6.1 Turkish Agrammatic Broca’s Aphasia
Four studies have been presented on Turkish agrammatic aphasia. Several conclusions can be drawn from these studies for sentence production and comprehension.

6.1.1. Sentence Production: Word Order, Verb Inflection and Case

Word Order
The production studies of object scrambling and relative clauses, and the comprehension study show that sentences with derived order are difficult for agrammatic speakers. In the production studies, the most common error is the use of base order (when derived order is required), which further supports the idea that this is the easiest structure. If necessary, the patients adapt verb inflection and case-to-base structures (see the study on relative clauses, Chapter 3). However, problems with derived order on its own cannot account for all the sentence production and comprehension deficits in agrammatic aphasia.

Verb Inflection
Verb inflection itself or more specifically ‘tense’ is not impaired as such, although the patients make some inflectional errors in linguistically simple (e.g., basic) and complex (e.g., derived) clauses. Both the morphological and semantic functions of tense are evaluated below.

(a) Tense Morphology: The overall data show that the patients can inflect verbs correctly for the past tense. However, they cannot refer to the correct time-frame through the same verb inflection. Therefore, it is assumed that the deficit is not in tense morphology but in time reference through verb inflection. These findings suggest that the problems with tense mainly stem from problems with interpretational features. The data also show that this is a rather selective deficit – reference to the past is more difficult than reference to another time frame – and it is also reflected in participles. The following further conclusions can be drawn for tense.

First, as mentioned earlier, the problems with tense across languages are neither related to the morphology of tense nor to the position of tense in the syntactic tree: the patients can produce features in T/C nodes well (e.g., Chapter 2 for tense and mood features). Second, the problems with time reference through verb inflection do not indicate a selective deficit in [+ finite] verbs only, because inflectional errors also extend to [− finite] verbs: the patients also make inflectional substitutions to participles.
(b) Semantic Interpretation (Time Reference): Expressing time reference through verb inflection by finite verbs and participles is difficult for agrammatic speakers. However, reference to the past (past tense/perfect aspect) through verb inflection is more difficult than reference to the future (future tense/imperfect aspect), at least as far as tensed verbs are concerned. A remoteness model accounts for the selective problems encountered with time reference through verb inflection. However, the question why inflecting a verb that refers to a remote time is more difficult than inflecting a verb that refers to a non-remote time does not have a straightforward answer, although certainty of past was proposed as a possible explanation. The patients seem to have problems in expressing semantic information in morphological inflection.

Case Inflection

The use of grammatical case has also been evaluated. Grammatical case interacts with sentence construction in both production and comprehension. The data obtained allow us to draw the following conclusions for the nominative, accusative and genitive cases. First, the patients can produce the nominative and accusative cases well in base order clauses. Second, they can produce the nominative and accusative cases well in derived order clauses when they produce the required order (e.g., moving the object to derive object scrambling order). The same is true for the genitive case: if the patients overtly moved the object in the subordinate clause, no problems with case were observed. These data suggest that there was an interaction between word order and case in production. Only when the patients were unable to derive the right order, did they adapt the case to the order they produced. Of course, the production of the genitive case may be more complex than the others since the genitive is used in subordinate clauses. These data suggest that when patients integrated word order and case information, they produced sentences correctly.

6.1.2. Sentence Comprehension: Word Order and Case

Word order and case interact significantly in sentence comprehension. Broca patients have more problems understanding sentences with derived order and non-base case assignment than simple active sentences with base order and case. The level of difficulty is determined by the interaction between word order and case. In other words, neither problems with derived word orders nor lost traces alone can explain the performance pattern.
6.2. Answers to Research Questions

Word Order

(1) Is derived word order more difficult than base order in a free word order language like Turkish?

Yes, derived order is more difficult than base order in Turkish, although Turkish is a free word order language. This is shown by the finding that object scrambling and relative clauses are more difficult to produce and to comprehend than sentences with base order. Of course, object scrambling and relative clauses are less frequent in a language. However, Bastiaanse, Bouma and Post (2009) show that the frequency of a construction does not influence agrammatic performance.

Verb Inflection, for Time Reference

(2) Do Turkish agrammatic speakers have problems using verb inflections for time reference?

Yes, Turkish agrammatic speakers have problems with time reference through verb inflection. They have difficulties expressing a time frame through verb inflection of both finite verbs (past tense – future tense) and participles (past participle – future participle).

