-linguistics*

a. Does feature movement or head require less processing resources than XP-movement?
b. Does head-movement require the same amount of processing resources as feature movement?
c. Are there other constructions differing only in the type of movement through which they are derived? If so, does patients’ comprehension of these constructions pattern with that observed on French wh-questions?
d. What is the effect of other factors on patients’ comprehension? How do these factors interact with syntactic movement?

**2. Related language difficulties in Broca’s aphasia**

This thesis examined the difficulties encountered by Broca patients in their comprehension of constructions involving syntactic movement. However, these are not the only language difficulties of Broca patients. In this section, I will briefly discuss two other language difficulties of these patients and examine in what way they are related to the comprehension deficits discussed in this thesis.

**2.1. Comprehension and production of wh-questions**

In this thesis, I have focused on the comprehension of wh-questions in Broca’s aphasia. However, these patients do not only have difficulties in comprehending wh-questions, but also in producing them. I have argued in chapter 1 that the relation between production and comprehension in Broca’s aphasia is unclear. It is, for
instance, not yet known whether patients’ comprehension and production difficulties arise from a single underlying deficit. Still, it remains interesting to compare patients’ production and comprehension of a certain construction and see whether there are differences or similarities. In this section, I will therefore discuss patients’ production of wh-questions and compare this with their comprehension.

There are several similarities, but also interesting differences between the data obtained on French-speaking Broca patients concerning their comprehension and production of wh-questions. Discussing the similarities first, it can be noted that in both modalities, these patients are sensitive to wh-movement: wh-in-situ questions are better understood and produced than their counterparts involving movement.\footnote{See chapter 3, section 3 for the comprehension data and section 4 for the production data obtained in the repetition experiment.}

Further, in both the comprehension and the production tasks, patients’ performance on argument questions is better than that on adjunct questions.\footnote{Note that the French findings on patients’ production of argument and adjunct questions might be language specific. Friedmann (2002) examined the production of wh-questions in Hebrew and Palestinian Arabic Broca patients. These patients showed better production of adjunct questions than of argument questions. It would be interesting to examine whether the crosslinguistic difference between these data and the data obtained on the French-speaking Broca patients can be related to other differences between these languages. It might be that the derivation of adjunct questions in these languages differs to the extent that adjunct questions involve syntactic movement in French, but not in Hebrew and Palestinian Arabic (see Friedmann 2002 for the assumption that adjunct questions in these last languages do not involve syntactic movement). See however Thompson et al. (1996) for different findings on English-speaking Broca patients.}

However, there are also several differences between patients’ comprehension and production of wh-questions. The most important difference concerns the effect of wh-movement in what-questions. French-speaking Broca patients show no difference in their comprehension of wh-in-situ what-questions \((17a)\) and what-questions involving overt wh-movement \((17b)\). By contrast, in their production of wh-questions, these patients do show better performance on questions of the type in \((17a)\) than on those of the type in \((17b)\).

\begin{align*}
(17) & \quad \text{a. La voiture tire quoi?} \\
& \quad \text{the car pulls what} \\
& \quad \text{‘What does the car pull?’} \\
& \quad \text{b. Qu’est-ce que la voiture tire?} \\
& \quad \text{what Q the car pulls} \\
& \quad \text{‘What does the car pull?’}
\end{align*}

The contrast in patients’ comprehension and production of sentences of the type in \((17)\) might indicate a difference in the effect of head movement on the production and comprehension in Broca’s aphasia. Recall that I have argued that the question in \((17b)\) is derived through head movement and that the absence of a difference between patients’ comprehension of the two types of wh-questions in \((17)\) suggest that head movement and feature movement have a similar effect on patients’ comprehension (see chapter 4, section 2.3.3). Both types of movement yield less comprehension difficulties for Broca patients than XP-movement does. Crucially, patients’ production of these constructions suggests that feature movement and head
movement do not have the same effect on patients’ production. Constructions involving head-movement, such as (17b), are more difficult to produce for Broca patients than constructions involving feature movement, such as (17a). This is in line with other findings showing that head movement is impaired in patients’ production (cf. Bastiaanse & Van Zonneveld 1998; Bastiaanse & Thompson 2003). The difference between the comprehension and production of what-questions observed on French-speaking Broca patients thus suggests that syntactic movement affects patients’ comprehension and production differently. This might be taken as evidence against the hypothesis of a general movement deficit underlying both patients’ comprehension and production difficulties (cf. chapter 1, section 1.2).

Note however, that it is as yet too early to draw such far-reaching conclusions. The production of wh-questions in French-speaking Broca patients has only been examined in one experiment in which only three patients participated. Additional data from more patients and obtained in several production experiments are needed to obtain a clear picture of the production of wh-questions by French-speaking Broca patients. Only then it is possible to make insightful comparisons between patients’ comprehension and production of wh-questions. In this light, it is important to recall that the data of French-speaking Broca patients revealed a contrast between their comprehension of subject and object wh-questions. Patients’ comprehension of object questions was better than that on subject questions. It would be interesting to examine whether the production of wh-questions by these Broca patients patterns with their comprehension.

Finally, data from English-speaking Broca patients also show differences between patients’ comprehension and production of wh-questions. These patients are able to understand both subject and object wh-questions (cf. table 1, chapter 2). By contrast, their production of these constructions is severely impaired (cf. Friedmann 2002).

In sum, the relation between comprehension and production in Broca’s aphasia remains a topic of further research. Data enabling a systematic comparison between patients’ performances in both modalities are still lacking.

