Time reference through verb inflection in Turkish agrammatic aphasia

Tuba Yarbay Duman *, Roelien Bastiaanse

Department of Linguistics, Graduate School for Behavioral and Cognitive Neurosciences (BCN), University of Groningen, P.O. Box 716, 9700 AS Groningen, The Netherlands

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A B S T R A C T

This study tested the production of tensed finite verbs and participles referring to the past and future in agrammatic speakers of Turkish. The agrammatic speakers did not make more time reference errors in tensed verbs than in participles. This is interesting because tense in general cannot therefore be the main problem, since time reference for participles lacking tense inflection is as difficult as for verbs with tense inflection. Besides that, the past tense/perfect aspect was found to be more difficult to produce for the agrammatic speakers than the future tense/imperfect aspect. None of the current theories on agrammatic deficits can explain why reference to the past/perfect aspect is more difficult than reference to future/imperfect aspect, although a similar finding was reported for Dutch by Bastiaanse [Bastiaanse, R. (2008). Production of verbs in base-position by Dutch agrammatic speakers: Inflection versus finiteness. Journal of Neurolinguistics, 21, 104–119]. We present a remoteness model of time reference to account for the data.

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1. Introduction

Agrammatism is considered to be a clinical symptom of Broca’s aphasia and is primarily characterized by omissions and/or substitutions of inflectional morphemes in constrained tasks and in spontaneous speech. Some verbal affixes have been shown to be particularly prone to impairment (e.g., Burchert, Swoboda-Moll, & de Bleser, 2005; Friedmann & Grodzinsky, 1997; Vartlokosta et al., 2006; Wenzlaff & Clahsen, 2005). Various proposals across several languages have been made to capture the generalization of impaired and spared verbal inflections in agrammatic aphasia.

Several recent hypotheses share the specific assumption that the agreement inflection is preserved better than tense (T) inflection because the tense node (TP) is inaccessible to agrammatic speakers, while the agreement node is available (Friedmann & Grodzinsky, 1997; Tree Pruning Hypothesis (TPH) for Hebrew) or because tense is underspecified (Wenzlaff & Clahsen, 2005; Tense Underspecification Hypothesis (TUH) for German). The difference between TPH and TUH is that Friedmann and Grodzinsky (1997) assume that the tense problem is purely syntactic in nature. The syntactic tree is pruned, tense is high in the tree, and therefore tense is impaired on the basis of its position. Wenzlaff and Clahsen (2004, 2005) also found that tense is impaired. However, they tested for grammatical mood as well. In German, mood is supposed to be part of the tense node and it is relatively well-preserved, whereas tense itself is impaired. Therefore, the authors assume that it is not the syntactic category of tense per se nor its position in the tree that is the cause of the problem, but the characteristics of tense, that is, the interpretability of the features that are used for time reference. Burchert et al.’s data (2005); Tense Agreement Underspecification Hypothesis (TAUH) for German) support these views only partially. According to these authors, tense and agreement can be affected independently. In other words, only some agrammatic speakers have problems with tense, whereas others have problems with agreement. What these theories have in common is that they focus on the tense and agreement nodes in the syntactic tree.

Bastiaanse (2008), however, suggests another reason why tense could be impaired. In her study she found that not only is the past tense more difficult than the present tense, but that participles (P) in present perfect constructions (auxiliary + particle) (e.g., de jongen heeft de brief geschreven: Lit. ‘the boy has the letter written’; infinitives (modal + infinitive) (e.g., de jongen kan de brief schrijven: Lit. ‘the boy can the letter write’) for Dutch agrammatic speakers. Problems with past verb forms have previously been reported for Greek, not only for tense but also for the grammatical aspect. Stavrukaki and Kouvava (2003) showed that the past tense is more difficult than the present tense and that the past tense with the perfective aspect (diava – s – a: Lit. ‘read-perfective-past-1sg, ‘I read’) is more difficult than the past tense with the imperfective aspect (diava – z – a: Lit. read – imperfective – past – 1sg, ‘I was reading’) in spontaneous speech. Poorer performance in the perfective compared to the imperfective aspect has also been reported by Nanousi, Masterson, Druks, and Atkinson (2006: for Greek). Taken together, these findings are in

* Corresponding author. Fax: +31(0)50 363 6855.
E-mail address: T.Yarbay.Duman@rug.nl (T. Yarbay Duman).