(a) Is reference to remote structures with certainty of past more difficult than reference to non-remote structures (e.g., the future)?

Yes, agrammatic speakers have more difficulties in expressing reference to the past than reference to the future through verb inflection. Therefore, it is concluded that reference to remote structures with certainty of past is more difficult than reference to non-remote structures.

(b) Do the time reference problems get more severe in a derived word order sentence?

The answer to this question is not straightforward. Agrammatic speakers made more errors when referring to the future in relative clauses than in main clauses in base order. According to this finding, the problems with time reference add up in derived order clauses, since the patients made more errors in referring to the future when the order was derived. In fact, they made as many time reference errors with the future as with past participles in relative clauses. Consequently, the question whether time reference problems get more severe in a derived word order sentences calls for additional future research, although when the factors add up, the difficulties add up as well.
DISCUSSION and CONCLUSION

Word Order, Case

(3) Is there an interaction between the effects of derived word order and the non-base case in sentence comprehension in Turkish?

In other words, do deviations from both base order and case make sentences more difficult to comprehend than sentences in which only one of these factors is deviant?

Yes, there is an interaction between the effects of derived word order and non-base case in sentence comprehension. The data show that the patients have more problems in comprehending sentences with derived order and non-base case than sentences with derived order and base case assignment. Therefore, sentences in which both order and case deviate are more difficult than sentence in which, for example, only order deviates.

Overall, the easier structures are clauses in base order, with base case assignment and non-remote reference. When the factors add up, difficulties add up as well. These are all captured by the Integration Problem Hypothesis (IPH), which will be introduced in section 6.4. Before that, an evaluation of the overall data in relation to theories of agrammatism is presented.

6.3. Turkish data and linguistic theories of agrammatism

6.3.1. Tree Pruning Hypothesis

Obviously, the Tree Pruning Hypothesis (TPH) has added much to neurolinguistic studies with the finding that not all functional categories are equally impaired in agrammatic speech. However, the present findings do not support the TPH (Friedmann & Grodzinsky, 1997) for several reasons. First, a single deficit in tense inflection (TP) cannot explain difficulties with derived word orders and finite verb inflection in agrammatic aphasia, since we found that the same node, TP, is affected by overt argument movement (object scrambling) and not by a tense or mood feature (T/C) (see Chapter 2). Second, relatively well-preserved production of the finite verb inflected for the present progressive at the morphosyntactic level, with verb movement to T/INFL on the one hand and impaired production of non-finite clauses with the overt movement of the NP (generated below the ‘pruning’ site, in AspPs) on the other, again shows that tree position does not predict performance patterns (see Chapter 3). Finally, our findings on time reference contrast with the TPH since the problems with tense relates to interpretational level (time reference), also reflected in participles (low in the tree) (see Chapter 4). Apparently, a single deficit in tense inflection is insufficient to account for the difficulties with verb inflection and derived word orders in Turkish agrammatic production. In sum, the TPH needs to take the
interpretational characteristics of verb inflection and the linguistic context of clause, base versus derived, into account to explain Turkish data efficiently.

6.3.2. Derived Order Problem Hypothesis
The Derived Order Problem Hypothesis (DOP-H) (Bastiaanse & Van Zonneveld, 2005) suggested that derived orders are difficult for agrammatic patients regardless of the position the elements take in the syntactic tree. Therefore, the DOP-H correctly predicted that sentences with object scrambling (Chapter 2) and relative clauses (Chapter 3) are difficult for Turkish patients. The DOP-H also correctly predicted that Turkish Broca patients have problems in understanding all sentence types with derived word order.

However, the DOP-H also has limitations. Firstly, problems in expressing time reference through verb inflection (see Chapter 4) are not covered by the DOP-H, a finding that shows that difficulties with verb inflection are not restricted to clauses in derived order. Second, word order alone does not predict performance patterns correctly: some clauses in derived word order are more difficult to comprehend than others, since word order and case interacted significantly. In sum, the DOP-H is successful in accounting for word order problems but the hypothesis needs modification to establish the relationship of word order to verb inflection and case.