2.2. Movement and binding

In this thesis, I focused on patients’ comprehension difficulties with sentences involving syntactic movement. It is sometimes claimed that such an approach is too narrow (cf. Caplan 1995, 2000). The reason for this is that Broca patients do not only have difficulties with constructions involving movement, but also with other syntactic phenomena such as binding. In a sense, movement and binding are similar, since they create a dependency relation between two elements: the moved element and its trace in the case of movement, and the antecedent and the pronoun or anaphor in the case of binding. Any account of the comprehension deficit in Broca’s aphasia should thus not only explain the difficulties with syntactic movement only, but also those with other dependency relations. This position is for instance taken by Caplan (1995, 2000), Piñango (2003), and Avrutin (2004). By contrast, Grodzinsky argues that the deficit observed in binding relations involving pronouns is not related
In this thesis, I have shown that the comprehension deficit of Broca patients cannot be reduced to a general deficit computing dependency relations. I have argued that a more detailed approach is needed to accurately describe the data of Broca patients. More specifically, I have shown that there are different types of movement relations, that each have their own characteristics. Importantly, these types of movement affect patients’ comprehension differently: some types of syntactic movement (e.g., XP-movement) have more effect on patients’ comprehension abilities than other types of movement do. In other words, in this thesis it was shown that any approach assuming that Broca patients have difficulties understanding dependency relations is too coarse. Not all dependency relations are equally impaired in Broca’s aphasia. In theoretical linguistics not only several types of movement relations are distinguished. It is also commonly assumed that there are several types of binding relations. It should thus be worked out in more detail what is the effect of each of these binding relations on patients’ comprehension. Further, it might be interesting to examine the syntactic similarities and differences between all these movement and binding relations. Such a study falls, however, outside the scope of this thesis.

3. Conclusion

In this thesis, I have examined and discussed the comprehension deficits of Broca patients and the way in which they are related to syntactic movement. Based on new data concerning patients’ comprehension of wh-questions, I have argued for a new characterization of the comprehension deficit in Broca’s aphasia. In particular, it was argued that patients’ comprehension of a certain construction is determined by the type of movement underlying this construction. Broca patients typically have more difficulties comprehending constructions derived through XP-movement than those derived through feature or head movement.

Crucially, this characterization is nothing more than a generalization of the observed data in linguistic terms. Thus, it is only a description and not an explanation of the comprehension deficit. I have shown that this description leads to an hypothesis, the TMH (cf. chapter 4, section 5), but this hypothesis also remains descriptive to the extent that it does not explain the nature of the comprehension deficit in Broca’s aphasia. I have argued that it might be possible to explain the proposed characterization in terms of a processing deficit. On this view, XP-movement requires more processing resources than feature movement or head movement. Since brain damage has reduced the processing resources of Broca patients, these patients have severe difficulties comprehending constructions involving XP-movement. However, it was also argued that empirical evidence sustaining this claim is still lacking. Further experiments examining the processing...
load of the relevant types of movement are required. It is therefore at this stage impossible to draw any conclusions concerning the nature of the comprehension deficit in Broca’s aphasia.

I have further argued that the characterization of the comprehension deficit proposed in this thesis leads to new syntactic analyses of several linguistic constructions. Thus, it was shown that this characterization favors a new analysis of French and English relative clauses. I hope to have shown that multidisciplinary research yields new insights in both disciplines. Theoretical linguistics provides tools enabling a generalization of the data of Broca patients. These data, in turn, yield new syntactic analyses as well as new research questions for the field of theoretical linguistics. Insights obtained in this discipline has shown that language is not just one of the ways in which humans happen to communicate. On the contrary, it is a biological system obeying many rules that can be identified by careful examination of what is grammatical or not. This has yielded several models of the language system. Neurolinguistics is a fascinating research field, which has provided important insights concerning the way in which language is represented in the brain. I hope that this thesis has shown that it is possible to build a bridge between both research fields and that such a bridge is valuable for the research in both disciplines.
References


Friedmann, N., M. Biran, A. Gvion & R. Novogrodsky (to appear). Do agrammatic aphasics understand verb movement?


Appendices

Appendix 1

Stimulus sentences for all conditions in experiment 1 (subject and object questions)

Object questions

<table>
<thead>
<tr>
<th>Object in-situ</th>
<th>Object moved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Le garçon arrose qui?</td>
<td>Qui est-ce que le garçon arrose?</td>
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<tr>
<td>La fille pousse qui?</td>
<td>Qui est-ce que la fille pousse?</td>
</tr>
<tr>
<td>La fille caresse qui?</td>
<td>Qui est-ce que la fille caresse?</td>
</tr>
<tr>
<td>La dame embrasse qui?</td>
<td>Qui est-ce que la dame embrasse?</td>
</tr>
<tr>
<td>L’homme frappe qui?</td>
<td>Qui est-ce que l’homme frappe?</td>
</tr>
<tr>
<td>La dame porte qui?</td>
<td>Qui est-ce que la dame porte?</td>
</tr>
<tr>
<td>Le chat poursuit qui?</td>
<td>Qui est-ce que le chat poursuit?</td>
</tr>
<tr>
<td>Le renard chasse qui?</td>
<td>Qui est-ce que le renard chasse?</td>
</tr>
<tr>
<td>Le chat lèche qui?</td>
<td>Qui est-ce que le chat lèche?</td>
</tr>
<tr>
<td>Le garçon tire qui?</td>
<td>Qui est-ce que le garçon tire?</td>
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<tr>
<td>Le garçon pousse qui?</td>
<td>Qui est-ce que le garçon pousse?</td>
</tr>
<tr>
<td>Le chien mord qui?</td>
<td>Qui est-ce que le chien mord?</td>
</tr>
<tr>
<td>Le roi couronne qui?</td>
<td>Qui est-ce que le roi couronne?</td>
</tr>
<tr>
<td>Le chien porte qui?</td>
<td>Qui est-ce que le chien porte?</td>
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<td>L’homme photographie qui?</td>
<td>Qui est-ce que l’homme photographie?</td>
</tr>
<tr>
<td>Le tigre poursuit qui?</td>
<td>Qui est-ce que le tigre poursuit?</td>
</tr>
<tr>
<td>Le chat mord qui?</td>
<td>Qui est-ce que le chat mord?</td>
</tr>
<tr>
<td>Le policier espionne qui?</td>
<td>Qui est-ce que le policier espionne?</td>
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</table>