1 The TPH (Friedmann & Grodzinsky, 1997) follows Pollock (1989) in assuming that tense and agreement head their own projections and that the agreement node is lower than the tense node in the syntactic tree.
line with Wenzlaff and Clahsen’s (2005) and Burchert et al.’s (2005) idea that, at least for some agrammatic speakers, it is not primarily the syntactic aspect of tense, i.e. its position in the tree, that is difficult. These authors suggest that inflection of the verb – i.e. tense as a functional category – is underspecified. However, these theories cannot adequately explain the data obtained by Stavrakaki and Kouvava (2003), Namousi et al. (2006) and Bastiaanse (2008), since underspecification as such neither accounts for the dissociation between different tenses nor predicts difficulties with grammatical aspect. According to Bastiaanse (2008), it is not only tense inflection on the finite verb that is affected, but time reference, particularly the past. This description does not allow for a possible discrepancy between two ‘past’ constructions, i.e. it cannot explain the clash between the perfective and imperfective aspects as such in agrammatic speech.

The outcomes of the studies of verb forms referring to different time lines – ‘present, past and future’ – are controversial, not only with respect to the production of the past but also future verb forms. Stavrakaki and Kouvava (2003) predict that agrammatic speakers make errors in past forms of tense and aspect but not in future verb forms. However, according to Varlokosta et al. (2006: for Greek), not only is the agrammatic speakers’ performance for the perfective and imperfective aspect indistinguishable but future tense forms are themselves prone to errors.

These findings have raised several questions, two of which will be addressed in this study. The first is whether reference to the past by tensed verbs and participles is difficult for Turkish agrammatic speakers. The second is whether only reference to the past is difficult or whether reference to the future is affected as well. None of the theories (TPH, TUH, TAUH) mentioned above are relevant to time reference and none of the studies mentioned tested the past and future participles expressed by a specific verb inflection, that is, without a modal verb or an auxiliary, or in the absence of a tense morpheme.

In this study, the focus will be on the interpretational, i.e. the semantic correlates of tense, and participles lacking tense. Finite verbs in the past tense (perfect aspect) and future tense (imperfect aspect) and non-finite verbs that are past participles (perfect aspect) and future participles (imperfect aspect) will be introduced. We will show that neither the syntactic (i.e. tree position) nor the morphological correlates of tense and participle (i.e. the particular verb inflection which refers to a given time point) are relevant to the difficulties the agrammatic speakers have with some verb forms over others. Rather, reference to the past, by finite verbs and participles, is difficult for Turkish agrammatic speakers and therefore parallels the results of Dutch agrammatic speakers as reported by Bastiaanse (2008).

1.1. Linguistic background

Turkish is an agglutinating language with the base subject–object–verb (SOV) order. Example 1 is a main clause where the finite verb is in the past tense/perfect aspect (see 1a, –DI) and in the future tense/imperfect aspect (see 1b, –EcEK). Example 2 is a subordinate clause where the non-finite participle verb expresses the past with a past participle/perfect aspect (see 2a, –DIK) and the future with a future participle/imperfect aspect (see 2b, –EcEK). Participles in Turkish are not inflected for tense (Aygen, 2004; Hanner & Knecht, 1976; Kornfilt, 2000). Past and future verb forms, and the present, are different in terms of their aspecual features – past tense expresses the perfect aspect that introduces ‘a completed event’, whereas the future expresses the imperfect aspect – ‘not complete and not progressive’. Accordingly, another relevant factor to the grammatical aspect is ‘factivity’. Factive sentences are accepted to be epistemically non-modal because they assert the certainty and the full commitment of the speaker to the truth of the utterance (Lyons, 1977). Factivity is thus not reserved to the subordinate contexts under verbs such as remember, regret. Past verb forms are ‘factive’, they express ‘certainty of an event’ – the speaker states his/her certainty with regards to the completion of the event (temporal completeness). A non-temporal factor involved is the ‘epistemic certainty’, in which ‘completed’ events are marked for some tense or aspect markers in various languages (e.g., in those years only men could vote). Future verb forms are ‘non-factive’, they express only the implication of an event. In the examples below, all the verbs are inflected with first person singular agreement (1sg). All the objects in the examples below are in the absolute case.3 The inflections introduced (–DI, –DIK, –EcEK) are all subject to morphophonological rules.

The subordinate clauses we tested (see 2) are structurally more complex than the main clauses. This is because the object has to follow the participle, which is achieved by overt syntactic movement of the object to the end of the clause, as the trace (t) co-indexed with the empty object in its base-position shows (Aygen, 2005; Kornfilt, 2000). Notice that inflections with a tense function (finite –DI, –EcEK) co-occur with nominative subjects in the main clauses (see 1a and 2b) whereas others (non-finite –DIK, –EcEK) accompany genitive subjects in the participle clauses with object relativization (see 2a and 2b). The genitive subject agrees in number and person with the verb.