6.3.3. Tense Underspecification Hypothesis
The Tense Underspecification Hypothesis (TUH) (Wenzlaff & Clahsen, 2005) correctly predicts that grammatical mood is not a major problem in agrammatic aphasia. Additionally, the TUH is the only hypothesis that links the interpretable features of tense. However, the TUH still relates the problem to the tense node by assuming that tense at T/INFL is underspecified. This is why the hypothesis cannot account for all Turkish time reference data: tense is impaired, but the so is the participle. The TUH is both too broad and too specific. It is too broad because it is not tense in general but reference to the past that is particularly vulnerable. It is too restrictive because it is not only time reference through tensed verbs that is impaired, but participles as well. Consequently, an underspecification of inflectional time reference features could still be assumed, but only in a selective manner (e.g., past is more difficult than present/future) (Chapter 4) and by taking the interpretational features for participles into account. Word order problems are not relevant to the TUH.

Although the TUH is modality independent, no data on comprehension of time reference through verb inflection in Turkish are yet available.
6.3.4. Tense and Agreement Underspecification Hypothesis
Not much can be said about the correctness of the Tense and Agreement Underspecification Hypothesis (TAUH) (Burchert et al., 2005) on the basis of the Turkish data reported here since we did not test Agreement. However, the TAUH correctly predicted that the inflectional problems are not dependent on the position of the functional elements in the syntactic tree. As noted above, a selective underspecification could be assumed only if the interpretational features of the participle are also considered. Word order problems are not part of the TAUH.

6.3.5. Trace Deletion Hypothesis
The Trace Deletion Hypothesis (TDH) (Grodzinsky, 1995) correctly predicted the performance levels of Turkish patients on different sentence types. However, there are drawbacks to the TDH.

First, the TDH predictions do not hold for each sentence type tested. For example, the TDH did not correctly predict performance in object relative clauses. Second, an analysis that only takes chance levels into account and ignores differences that are significant misses important variations in performance among different sentences types, hindering understanding of crucial aspects of agrammatic behavior. Third, the TDH only takes traces of moved arguments into account and thus cannot account for the interaction between case and word order in the group data. Finally, the comprehension patterns are similar to those reported for production in terms of difficulties with derived orders, and integration from different linguistic levels in general. It is thus more economical to consider one underlying deficit for comprehension and production since there seems to be more similarities than differences between the two.

Overall, the Turkish data suggest that traces are either not lost in agrammatism or that the patients use a different (default) strategy in Turkish-type languages. This particular topic should be further investigated in online studies.

6.3.6. Summary
In sum, word order and verb inflection are vulnerable in agrammatic aphasia. Therefore, the Integration Problem Hypothesis (IPH), which forms a bridge between word order, verb inflection for time reference and case, has been formulated. The IPH will be described below, gathering together previous neurolinguistic findings and current data on Turkish.
6.4. A new theory: Integration Problem Hypothesis

Language production and comprehension require the integration of information from several linguistic (e.g., morphosyntactic) and non-linguistic (e.g., pragmatic, semantic) levels. When a sentence is produced or processed, the preverbal message can be grammatically encoded (see Levelt, 1995) to formulate a sentence. The sentence can be very simple (say ‘base’") or very complex – for example, a passive can be embedded in a relative clause. Sentences with fewer morphosyntactic dependencies are easier for patients. The easiest sentence frame to produce and comprehend sentences is outlined below.

First, sentences with base order are easier than sentences with derived order. For example, base order in Turkish (SOV) requires the fewest morphosyntactic computations in comparison to other word orders. Therefore, sentences with base order are easier than sentences with derivation, since the latter are structurally more complex. As a result of problems with word orders other than base order, agrammatic speakers cannot convey pragmatic information obtained through word order changes properly.

Second, in easy sentences, not only are the constituents in base order, but the case is also used in its most basic way (subj/agent=nom; obj/theme=acc). For example, in Turkish, the subject is generally inflected in the nominative case and the object in the accusative case. However, for pragmatic reasons, a derived order can be used, which sometimes results in a non-base case assignment. In Turkish object relative clauses, word order is derived and the subject is inflected in the genitive case. The patients often avoid this sentence structure because they cannot convey pragmatic information obtained through word order changes and the corresponding case changes are difficult for them, forcing more complex morphosyntactic computations among sentence elements.