Subject questions

<table>
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<th>Long subject</th>
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<tbody>
<tr>
<td>Qui arrose le garçon?</td>
<td>Qui est-ce qui arrose le garçon?</td>
</tr>
<tr>
<td>Qui pousse la fille?</td>
<td>Qui est-ce qui pousse la fille?</td>
</tr>
<tr>
<td>Qui caresse la fille?</td>
<td>Qui est-ce qui caresse la fille?</td>
</tr>
<tr>
<td>Qui embrasse la dame?</td>
<td>Qui est-ce qui embrasse la dame?</td>
</tr>
<tr>
<td>Qui frappe l’homme?</td>
<td>Qui est-ce qui frappe l’homme?</td>
</tr>
<tr>
<td>Qui porte la dame?</td>
<td>Qui est-ce qui porte la dame?</td>
</tr>
<tr>
<td>Qui poursuit le chat?</td>
<td>Qui est-ce qui poursuit le chat?</td>
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<tr>
<td>Qui chasse le renard?</td>
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<td>Qui tire le garçon?</td>
<td>Qui est-ce qui tire le garçon?</td>
</tr>
<tr>
<td>Qui pousse le garçon?</td>
<td>Qui est-ce qui pousse le garçon?</td>
</tr>
<tr>
<td>Qui mord le chien?</td>
<td>Qui est-ce qui mord le chien?</td>
</tr>
<tr>
<td>Qui couronne le roi?</td>
<td>Qui est-ce qui couronne le roi?</td>
</tr>
<tr>
<td>Qui porte le chien?</td>
<td>Qui est-ce qui porte le chien?</td>
</tr>
<tr>
<td>Qui photographie l'homme?</td>
<td>Qui est-ce qui photographie l'homme?</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Qui poursuit le tigre?</td>
<td>Qui est-ce qui poursuit le tigre?</td>
</tr>
<tr>
<td>Qui mord le chat?</td>
<td>Qui est-ce qui mord le chat?</td>
</tr>
<tr>
<td>Qui espionne le policier?</td>
<td>Qui est-ce qui espionne le policier?</td>
</tr>
</tbody>
</table>
Appendix 2

Stimulus sentences for all conditions in experiment 2 (who- versus what-questions)

### Who-questions

<table>
<thead>
<tr>
<th>in-situ</th>
<th>moved</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Le garçon arrose qui?</td>
<td>Qui est-ce que le garçon arrose?</td>
<td>Who does the boy splash?</td>
</tr>
<tr>
<td>La fille pousse qui?</td>
<td>Qui est-ce que la fille pousse?</td>
<td>Who does the girl push?</td>
</tr>
<tr>
<td>La fille caresse qui?</td>
<td>Qui est-ce que la fille caresse?</td>
<td>Who does the girl caress?</td>
</tr>
<tr>
<td>La dame embrasse qui?</td>
<td>Qui est-ce que la dame embrasse?</td>
<td>Who does the lady kiss?</td>
</tr>
<tr>
<td>L’homme frappe qui?</td>
<td>Qui est-ce que l’homme frappe?</td>
<td>Who does the man hit?</td>
</tr>
<tr>
<td>La dame porte qui?</td>
<td>Qui est-ce que la dame porte?</td>
<td>Who does the lady carry?</td>
</tr>
<tr>
<td>Le chat poursuit qui?</td>
<td>Qui est-ce que le chat poursuit?</td>
<td>Who does the cat chase?</td>
</tr>
<tr>
<td>Le renard chasse qui?</td>
<td>Qui est-ce que le renard chasse?</td>
<td>Who does the fox chase?</td>
</tr>
<tr>
<td>Le chat léche qui?</td>
<td>Qui est-ce que le chat léche?</td>
<td>Who does the cat lick?</td>
</tr>
<tr>
<td>Le garçon tire qui?</td>
<td>Qui est-ce que le garçon tire?</td>
<td>Who does the boy pull?</td>
</tr>
<tr>
<td>Le garçon pousse qui?</td>
<td>Qui est-ce que le garçon pousse?</td>
<td>Who does the boy push?</td>
</tr>
<tr>
<td>Le chien mord qui?</td>
<td>Qui est-ce que le chien mord?</td>
<td>Who does the dog bite?</td>
</tr>
<tr>
<td>Le roi couronne qui?</td>
<td>Qui est-ce que le roi couronne?</td>
<td>Who does the king crown?</td>
</tr>
<tr>
<td>Le chien porte qui?</td>
<td>Qui est-ce que le chien porte?</td>
<td>Who does the dog carry?</td>
</tr>
<tr>
<td>L’homme photographie qui?</td>
<td>Qui est-ce que l’homme photographie?</td>
<td>Who does the man photograph?</td>
</tr>
<tr>
<td>Le tigre poursuit qui?</td>
<td>Qui est-ce que le tigre poursuit?</td>
<td>Who does the tiger follow?</td>
</tr>
<tr>
<td>Le chat mord qui?</td>
<td>Qui est-ce que le chat mord?</td>
<td>Who does the cat bite?</td>
</tr>
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</table>