These morphemes (–DIK, –DI, –EcEK) appear in complementary structures: –DIK and –EcEK as participles in the subordinate

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2 In several languages, aspect is assumed to be lower than tense in a syntactic tree (e.g., see Philippaki-Warburton, 1998 for Greek; Aygen, 2004 for Turkish).

3 The –DIK participle in Turkish can refer to the present or the past, depending on the context (e.g., benim şu anda ütülediğim etek ‘the skirt that I am ironing now’ versus benim diün ütülediğim etek ‘the skirt that I have ironed yesterday’). We call –DIK a past participle/perfect aspect morpheme since we test this morpheme in the presence of the adverb ‘yesterday’.

4 Turkish has no distinction between perfect and progressive aspect.

5 Following the work of Erguvanlı (1984) and Aygen (2004), among others, we assume that these bare objects are in the absolute case assigned as a default case. The fact that these objects can be scrambled under certain discourse settings (e.g., etek ben giyerim ‘skirt, I wear’) provides further empirical evidence against an analysis based on varieties of incorporation.
clauses versus –DI and –EcEK as tense/aspect morphemes in main clauses with a base order. Therefore, when –DIK and –EcEK are used as participles in subordinate clauses i.e. when the subject is in the genitive case, the participle verb has to precede its object and it cannot follow it (see 3). Yet, when –DI and –EcEK are used as tense/aspect morphemes in main clauses with a base order i.e. when the subject is in the nominative case, the finite verb has to follow its object (see 1a and 1b). Table 1 gives an overview of the verb morphology of finite verbs in main clauses with a base order and participles with object relativization, and the consequences for the verb position and subject case. Semantically, these inflections are discriminated on the basis of whether an event has been completed. There is no semantic difference between the past tense and participle (both express the perfect aspect and both are factive) and between the future tense and participle (both express the imperfect aspect and both are non-factive).6

The hierarchy of functional categories in Turkish is Complementizer Phrase (CP) – Tense Phrase/Inflection (TP/INFL) – Aspect Phrase (AspP) – Verb Phrase (VP) (Aygen, 2004). In main clauses, the finite verb moves to T to check its inflectional features i.e. tense and aspect (Chomsky, 1995). However, there is no T head within the subordinate clauses we have tested; the highest inflection head within the higher Determiner Phrase (DP) is an AspP. Consequently, the successive cyclic movement of the verb ends at Asp, that is, within the DP (Aygen, 2005; Krause, 2001). The object overtly moves to the superordinate DP (Aygen, 2005). Fig. 1 shows the internal structure of a Turkish main clause and a subordinate clause. Notice that the position of the inflection in the syntactic tree changes with respect to their functions – if the inflection has a tense function, it occupies T/INFL and if it has a participle function, it is in AspP as a head. Neither of these verb movements changes the order of the constituents at the surface level.

1.2. The present study

In a previous study of constituent order problems in Turkish agrammatism, production of main and relative clauses was compared (Yarbay Duman, Aygen, & Bastiaanse, 2008). It was found that the production of relative clauses was more impaired than the production of main clauses and constituent order errors were dominant in the relative clauses. The present study focuses on the production of time reference in main and subordinate clauses corresponding to (object) relative clauses7 in Turkish. The main objective of this study is to investigate the origin of the verb inflection deficits in Turkish agrammatic speakers by examining their ability to produce a verb inflection to refer to past and future. In this report, reference to past and future through verb inflection will be termed time reference. We tested two verb forms that refer to the past and the future – finite verbs and participles. Finite verbs are inflected for tense and agreement. The past tense expresses the perfect and the future tense expresses the imperfect aspect. Participles are inflected for agreement but they lack tense inflection. The past participle expresses the perfect and the future participle expresses the imperfect aspect. We included participles because they allow the distinguishing of a deficit in tense from a deficit in time reference. In other words, if ‘tense’ is the problem, no time reference errors to participles are expected. Tense, aspect and agreement in Turkish finite verbs and participles are presented in Table 2.

The tense-related theories (TPH, TUH, TAUH) predict impaired production of tense morphemes on the finite verbs. This could either be because TP is unavailable to the agrammatic speakers (TPH) or because T/INFL is selectively underspecified for tense (TUH) in agrammatic speech. According to the TAUH, some agrammatic speakers have problems with tense, whereas others have problems with agreement. Thus, they predict that more errors will be made with finite verbs than with the participles since participles neither move as high as the T node nor are they inflected for agreement. Thus, they predict that more errors will be made with finite verbs than with the participles since participles neither move as high as the T node nor are they inflected for tense. In addition, none of these theories predict differences between the past and future tenses. However, if the data reported for Dutch by Bastiaanse (2008) are universal, then we expect no differences between finite verbs and participles. Reference to the future has only been tested for Greek so far and the results are unequivocal. According to Stavrakaki and Kouvava (2003), future forms are intact, and according to Varlokosta et al. (2006) they are impaired.