Finally, agrammatic speakers use non-remote verb forms (present and future). This is because reference to the past through verb inflection (=remote verb forms) is difficult for them, regardless of whether the past is expressed through a finite verb or a participle. The reason this makes remote verb forms more difficult for the patients could be that temporal interpretation of epistemic modality (the degree of certainty that a speaker has with respect to his proposition) becomes more difficult when certainty of past (certainty that something happened or certainty that an event has been completed) is involved (see Chapter 4).

Accordingly, a sentence composed of (base order + base case + non-remote verb form) constitutes the simplest form of a sentence for agrammatic speakers. They can comprehend and produce a sentence using this frame better than any other. Furthermore, the patients are not able to express more information through morphosyntax than as
reflected in this frame: if they are required to use derived order, case that is not ‘base’ or +
remote verb forms, their performance drops significantly. In addition, if they have to
integrate information from two morphosyntactic levels at the same time (derived order and
non-base case), more problems arise. This is an integration problem: sentences with
derived order and ‘non-base’ case are more difficult than sentences with only derived
order, which are in turn more difficult than sentences with base order.

Furthermore, anything deviating from the base sentence frame [base word order+base
case+non-remote verb forms] makes sentence production and comprehension more
difficult for agrammatic speakers. Therefore, they can neither express pragmatic shifts nor
[+remote] time frames through morphosyntax, because they cannot apply all the rules at
the same time correctly. In other words, they cannot adequately and consistently translate
pragmatic or semantic information into a structure, because they cannot integrate
morphosyntactic information. However, once the integration is complete, the sentence is
produced correctly. The IPH therefore predicts that when the patients derive an order
correctly, they will also produce the case correctly.

The IPH assumes that patients cannot interpret a derived order sentence successfully
solely on the basis of case (in case-marking languages), since the problem is an integration
problem, as shown for Turkish. Therefore, the IPH can account why case was found not to
help comprehension in several case-marking languages: Turkish (McWhinney et al., 1991;
Yarbay Duman et al., submitted; see Chapter 5); German (Burchert et al., 2003); Hebrew
(Friedmann & Shapiro, 2003); Serbo-Croatian (Smith & Mimica, 1984; Lukatela et al.,
1995). It is an integration problem.

The IPH can also explain the findings of the earlier studies of word order. Bastiaanse
et al. (2002a) showed in several studies that Verb Second is difficult for patients. This was
confirmed by Wenzlaff and Clahsen (2005) for German, at least for some of their patients.
Bastiaanse et al. (2003) and Burchert et al. (2007) found that object scrambling is also
difficult in Dutch and German respectively. Similar findings were reported for Turkish
(Yarbay Duman et al, 2007, see Chapter 2; Yarbay Duman et al. 2008, see Chapter 3).
Scrambled sentence have a derived word order by definition and are difficult to produce
for agrammatic speakers according to the IPH.

According to the IPH, the linguistic elements or operations themselves (e.g., the
operation of moving) are not impaired, but the linguistic contexts required for the
use/processing of these elements are difficult. Therefore, syntactic tree position is not
relevant to the IPH. In other words, the IPH assumes that derivation is a fundamental part
of the integration difficulty, relating to word order, but the internal mechanisms of the
derivation (movement, merge, merge and move etc.) or the relative position of the
elements in the syntactic tree are not relevant. Whenever a word order is different from the
base order of a language, it is difficult for patients. The factors involved in such a
derivation, for example case, add further difficulty if they are also deviant (e.g., non-base
case).

Obviously, it is not only derived order and non-base case that are difficult, but also
remote verb forms. The IPH predicts that integrating information from verb inflection and
time reference, particularly to the past, is difficult for patients due to an integration
problem. For example, Turkish agrammatic speakers produced verb inflections that do not
match the given adverbs (e.g., yesterday), particularly because a past time adverb as such
adds an extra level of interpretation. It would be interesting to test whether the patients
always refer to the past when they use past tense morphology (that is, that they should not
associate what they said in past morphology to a present/future event in picture
descriptions). Note that the IPH can also account for the difficulties with past verb forms
found in, for example, Greek (Stavrakaki & Kouvava, 2003) and Dutch (Bastiaanse, 2008).

Accordingly, the problem is not solely of word order or verb inflection, as suggested
by the theories of agrammatism. The IPH is meant to capture both types of difficulties.
Indeed, IPH does not only capture the problems with word order and verb inflection for
time reference but also the interaction between different linguistic levels such as word
order and case. Apparently, the problem is at the grammatical level.