### What-questions

<table>
<thead>
<tr>
<th>in-situ</th>
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</tr>
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<tbody>
<tr>
<td>La voiture tire quoi?</td>
<td>Qu’est-ce que la voiture transporte?</td>
<td>What does the car pull?</td>
</tr>
<tr>
<td>La bouteille contient quoi?</td>
<td>Qu’est-ce que la bouteille contient?</td>
<td>What does the bottle contain? (flag)</td>
</tr>
<tr>
<td>La bouteille contient quoi?</td>
<td>Qu’est-ce que la bouteille contient?</td>
<td>What does the bottle contain? (marbles)</td>
</tr>
<tr>
<td>Le grand bateau pousse quoi?</td>
<td>Qu’est-ce que le grand bateau pousse?</td>
<td>What does the big boat push?</td>
</tr>
<tr>
<td>Le ballon englobe quoi?</td>
<td>Qu’est-ce que le ballon englobe?</td>
<td>What does the balloon enclose? (teapot)</td>
</tr>
<tr>
<td>Le ballon englobe quoi?</td>
<td>Qu’est-ce que le ballon englobe?</td>
<td>What does the balloon enclose? (toy)</td>
</tr>
<tr>
<td>La voiture abîme quoi?</td>
<td>Qu’est-ce que la voiture abîme?</td>
<td>What does the car damage?</td>
</tr>
<tr>
<td>La voiture transporte quoi?</td>
<td>Qu’est-ce que la voiture transporte?</td>
<td>What does the car transport?</td>
</tr>
<tr>
<td>Le camion suit quoi?</td>
<td>Qu’est-ce que le camion suit?</td>
<td>What does the van follow?</td>
</tr>
<tr>
<td>French Sentence</td>
<td>French Question</td>
<td>English Question</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>L’hélicoptère poursuit quoi?</td>
<td>Qu’est-ce que l’hélicoptère poursuit?</td>
<td>What does the helicopter follow?</td>
</tr>
<tr>
<td>La boîte contient quoi?</td>
<td>Qu’est-ce que la boîte contient?</td>
<td>What does the box contain?</td>
</tr>
<tr>
<td>Le bateau de voile tire quoi?</td>
<td>Qu’est-ce que le bateau de voile tire?</td>
<td>What does the sailboat pull?</td>
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</table>
Appendix 3

Stimulus sentences for all conditions in experiment 3 (argument versus adjunct questions)

Arguments

<table>
<thead>
<tr>
<th>animate in-situ</th>
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</thead>
<tbody>
<tr>
<td>Le chien saute sur qui?</td>
<td>Sur qui est-ce que le chien saute?</td>
<td>La fille se dirige vers quoi?</td>
<td>Vers quoi est-ce que la fille se dirige?</td>
</tr>
<tr>
<td>Le policier tire sur qui?</td>
<td>Sur qui est-ce que le policier tire?</td>
<td>La fille met le plateau sur quoi?</td>
<td>Sur quoi est-ce que la file met le plateau?</td>
</tr>
<tr>
<td>Le garçon grimpe sur qui?</td>
<td>Sur qui est-ce que le garçon grimpe?</td>
<td>La planche s’appuie sur quoi?</td>
<td>Sur quoi est-ce que la planche s’appuie?</td>
</tr>
<tr>
<td>Le grand-père s’appuie sur qui?</td>
<td>Sur qui est-ce que le grand-père s’appuie?</td>
<td>La moto tombe sur quoi?</td>
<td>Sur quoi est-ce que la moto tombe?</td>
</tr>
<tr>
<td>La fille tape sur qui?</td>
<td>Sur qui est-ce que la fille tape?</td>
<td>La table glisse sur quoi?</td>
<td>Sur quoi est-ce que la table glisse?</td>
</tr>
<tr>
<td>Le chat joue avec qui?</td>
<td>Avec qui est-ce que le chat joue?</td>
<td>Le train s’écrase contre quoi?</td>
<td>Contre quoi est-ce que le train s’écrase?</td>
</tr>
<tr>
<td>Le garçon se fâche contre qui?</td>
<td>Contre qui est-ce que le garçon se fâche?</td>
<td>L’arbre pousse contre quoi?</td>
<td>Contre quoi est-ce que l’arbre pousse?</td>
</tr>
<tr>
<td>La grand-mère se dirige vers qui?</td>
<td>Vers qui est-ce que la grand-mère se dirige?</td>
<td>La fille frappe le garçon avec quoi?</td>
<td>Avec quoi est-ce que la fille frappe le garçon?</td>
</tr>
<tr>
<td>La fille partage son gateau avec qui?</td>
<td>Avec qui est-ce que la fille partage son gateau?</td>
<td>L’homme menace la</td>
<td>Avec quoi est-ce que l’homme menace la</td>
</tr>
</tbody>
</table>

On who does the dog jump?
Who does the policeman shoot?
On who does the boy climb?
On who does grandfather lean?
On who does the girl tap?
With whom does the girl telephone?
Against whom is the cat angry?
To whom does grandmother go?
With whom does the girl share her cake?
For whom does the woman kneel?
To what does the girl go?
On what does the girl place the tray?
On what does the plank lean?
On what does the motor fall?
On what does the table slide?
Against what does the train crash?
Against what does the tree push?
With what does the girl hit the boy?
With what does the man
<table>
<thead>
<tr>
<th>French (Direct)</th>
<th>English (Indirect)</th>
<th>English (Direct)</th>
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<tbody>
<tr>
<td>femme avec quoi? menace la femme? threaten the woman?</td>
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<td></td>
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<tr>
<td>Le garçon se heurte contre quoi? Contre quoi est-ce que le garçon se heurte? Against what does the boy hurt himself?</td>
<td></td>
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</tr>
<tr>
<td>L’homme pousse la boîte contre quoi? Contre quoi est-ce que l’homme pousse la boîte? Against what does the man push the box?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Adjuncts**