2. Methods

2.1. Subjects

Seven individuals (4 female, 3 male) clinically diagnosed with Broca’s aphasia at the Ankara Physical Medicine and Rehabilitation Center participated in the study. The diagnoses were based on the Gülhane Aphasia Test (Tannırdağ, 1993) and the clinical judgments of a speech therapist. The speech therapist confirmed that they were all non-fluent, with slower than normal speech patterns, producing simplified and short utterances. They will therefore be referred to as agrammatic speakers.

The agrammatic speakers were at least 3 months post onset (but see B1) of left CVA (Cerebro Vascular Accident), except B6 who had had traumatic brain injury. All were right-handed before their strokes, but suffered from right-hemiplegia at the time of testing. The individual data of the agrammatic speakers are presented in Table 3.

A group of seven non-brain-damaged Turkish speakers participated in the study. They had no history of neurological disease and were matched on age and education to the agrammatic speakers group.

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6 –DI and –DIK are morphologically different. Kural (1993) argues that the –DIK morpheme consists of tense –DI and a complementizer –k. Studies of the extraction possibilities and consequences of T-to-C in Turkish (e.g., Aygen-Tosun, 1999) indicate that there is neither an overt complementizer in such structures nor a tense.

7 We used relatives instead of complement clauses where traces and heads do not occur for two reasons: (1) preference was given to the equal number of clauses in both conditions; (2) other participle constructions all imply embedding, which is known to be difficult for agrammatic speakers (Friedmann, 2001). The disadvantage of this choice is that in relatives constituent order and subject case might interfere with time reference, which was, however, taken into account by the error analysis.
2.2. Materials

Fifteen transitive verbs were chosen (e.g., ‘to iron’). These verbs were matched with an object pair (such as, skirt–trousers). Each verb and object pair was used to elicit a clause, either with a tensed \((n = 30)\) or a participle verb \((n = 30)\). Half of the clauses with tense were in the past tense/perfect aspect condition \((n = 15)\) (–DI is the tense/epistemic modality marker for the past) and the other half were in the future tense/imperfect aspect condition \((n = 15)\) (–EcEK is the tense/modality marker for the future). Similarly, half of the clauses with participle verbs belonged to the past participle/perfect aspect condition \((n = 15)\) (–DIK is the past participle expressing the perfect aspect) and the other half future participle/imperfect aspect condition \((n = 15)\) (–EcEK is the future participle expressing the imperfect aspect). Accordingly, there were four conditions with 15 items each in the test (a total of 60 items per participant). The agreement inflection \((-\text{Im})\) was the same for all the conditions.

The subject of the clause in tensed clauses was inflected for the first person singular pronoun (ben ‘I’), which is marked with the nominative case, which is a null morpheme in Turkish \((\text{ben-nom})\). The subject in participle clauses was inflected with the DP