6.5. Turkish Grammar and Agrammatism in Turkish

Three characteristics of Turkish – (1) word order; (2) verb inflection, including time
reference; and (3) case inflection – have been investigated. Turkish agrammatic speakers
have problems in using derived word orders in structured tests, even though word order is
free. They have problems adequately expressing time reference through verb inflection,
particularly to the past, despite the fact that Turkish is an inflectional language that has
specific tense inflections. The patients cannot make use of case in comprehension
although case is marked overtly on the nouns. These findings suggest that the
characteristics of Turkish grammar did not draw a different profile for agrammatism in
this language. This is according to expectation if the underlying deficit or deficits in
agrammatic aphasia is the same across languages (e.g., derived orders are difficult for
Turkish, Dutch and German patients).
However, the specific grammar of the patient influences how agrammatism manifests itself in a language. For example, agrammatic speakers of Turkish might use fewer nominalized or participle clauses compared to agrammatic speakers in other languages because most nominalized clauses involve word order derivation in Turkish. Another example is that if time reference is difficult only when it is expressed by verb inflection, as in Turkish, then patients might express time reference better in Chinese, which marks time reference with an aspectual adverb. Consequently, the investigation of the specific grammar of the patient is crucial to understanding how the underlying deficit or deficits in agrammatism are reflected in that language, which is then crucial to correctly understanding agrammatism in general.

Apparently, the structure of Turkish was useful in determining the nature of impairments in agrammatic aphasia by testing the following aspects in agrammatism for the first time: testing overt movement in ‘non-finite’ clauses; testing time reference through finite verbs and participles inflected for past and future; testing the interaction between case and word order, not only when word order but also when case varied. None of these factors had been tested for Turkish previously. Indeed, in understanding agrammatism, caution is needed not only to examine how a grammatical phenomenon surfaces in a specific grammar but also how the grammatical deficit is reflected in different modalities in that language. An example of this is that the patients produced case quite well in production but they could not comprehend a sentence on the basis of case. This is because the deficit (integration of word order and case) surfaces differently in both modalities, as explained below.

In production, when the patients were prompted with base order and base case, they produced sentences that pertain to these characteristics correctly. When the patients were prompted with derived order and basic case (nominative + accusative) or non-basic case (e.g., genitive + nominative), they either (a) overtly moved the required argument and produced the required case correctly or (b) produced a base order clause in base case. Note that (a) is a moment when integration is already complete and (b) is a moment when the patient rules out the negative effect of derived word order. There was no instance where the patient produced the derived order correctly but the case incorrectly. The data then permitted the evaluation of how the patients produced base/non-base case when they produced a base/derived order.

However, in comprehension the patients had no opportunity to rule out the negative effect of word order or case, as they did not have a chance to adapt the clause to one that
they could understand better – as they did in the production test by avoiding movement (see above). Therefore, when they misinterpret a sentence, it is not possible to specify directly the exact factor (e.g., case inflection) that hampered the patients’ sentence interpretation ability. If it was only derived word order that affected patients’ performance, then the patients could understand the sentences solely on the basis of case information. Indeed, if the deficit is an integration difficulty as proposed in IPH, it is already misleading to assume that case information alone predicts the correct interpretation of the clause. This is not possible if the patient cannot eliminate the effect of derived word order that blocks information coming from order and case (= an integration difficulty). The IPH can therefore explain why the patients seem to be impaired in comprehending case while being able to produce it well, by considering the consequences of such an integration deficit for both modalities. This point of view makes IPH a more economical approach in that the IPH assumes one underlying deficit for production and comprehension rather than two: one for production and the other for comprehension. Obviously, an efficient examination of agrammatism also requires an investigation of how the deficit surfaces in a specific grammar and in different modalities.

6.6. Conclusion

Sentence production and comprehension deficits in Turkish agrammatic Broca’s aphasia were discussed in terms of linguistic theories of agrammatism. The discussion was focused on the difficulties with derived word orders in relation to case morphology and verb inflection, particularly with reference to remote structures. The Integration Problem Hypothesis (IPH) was introduced to account for the sentence production and comprehension difficulties that the patients experience. The IPH could not have been formulated without testing the current linguistic hypothesis of agrammatism (TPH, DOP-H, TUH, TAUH and TDH), all of which motivated testing a particular aspect of the language, and which all thus contributed substantially to this research.