<table>
<thead>
<tr>
<th>animate in-situ</th>
<th>animate moved</th>
<th>inanimate in-situ</th>
<th>inanimate moved</th>
</tr>
</thead>
<tbody>
<tr>
<td>La fille dort sur qui? Sur qui est-ce que la fille dort?</td>
<td>On who does the girl sleep?</td>
<td></td>
<td></td>
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<tr>
<td>La fille danse sur qui? Sur qui est-ce que la fille danse?</td>
<td>On who does the girl dance?</td>
<td></td>
<td></td>
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<tr>
<td>Le chat marche derrière qui? Derrière qui est-ce que le chat marche?</td>
<td>Behind who does the cat walk?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L’homme nage sous qui? Sous qui est-ce que l’homme nage?</td>
<td>Under who does the man swim?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>La femme travaille sous qui? Sous qui est-ce que la femme travaille?</td>
<td>Under who does the woman work?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>La fille s’évanouit contre qui? Contre qui est-ce que la fille s’évanouit?</td>
<td>Against who does the girl faint?</td>
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<tr>
<td>La femme pleure auprès de qui? Auprès de qui est-ce que la femme pleure?</td>
<td>By whom does the woman cry?</td>
<td></td>
<td></td>
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<tr>
<td>L’homme marche devant qui? Devant qui est-ce que l’homme marche?</td>
<td>In front of who does the man walk?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L’homme arrive après qui? Après qui est-ce que l’homme arrive?</td>
<td>After who does the man arrive?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>La dame verse un verre pour qui? Pour qui est-ce que la dame verse un verre?</td>
<td>For whom does the lady pour a drink?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>La femme prépare un dîner pour qui? Pour qui est-ce que la femme prépare un dîner?</td>
<td>For whom does the woman prepare dinner?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L’avion vole sous quoi? Sous quoi est-ce que l’avion vole?</td>
<td>Under what does the plane fly?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Le ballon flotte sous quoi? Sous quoi est-ce que le ballon flotte?</td>
<td>Under what does the balloon float?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L’arbre pousse sous quoi? Sous quoi est-ce que l’arbre pousse?</td>
<td>Under what does the tree grow?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Le garçon dort sur quoi? Sur quoi est-ce que le garçon dort?</td>
<td>On what does the boy sleep?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Le camion roule devant quoi? Devant quoi est-ce que le camion roule?</td>
<td>In front of what does the van drive?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>La rose fleurit contre quoi? Contre quoi est-ce que la rose fleurit?</td>
<td>Against what does the rose bloom?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>La moto dérape derrière quoi? Derrière quoi est-ce que la moto dérape?</td>
<td>Behind what does the motor slip?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Le bateau à voile bleu est amarré devant quoi? Devant quoi est-ce que le bateau à voile bleu est amarré?</td>
<td>In front of what has the boat been tied up?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>La voiture orange arrive après quoi? Après quoi est-ce que la voiture orange arrive?</td>
<td>After what does the orange car arrive?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Le drapeau rouge flotte Au dessus de quoi est-ce que le</td>
<td>Under what does the red flag</td>
<td></td>
<td></td>
</tr>
<tr>
<td>au dessus de quoi?</td>
<td>drapeau rouge flotte?</td>
<td>blow?</td>
<td></td>
</tr>
<tr>
<td>--------------------</td>
<td>----------------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>La voiture rouge part avant quoi?</td>
<td>Avant quoi est-ce que la voiture rouge part?</td>
<td>Before what does the red car leave?</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 4

Stimulus sentences for all conditions in experiment 4 (repetition task)

Arguments (who-questions)

<table>
<thead>
<tr>
<th>In-situ</th>
<th>moved</th>
<th>restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>L’homme embrasse qui?</td>
<td>Qui est-ce que l’homme embrasse?</td>
<td>Who does the man kiss?</td>
</tr>
<tr>
<td>Le policier a arrêté qui?</td>
<td>Qui est-ce que le policier a arrêté?</td>
<td>Who did the police arrest?</td>
</tr>
<tr>
<td>Le garçon a vu qui?</td>
<td>Qui est-ce que le garçon a vu?</td>
<td>Who did the boy see?</td>
</tr>
<tr>
<td>L’homme a rencontré qui?</td>
<td>Qui est-ce que l’homme a rencontré?</td>
<td>Who did the man meet?</td>
</tr>
<tr>
<td>L’homme dépasse qui?</td>
<td>Qui est-ce que l’homme dépasse?</td>
<td>Who did the man overtake?</td>
</tr>
<tr>
<td>La fille adore qui?</td>
<td>Qui est-ce que la fille adore?</td>
<td>Who does the girl adore?</td>
</tr>
<tr>
<td>L’enfant aime qui?</td>
<td>Qui est-ce que l’enfant aime?</td>
<td>Who does the child like?</td>
</tr>
<tr>
<td>Pierre méprise qui sans raison?</td>
<td>Qui est-ce que Pierre méprise?</td>
<td>Who does Peter despise?</td>
</tr>
<tr>
<td>L’homme admire qui?</td>
<td>Qui est-ce que l’homme admire?</td>
<td>Who does the man admire?</td>
</tr>
<tr>
<td>Marie accompagne qui à la gare?</td>
<td>Qui est-ce que Marie accompagne à la gare?</td>
<td>Who does Mary bring to the station?</td>
</tr>
<tr>
<td>La femme conduit qui à l’école?</td>
<td>Qui est-ce que la femme conduit à l’école?</td>
<td>Who does the woman drive to school?</td>
</tr>
<tr>
<td>Pierre invite qui à son anniversaire?</td>
<td>Qui est-ce que Pierre invite à son anniversaire?</td>
<td>Who does Peter invite to his birthday?</td>
</tr>
<tr>
<td>Qui est-ce que l’homme n’embrasse pas?</td>
<td>Who does the man not kiss?</td>
<td></td>
</tr>
<tr>
<td>Qui est-ce que le policier n’a pas arrêté?</td>
<td>Who did the police not arrest?</td>
<td></td>
</tr>
<tr>
<td>Qui est-ce que le garçon n’a pas vu?</td>
<td>Who did the boy not see?</td>
<td></td>
</tr>
<tr>
<td>Qui est-ce que l’homme n’a pas rencontré?</td>
<td>Who did the man not meet?</td>
<td></td>
</tr>
<tr>
<td>Qui est-ce que l’homme ne dépasse pas?</td>
<td>Who does the man not overtake?</td>
<td></td>
</tr>
<tr>
<td>Qui est-ce que Pierre n’invite pas à son anniversaire?</td>
<td>Who does Peter not invite to his birthday?</td>
<td></td>
</tr>
<tr>
<td>Qui est-ce que tous les élèves aiment?</td>
<td>Who do all the students like?</td>
<td></td>
</tr>
<tr>
<td>Qui est-ce que toutes les filles adorent?</td>
<td>Who do all the girls adore?</td>
<td></td>
</tr>
<tr>
<td>Qui est-ce que tous les hommes admirent?</td>
<td>Who do all the men admire?</td>
<td></td>
</tr>
<tr>
<td>Qui est-ce que Pierre a toujours méprisé?</td>
<td>Who did Peter always despise?</td>
<td></td>
</tr>
<tr>
<td>Qui est-ce que Marie accompagne toujours la gare?</td>
<td>Who does Mary always bring to the station?</td>
<td></td>
</tr>
<tr>
<td>Qui est-ce que la femme conduit toujours à l’école?</td>
<td>Who does the woman always drive to school?</td>
<td></td>
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</tbody>
</table>
Adjuncts