\[
\text{DP} \quad \text{Spec \ Subj, ben-im} \\
\text{V} + \text{v} + \text{T} \\
\text{úllüle-d-i-m [past] úllüle-(y)ece-g-im[future]} \\
\text{Spec N'} \\
\text{AspP t_l} \\
\text{Spec Asp'} \\
\text{vP t_k} \\
\text{Spec t_l} \\
\text{V', Vi + vj + T} \\
\text{e-di-m [past]} \\
\text{e-(y)ece -im [future]} \\
\text{Subj1 ben} \\
\text{Obj etek} \\
\text{Spec t_l} \\
\text{Spec t1} \\
\text{V'} \\
\text{Vj} \\
\text{V} \\
\text{t_k} \\
\text{t_s} \\
\text{t_i} \\
\text{Spec N'} \\
\text{AspP t_l} \\
\text{Spec Asp'} \\
\text{vP t_k} \\
\text{Spec t_l} \\
\text{V', Vi + vj + T} \\
\text{e-di-m [past]} \\
\text{e-(y)ece -im [future]} \\
\text{Subj1 ben} \\
\text{Obj etek} \\
\text{Spec t_l} \\
\text{Spec t1} \\
\text{V'} \\
\text{Vj} \\
\text{V} \\
\text{t_k} \\
\text{t_s} \\
\text{t_i} \\
\text{Spec N'} \\
\text{AspP t_l} \\
\text{Spec Asp'} \\
\text{vP t_k} \\
\text{Spec t_l} \\
\text{V', Vi + vj + T} \\
\text{e-di-m [past]} \\
\text{e-(y)ece -im [future]} \\
\text{Subj1 ben} \\
\text{Obj etek} \\
\text{Spec t_l} \\
\text{Spec t1} \\
\text{V'} \\
\text{Vj} \\
\text{V} \\
\text{t_k} \\
\text{t_s} \\
\text{t_i} \\
\text{Spec N'} \\
\text{AspP t_l} \\
\text{Spec Asp'} \\
\text{vP t_k} \\
\text{Spec t_l} \\
\text{V', Vi + vj + T} \\
\text{e-di-m [past]} \\
\text{e-(y)ece -im [future]} \\
\text{Subj1 ben} \\
\text{Obj etek} \\
\text{Spec t_l} \\
\text{Spec t1} \\
\text{V'} \\
\text{Vj} \\
\text{V} \\
\text{t_k} \\
\text{t_s} \\
\text{t_i} \\
\text{Spec N'} \\
\text{AspP t_l} \\
\text{Spec Asp'} \\
\text{vP t_k} \\
\text{Spec t_l} \\
\text{V', Vi + vj + T} \\
\text{e-di-m [past]} \\
\text{e-(y)ece -im [future]} \\
\text{Subj1 ben} \\
\text{Obj etek} \\
\text{Spec t_l} \\
\text{Spec t1} \\
\text{V'} \\
\text{Vj} \\
\text{V} \\
\text{t_k} \\
\text{t_s} \\
\text{t_i} \\
\text{Spec N'} \\
\text{AspP t_l} \\
\text{Spec Asp'} \\
\text{vP t_k} \\
\text{Spec t_l} \\
\text{V', Vi + vj + T} \\
\text{e-di-m [past]} \\
\text{e-(y)ece -im [future]} \\
\text{Subj1 ben} \\
\text{Obj etek} \\
\text{Spec t_l} \\
\text{Spec t1} \\
\text{V'} \\
\text{Vj} \\
\text{V} \\
\text{t_k} \\
\text{t_s} \\
\text{t_i} \\
\text{Spec N'} \\
\text{AspP t_l} \\
\text{Spec Asp'} \\
\text{vP t_k} \\
\text{Spec t_l} \\
\text{V', Vi + vj + T} \\
\text{e-di-m [past]} \\
\text{e-(y)ece -im [future]} \\
\text{Subj1 ben} \\
\text{Obj etek} \\
\text{Spec t_l} \\
\text{Spec t1} \\
\text{V'} \\
\text{Vj} \\
\text{V} \\
\text{t_k} \\
\text{t_s} \\
\text{t_i} \\
\text{Spec N'} \\
\text{AspP t_l} \\
\text{Spec Asp'} \\
\text{vP t_k} \\
\text{Spec t_l} \\
\text{V', Vi + vj + T} \\
\text{e-di-m [past]} \\
\text{e-(y)ece -im [future]} \\
\text{Subj1 ben} \\
\text{Obj etek} \\
\text{Spec t_l} \\
\text{Spec t1} \\
\text{V'} \\
\text{Vj} \\
\text{V} \\
\text{t_k} \\
\text{t_s} \\
\text{t_i} \\
\text{Spec N'} \\
\text{AspP t_l} \\
\text{Spec Asp'} \\
\text{vP t_k} \\
\text{Spec t_l} \\
\text{V', Vi + vj + T} \\
\text{e-di-m [past]} \\
\text{e-(y)ece -im [future]} \\
\text{Subj1 ben} \\
\text{Obj etek} \\
\text{Spec t_l} \\
\text{Spec t1} \\
\text{V'} 

Fig. 1. Syntactic tree of a basic SOV (left) and a subordinate [\text{NP}SVO] (right) clause in Turkish.

Table 2
Tense, aspect and agreement in Turkish finite verbs and participles.