<table>
<thead>
<tr>
<th>in-situ</th>
<th>moved</th>
</tr>
</thead>
<tbody>
<tr>
<td>L’homme mange où ce soir?</td>
<td>Où est-ce l’homme mange ce soir?</td>
</tr>
<tr>
<td>La femme fait ses courses où?</td>
<td>Où est-ce que la femme fait ses courses?</td>
</tr>
<tr>
<td>Pierre fume où d’habitude?</td>
<td>Où est-ce que Pierre fume d’habitude?</td>
</tr>
<tr>
<td>Pierre travaille où d’habitude?</td>
<td>Où est-ce que Pierre travaille d’habitude?</td>
</tr>
<tr>
<td>L’homme lit le journal où?</td>
<td>Où est-ce que l’homme lit le journal?</td>
</tr>
<tr>
<td>Marie part où en vacances cette année?</td>
<td>Où est-ce que Marie part en vacances cette année?</td>
</tr>
<tr>
<td>Pierre regarde la télé quand?</td>
<td>Quand est-ce Pierre regarde la télé?</td>
</tr>
<tr>
<td>Jean va à la mer quand?</td>
<td>Quand est-ce que Jean va à la mer?</td>
</tr>
<tr>
<td>Marie travaille quand selon sa mère?</td>
<td>Quand est-ce que Marie travaille selon sa mère?</td>
</tr>
<tr>
<td>L’enfant reçoit des cadeaux quand?</td>
<td>Quand est-ce que l’enfant reçoit des cadeaux?</td>
</tr>
<tr>
<td>Jean fume une cigarette quand?</td>
<td>Quand est-ce que Jean fume une cigarette?</td>
</tr>
<tr>
<td>L’oiseau chante quand d’habitude?</td>
<td>Quand est-ce que l’oiseau chante d’habitude?</td>
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</table>

restriction

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Où est-ce que tous les hommes mangent?</td>
<td>Where do all the men eat?</td>
</tr>
<tr>
<td>Où est-ce que la femme ne fait pas ses courses?</td>
<td>Where does the woman not shop?</td>
</tr>
<tr>
<td>Où est-ce que Pierre ne fume pas?</td>
<td>Where does Peter not smoke?</td>
</tr>
<tr>
<td>Où est-ce que tous les hommes lisent le journal?</td>
<td>Where does Peter no longer work?</td>
</tr>
<tr>
<td>Où est-ce que Marie part toujours en vacances?</td>
<td>Where do all the men read the newspaper?</td>
</tr>
<tr>
<td>Quand est-ce que Pierre ne regarde pas la télé?</td>
<td>Where does Mary always go for holidays?</td>
</tr>
<tr>
<td>Quand est-ce que Jean ne va pas à la mer?</td>
<td>When does Peter not watch television?</td>
</tr>
<tr>
<td>Quand est-ce que Marie ne travaille pas selon sa mère?</td>
<td>When does John not go to the beach?</td>
</tr>
<tr>
<td>Quand est-ce que tous les enfants reçoivent des cadeaux?</td>
<td>When does Mary not work according to her mother?</td>
</tr>
<tr>
<td>Quand est-ce que Jean fume toujours une cigarette?</td>
<td>When does the child receive presents?</td>
</tr>
<tr>
<td>Quand est-ce que tous les oiseaux chantent?</td>
<td>When does John always smoke a cigarette?</td>
</tr>
<tr>
<td>Quand est-ce que tous les oiseaux chantent?</td>
<td>When do all the birds sing?</td>
</tr>
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</table>
## What-questions

<table>
<thead>
<tr>
<th>in-situ</th>
<th>moved</th>
<th>What does the man eat tonight?</th>
</tr>
</thead>
<tbody>
<tr>
<td>L’homme mange quoi ce soir?</td>
<td>Qu’est-ce que l’homme mange ce soir?</td>
<td></td>
</tr>
<tr>
<td>La femme lit quoi dans le journal?</td>
<td>Qu’est-ce que la femme lit dans le journal?</td>
<td>What does the woman read in the paper?</td>
</tr>
<tr>
<td>Le garçon a perdu quoi dans la neige?</td>
<td>Qu’est-ce que le garçon a perdu dans la neige?</td>
<td>What did the boy loose in the snow?</td>
</tr>
<tr>
<td>Le juge a dit quoi au voleur?</td>
<td>Qu’est-ce que le juge a dit au voleur?</td>
<td>What did the judge say to the thief?</td>
</tr>
<tr>
<td>Le chasseur poursuit quoi dans le bois?</td>
<td>Qu’est-ce que le chasseur poursuit dans le bois?</td>
<td>What did the hunter chase in the woods?</td>
</tr>
<tr>
<td>Le garçon a cassé quoi chez le voisin?</td>
<td>Qu’est-ce que le garçon a cassé chez le voisin?</td>
<td>What did the boy find at the neighbours?</td>
</tr>
<tr>
<td>Le fille trouve quoi sur le trottoir?</td>
<td>Qu’est-ce que la fille trouve sur le trottoir?</td>
<td>What did the girl find on the pavement?</td>
</tr>
<tr>
<td>La grand-mère tricote quoi?</td>
<td>Qu’est-ce que la grand-mère tricote?</td>
<td>What does the grandmother knit?</td>
</tr>
<tr>
<td>Le garçon écrit quoi à son ami?</td>
<td>Qu’est-ce que le garçon écrit à son ami?</td>
<td>What does the boy write to his friend?</td>
</tr>
<tr>
<td>La fille cherche quoi dans la salle de bain?</td>
<td>Qu’est-ce que la fille cherche dans la salle de bain?</td>
<td>What does the girl look for in the bathroom?</td>
</tr>
<tr>
<td>Le garçon déplace quoi dans le bureau?</td>
<td>Qu’est-ce que le garçon déplace dans le bureau?</td>
<td>What does the boy move in the office-room?</td>
</tr>
<tr>
<td>Marie achètera quoi pour l’anniversaire de Pierre?</td>
<td>Qu’est-ce que Marie achètera pour l’anniversaire de Pierre?</td>
<td>What will Mary buy for Peters birthday?</td>
</tr>
</tbody>
</table>

## Yes/no questions

<table>
<thead>
<tr>
<th>Est-ce que Marie partira en vacances cette année?</th>
<th>Does Mary go on holidays this year?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Est-ce que le magasin vend du fromage?</td>
<td>Does the shop sell cheese?</td>
</tr>
<tr>
<td>Est-ce que le bus pour Québec/Anvers/Paris part bientôt?</td>
<td>Does the bus to Quebec/Antwerp/Paris leave soon?</td>
</tr>
<tr>
<td>Est-ce que le garçon a perdu quelque chose?</td>
<td>Has the boy lost something?</td>
</tr>
<tr>
<td>Est-ce que les enfants fument?</td>
<td>Do the children smoke?</td>
</tr>
<tr>
<td>Est-ce que les voisins ont des enfants?</td>
<td>Do the neighbours have children?</td>
</tr>
<tr>
<td>Est-ce que l’auto coûte cher?</td>
<td>Is the car expensive?</td>
</tr>
<tr>
<td>Est-ce que Pierre aime la musique classique?</td>
<td>Does Peter like classical music?</td>
</tr>
<tr>
<td>Est-ce que Pierre achètera des cadeaux pour Noël?</td>
<td>What will Peter buy for Christmas?</td>
</tr>
<tr>
<td>Est-ce que Marie sait skier?</td>
<td>Does Mary like to ski?</td>
</tr>
<tr>
<td>Est-ce que les voisins peuvent emprunter quelques dollars?</td>
<td>Can the neighbours lend some dollars?</td>
</tr>
<tr>
<td>Est-ce que le livre vous plait?</td>
<td>Do you like the book?</td>
</tr>
</tbody>
</table>
Samenvatting

Dit proefschrift geeft een nieuwe omschrijving van de relatie tussen syntactische verplaatsing en begripsproblemen bij Broca-patiënten. Het begeeft zich daarmee op het snijvlak van twee disciplines, namelijk de theoretische taalkunde en de neurolinguïstiek, en beoogt te laten zien dat een kruisbestuiving van deze twee disciplines leidt tot nieuwe inzichten en onderzoeksvragen in beide domeinen.

Het is bekend dat syntactische verplaatsing een belangrijke onderliggende factor is van de begripsproblemen bij mensen met een afasie van Broca. Het proefschrift beargumenteert dat de gangbare omschrijving van de relatie tussen deze begripsproblemen en syntactische verplaatsing te grof is. Het laat zien dat meer fijnmaziger syntactische mechanismen nieuwe inzichten opleveren voor de data van Broca-patiënten. Theoretische taalkunde kan dus gebruikt worden om de resultaten van neurolinguïstisch onderzoek te beschrijven en om er generalisaties van te formuleren. Tegelijkertijd leiden de data van Broca-patiënten tot nieuwe onderzoeksvragen en analyses binnen de theoretische taalkunde. In het proefschrift wordt één van deze analyses, namelijk een analyse voor clefts en relatiefzinnen, uitgewerkt.

In hoofdstuk 1 wordt een aantal begrippen uitgelegd. Het beschrijft wat afasie en met name afasie van Broca is. Er wordt een kort historisch overzicht gegeven van het onderzoek naar de linguïstische problemen van personen met dit type afasie. Daarnaast geeft dit hoofdstuk een overzicht van de verschillende types verplaatsing die binnen de theoretische taalkunde onderscheiden worden.

Hoofdstuk 2 behandelt de neurolinguïstische en de syntactische achtergrond van het experimentele onderzoek dat voor dit proefschrift gedaan is. Kenmerkend voor Broca-patiënten is de moeite met het begrijpen van passieve zinnen, object relativa en object clefts. Actieve zinnen, subject relativa en subject clefts worden echter relatief goed begrepen. In de neurolinguïstische literatuur wordt daarom gesteld dat de begripsproblemen van Broca-patiënten gerelateerd zijn aan de positie van waaruit verplaatsing is opgetreden: verplaatsing uit een objectspositie leidt tot begripsproblemen, maar verplaatsing uit een subjectspositie niet. Deze subject/object asymmetrie vormt het uitgangspunt voor verschillende modellen die de begripsproblemen van Broca-patiënten willen verklaren. Het probleem is echter dat het onderzoek zich tot nu toe geconcentreerd heeft op een subset van verplaatsingsconstructies. Er is relatief weinig bekend over het begrip van wh-vragen en topicalisatie- of scrambling constructies. Bovendien gaan alle verklaringen van de begripsproblemen van Broca-patiënten ervan uit dat mensen met dit type afasie moeite hebben met het toekennen van thematische rollen aan verplaatste argumenten. Het is echter nog maar de vraag of verplaatsing van niet-argumenten, zoals adjuncten en syntactische hoofden, geen effect heeft op het begrip van Broca-patiënten.