<table>
<thead>
<tr>
<th>Finite</th>
<th>Agreement</th>
<th>Tense</th>
<th>Aspect</th>
<th>Reference to</th>
<th>Factive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Past finite verbs</td>
<td>+</td>
<td></td>
<td>+</td>
<td>Perfect</td>
<td>Past</td>
</tr>
<tr>
<td>Future finite verbs</td>
<td>+</td>
<td></td>
<td>+</td>
<td>Imperfect</td>
<td>Future</td>
</tr>
<tr>
<td>Past participles</td>
<td>–</td>
<td></td>
<td>–</td>
<td>Perfect</td>
<td>Past</td>
</tr>
<tr>
<td>Future participles</td>
<td>–</td>
<td></td>
<td>–</td>
<td>Imperfect</td>
<td>Future</td>
</tr>
</tbody>
</table>

Table 3
The data of agrammatic speakers.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age</th>
<th>Etiology</th>
<th>Months post onset</th>
<th>Right-hemiplegia</th>
<th>Handedness</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>Female</td>
<td>66</td>
<td>Left CVA</td>
<td>&gt;2.5</td>
<td>Yes</td>
</tr>
<tr>
<td>B2</td>
<td>Male</td>
<td>70</td>
<td>Left CVA</td>
<td>6</td>
<td>Yes</td>
</tr>
<tr>
<td>B3</td>
<td>Female</td>
<td>44</td>
<td>Left CVA</td>
<td>16</td>
<td>Yes</td>
</tr>
<tr>
<td>B4</td>
<td>Female</td>
<td>47</td>
<td>Left CVA</td>
<td>26</td>
<td>Yes</td>
</tr>
<tr>
<td>B5</td>
<td>Male</td>
<td>40</td>
<td>Left CVA</td>
<td>28</td>
<td>Yes</td>
</tr>
<tr>
<td>B6</td>
<td>Female</td>
<td>26</td>
<td>Head-trauma</td>
<td>120</td>
<td>Yes</td>
</tr>
<tr>
<td>B7</td>
<td>Male</td>
<td>75</td>
<td>Left CVA</td>
<td>20</td>
<td>Yes</td>
</tr>
</tbody>
</table>

2.2. Materials

Fifteen transitive verbs were chosen (e.g., ‘to iron’). These verbs were matched with an object pair (such as, skirt–trousers). Each verb and object pair was used to elicit a clause, either with a tensed \((n = 30)\) or a participle verb \((n = 30)\). Half of the clauses with tense were in the past tense/perfect aspect condition \((n = 15)\) (–DI is the tense/epistemic modality marker for the past) and the other half were in the future tense/imperfect aspect condition \((n = 15)\) (–EcEK is the tense/modality marker for the future). Similarly, half of the clauses with participle verbs belonged to the past participle/perfect aspect condition \((n = 15)\) (–DIK is the past participle expressing the perfect aspect) and the other half future participle/imperfect aspect condition \((n = 15)\) (–EcEK is the future participle expressing the imperfect aspect). Accordingly, there were four conditions with 15 items each in the test (a total of 60 items per participant). The agreement inflection \((-\text{Im})\) was the same for all the conditions.

The subject of the clause in tensed clauses was inflected for the first person singular pronoun (ben ‘I’), which is marked with the nominative case, which is a null morpheme in Turkish (ben-nom ‘I-nom’). The subject in participle clauses was inflected with the

\(^8\) First person singular agreement has been chosen for testing since it is overtly inflected in both the finite verb and the participle and it cannot be dropped, whereas in a Turkish main clause, third person singular agreement is a null morpheme and third person plural agreement is overly inflected, but the inflection is usually omitted.
...is the root of the verb ütüle-mek: "I have ironed (it) yesterday" (as in yarın ütülemeğim: Lit. 'tomorrow iron-future-1sg', 'I will iron the trousers tomorrow. I have ironed the skirt yesterday.

Condition 2: Future tense/imperfect aspect (--EcEK)


The trousers that I will iron tomorrow. The skirt that I have ironed yesterday.

Condition 4: Future participle/imperfect aspect (--EcEK)


The skirt that I have ironed yesterday. The trousers that I will iron tomorrow.

The given and expected verb forms were always different throughout the tests. The test was self-paced, audio-recorded and transcribed orthographically.

3. Results

3.1. Quantitative analysis

The control group performed all the conditions perfectly. Their data will not be discussed further. The agrammatic speakers had problems in producing the required verb inflection and performed worse than the control group in all conditions. The total number

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Fig. 2. Example stimuli used for future tense and past participle condition. The picture shows 'iron' skirt–trousers pair.

Condition 1: Past tense/perfect aspect (-- DI, epistemic modality)

Ben yarın pantolon ütüleyecğim. Ben dün —— (participant: etek ütüledim).

I-nom tomorrow the trousers iron-future-1sg. L-nom yesterday —— (participant: the skirt iron-perfect-1sg).

I will iron the trousers tomorrow. I have ironed the skirt yesterday.

Condition 3: Past participle/perfect aspect (--DIK)

Ben dün etek ütüledim. Ben yarın —— (participant: pantolon ütüleyecğim).

I-nom yesterday the skirt iron-perfect-1sg. I-nom tomorrow —— (participant: the trousers iron-future-1sg).

I have ironed the skirt yesterday. I will iron the trousers tomorrow.

Condition 4: Future participle/imperfect aspect (--EcEK)


I-gen tomorrow iron-future-1sg the trousers. I-gen yesterday —— (participant: iron-future-1sg the skirt).

The trousers that I will iron tomorrow. The skirt that I have ironed yesterday.

The skirt that I have ironed yesterday. The trousers that I will iron tomorrow.

The given and expected verb forms were always different throughout the tests. The test was self-paced, audio-recorded and transcribed orthographically.
Table 4
Total number (percentages in round brackets) of correctly completed clauses for the past and future, and for finite verbs and participles. The maximum score is 105 per condition.

<table>
<thead>
<tr>
<th></th>
<th>Reference</th>
<th>Reference + order</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Past</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Past tense/perfect aspect</td>
<td>58 (55.2)</td>
<td></td>
<td>58 (55.2)</td>
</tr>
<tr>
<td>Past participle/perfect aspect</td>
<td>19 (18.1)</td>
<td></td>
<td>19 (18.1)</td>
</tr>
<tr>
<td>Total</td>
<td>77 (36.6)</td>
<td></td>
<td>77 (36.6)</td>
</tr>
<tr>
<td>Future</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Future tense/imperfect aspect</td>
<td>91 (86.6)</td>
<td></td>
<td>91 (86.6)</td>
</tr>
<tr>
<td>Future participle/imperfect aspect</td>
<td>17 (16.1)</td>
<td></td>
<td>17 (16.1)</td>
</tr>
<tr>
<td>Total</td>
<td>108 (51.4)</td>
<td></td>
<td>108 (51.4)</td>
</tr>
<tr>
<td>Finite verbs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Past tense/perfect aspect + future tense/imperfect aspect</td>
<td>148 (70.4)</td>
<td></td>
<td>148 (70.4)</td>
</tr>
<tr>
<td>Participles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Past participle/perfect aspect + future participle/imperfect aspect</td>
<td>36 (17.1)</td>
<td></td>
<td>36 (17.1)</td>
</tr>
</tbody>
</table>

Table 5 also shows that the agrammatic speakers made more (reference + order) errors in the subordinate clauses than in the main clauses. The overall data in Table 5 suggest that they had more problems with the past than with the future. First, errors in tense and participle were compared. The total number and percentages of errors in tense and participle. The individual data can be found in Appendix C.

The results show that finite main clauses with tense were easier than participle clauses (wilcoxon, \( z = -2.375, p = .018 \)). There was a trend that past participle/perfect aspect clauses were more difficult than past tense/perfect aspect clauses (wilcoxon, \( z = -1.947, p = .051 \)). Future participle/imperfect aspect clauses were more difficult than future tense/imperfect aspect clauses (wilcoxon, \( z = -2.375, p = .018 \)). Apart from this, clauses with the past tense/perfect aspect were more difficult than those with the future tense/imperfect aspect (wilcoxon, \( z = -2.207, p = .027 \)).

Participle clauses are syntactically more complex than main clauses in base order, as shown earlier by Yarbay Duman et al. (2008). The fact that so many errors were made with the participles could very well be due to the syntactic complexity of the subordinate clause – i.e. the derived order. The present study focuses on time reference and therefore a qualitative analysis of the finite verbs and participles produced is required for all error types, to disentangle the time reference errors from the constituent order errors.

3.2. Qualitative analysis

The qualitative analysis focuses on inflectional substitutions. Two types were produced – (1) inflectional substitutions that are time reference errors and (2) inflectional substitutions that are not time reference errors. Table 5 presents the total number (percentages) of time reference errors produced per condition (see Appendix B for time reference errors per agrammatic speaker). In the past tense/perfect aspect condition, almost all inflectional substitutions were ‘reference’ errors (98%). This was the same for the future tense/imperfect aspect condition – all inflectional substitutions involved ‘reference’ errors (100%). However, the agrammatic speakers produced four times more reference errors in the past tense/perfect aspect condition (37%) than in the future tense/imperfect aspect condition (7.6%).

The agrammatic speakers made verb inflection substitutions in participle conditions, also involving ‘reference’ errors. There were several verb inflection substitutions in past participle/perfect aspect and future participle/imperfect aspect conditions; however, only part of these substitutions involved ‘reference’ errors (35% for the past tense/perfect aspect and 30% for the future tense/imperfect aspect). The verb inflection substitutions were reflected either as a single (reference) error or as a multiple (reference + order) error. Multiple errors were most often observed in structurally complex clauses in derived order.