Dit proefschrift draagt bij aan een beter inzicht in de rol van verplaatsing door een aantal typen verplaatsing te onderzoeken die tot nu toe weinig of geen aandacht hebben gekregen. Daartoe wordt het begrip van wh-vragen bij Franstalige Broca-
patiënten onderzocht. Onderzoek op Franstalige patiënten is interessant omdat in het Frans wh-verplaatsing optioneel is. De vraagzinnen in (1) betekenen hetzelfde, maar verschillen in de positie van het wh-woord. In (1a) is het wh-woord in-situ blijven staan, terwijl het in (1b) verplaatst is.

(1) a. Tu as vu qui?
   je hebt gezien wie
   ‘Wie heb je gezien?’

b. Qui as-tu vu?
   wie heb je gezien
   ‘Wie heb je gezien?’

Door het begrip van Broca-patiënten van deze twee constructies met elkaar te vergelijken kan vastgesteld worden wat het effect is van wh-verplaatsing op het begrip van Broca-patiënten.

Het tweede gedeelte van dit hoofdstuk behandelt de syntactische analyse van de wh-vragen in (1). Het geeft een overzicht van de eigenschappen van deze twee typen vraagzinnen en de analyses die hiervoor binnen de theoretische taalkunde zijn gegeven. Dit overzicht eindigt in de conclusie dat er in beide typen vraagzinnen in (1) verplaatsing is. Het verschil ligt in het type verplaatsing: in (1b) is het hele wh-woord verplaatst, terwijl in (1a) alleen de formele kenmerken (features) van dit wh-woord verplaatst zijn.


Het begrip van wh-vragen is onderzocht bij een groep Franstalige Broca-patiënten. Deze groep bestond uit 9 personen, afkomstig uit Franstalig Canada en België. Daarnaast is een controlegroep getest, bestaande uit 14 personen zonder hersenletsel, die qua leeftijd, opleiding, geslacht en nationaliteit zo veel mogelijk overeenkomen met de patiëntengroep.

In drie experimenten is respectievelijk het begrip van *wie*-vragen, *wat*-vragen en adjunct vragen onderzocht. De belangrijkste resultaten van deze experimenten kunnen als volgt worden samengevat:

- voor de *wie*-vragen en de adjunctvragen begrijpen patiënten wh-in-situ vragen beter dan wh-vragen waarin het wh-woord verplaatst is.
- voor de *wat*-vragen is er geen verschil tussen het begrip van wh-in-situ vragen en wh-vragen waarin het wh-woord verplaatst is.
Franstalige Broca-patiënten, in tegenstelling tot Engelstalige Broca-patiënten, hebben meer moeite met het begrijpen van subject wh-vragen dan met het begrijpen van object wh-vragen.

Ook is er een vierde experiment gedaan om vast te stellen of de grammatica van Franstalige Broca-patiënten dezelfde structuur toekent aan wh-in-situ vragen als die beargumenteerd in hoofdstuk 2. De resultaten van dit experiment laten zien dat dit een plausibele aanname is.

De resultaten op wh-vragen vormen het uitgangspunt voor een nieuwe beschrijving van de begripsproblemen van personen met afasie van Broca. Deze beschrijving is het onderwerp van hoofdstuk 4. De studies naar het begrip van wh-vragen laten zien dat het patroon van begripsproblemen bij Broca-patiënten complexer is dan waar men tot nu toe vanuit ging: er is hier niet dezelfde subject/object asymmetrie als bij andere verplaatsingsconstructies. Ik beargumenteer dat de begripsproblemen van Broca-patiënten niet gerelateerd zijn aan de positie van waaruit verplaatsing is opgetreden, maar aan het type verplaatsing. Met behulp van recente ontwikkelingen binnen de theoretische taalkunde stel ik een nieuwe beschrijving voor van de begripsproblemen van deze patiënten: Broca-patiënten hebben meer moeite met het begrijpen van zinnen waarin een XP verplaatst is dan met zinnen waarin een X₀ of alleen features verplaatst zijn. Het hoofdstuk toont aan dat dit een correcte generalisatie is van zowel de data over wh-vragen als die over clefts en relatiefzinnen.

Deze beschrijving suggereert een nieuwe syntactische analyse voor clefts en relatiefzinnen: de subject varianten van deze constructies worden gevormd door feature verplaatsing, terwijl in de object varianten een XP verplaatst is. Ik laat zien dat met deze analyse een tweetal eigenschappen van Franse en Engelse clefts en relatiefzinnen beter verklaard kunnen worden dan met de analyse die binnen de taalkunde gebruikelijk is.

In het laatste hoofdstuk wordt kort ingegaan op een aantal onderzoeksvragen die voortvloeien uit het onderzoek in dit proefschrift. Een van de belangrijkste vragen is waarom feature verplaatsing en X₀-verplaatsing minder effect hebben op het begrip van Broca-patiënten dan XP-verplaatsing. Ik laat zien dat deze vraag verbonden kan worden aan discussies binnen de theoretische taalkunde over feature verplaatsing en geef aan hoe de data van Broca-patiënten nieuw licht werpen op deze discussies. Ik suggereer dat feature verplaatsing en X₀-verplaatsing ‘makkelijkere’ typen verplaatsing zijn, in die zin dat ze minder verwerkingscapaciteit vragen dan XP-verplaatsing. Ook geef ik aan met welke experimenten deze suggestie verder onderzocht kan worden.
Curriculum vitae

Ineke van der Meulen was born in Pretoria on December 4th in 1975. In 1994, she started studying French linguistics and literature at Leiden University. In 1995, she also began studies of General Linguistics at the same university. She received her MA-degree for French in 1998 (*cum laude*), and in 1999 she received her MA-degree in General Linguistics (*cum laude*). From 1999 until 2004 she was a PhD student at the *Holland Institute of Generative Linguistics* (HIL) and its successor, the *Universiteit Leiden Centre for Linguistics* (ULCL), carrying out the research resulting in this dissertation. She currently teaches in the Department of French at Leiden University.