Table 5 also shows that the agrammatic speakers made more (reference + order) errors in the subordinate clauses than in the main clauses. The overall data in Table 5 suggest that they had more problems with the past than with the future.

First, errors in tense and participle were compared. The overall data in Table 5 suggest that they had more problems with the past than with the future. First, errors in tense and participle were compared. The total number and percentages of errors in tense and participle. The individual data can be found in Appendix C.

The results show that the agrammatic speakers did not make more time reference errors in the finite verbs than in the participles (wilcoxon, \( z = -0.736, p = .461 \)). This is interesting because tense in general cannot then be the main problem, since time reference on participles that lack tense inflection is as difficult as verbs with tense inflection, even when they are identical in form.

Second, time reference comparisons were made between past tense/perfect aspect and future tense/imperfect aspect. There were more errors to past tense/perfect aspect than to future tense/imperfect aspect (wilcoxon, \( z = -2.120, p = .034 \)). Past participle/perfect aspect was not more difficult than the future participle/imperfect aspect (wilcoxon, \( z = -1.511, p = .131 \)). The lack of a significant difference between past and future participles will be discussed in the next section. The agrammatic speakers produced twice as many time reference errors on past forms (tense and participle: both are perfect aspect) than on future forms (tense and participle: both are imperfect aspect), yet the difference fails to reach statistical significance (wilcoxon, \( z = -1.101, p = .271 \)). Given these results, it can be concluded that past tense/perfect aspect is more difficult than future tense/imperfect aspect, and past forms (perfect aspect) are prone to more errors than future forms (imperfect aspect).

In a group comparison, the difference between past and future forms was not statistically significant. However, when individual analyses were performed, interesting patterns emerged.

3.3. Individual analyses on agrammatic speakers with specific time reference problems

Three out of seven agrammatic speakers (B2, B3, B7) are significantly impaired in time reference. Reanalysis of the Dutch agrammatic speakers from Bastiaanse (2008) showed that 5 out of 10 Dutch agrammatic speakers also have specific problems with time reference. In the next paragraphs, the individual analyses of these participants are given.

For B2 and B7, past tense/perfect aspect was more difficult than future tense/imperfect aspect (\( \chi^2 = 25.33, df = 1, p < .001 \) for B2; \( \chi^2 = 16.13, df = 1, p < .001 \) for B7). Also, the past participle/perfect aspect was more difficult than future participle/imperfect aspect (\( \chi^2 = 9.13, df = 1, p < .01 \) for B2; \( \chi^2 = 5, df = 1, p < .05 \) for B7). There-

\[ \text{The present study was not designed to test agreement; accordingly, the verb was always inflected for first person singular agreement.} \]
fore, we suggest that these two agrammatic speakers have selective problems with time reference, where reference to the past is more difficult than reference to the future, both with a finite verb and with a participle. B2 makes more reference errors with tense than with participles ($\chi^2 = 4.59, df = 1, p < .05$), and B3 makes more errors to reference with participles than those with tense ($\chi^2 = 4.81, df = 1, p < .05$), with no significant difference in his ability to refer to the past and the future with a participle ($\chi^2 = 2.40, df = 1, p < .20$). Considering these individual results, participants B2, B7, and B3 have in common that they are impaired in time reference and for two of them, this impairment is highly selective: reference to the past is more difficult than reference to the future.

The Dutch data show a similar pattern: 4 out of 10 agrammatic speakers are significantly worse in reference to the past overall ([participle + past tense] < [infinitives + present tense]), two agrammatic speakers are significantly impaired in past tense compared to present tense. Remarkably, one participant is better in past than present tense.

3.4. Summary of the results

The main objective of the present study is to examine the agrammatic speakers’ ability for time reference. The results show that (1) reference with verbs that are inflected for tense are as difficult as participle verbs that lack tense, (2) past tense/perfect aspect is more difficult than the future tense/imperfect aspect, (3) there is no difference between past and future participles, (4) verb forms referring to the past are prone to more errors than future verb forms. In sum, past tense is more impaired than future tense, but there is no difference between non-tensed past and future verb forms. These results will be discussed in the next section.

4. Discussion

On the basis of the results above, there are two main findings. Firstly, agrammatism is not a tense problem but a problem in time reference, also reflected in participles. Secondly, the deficit is not just time reference, but reference to the past at least for tensed verbs. No current theory on agrammatic speech production can explain these results. The next section discusses time reference problems with regard to the theories of agrammatic production mentioned in Section 1.

4.1. The time reference problem in agrammatic aphasia

The time reference problems have been noticed before, of course, by theories that relate the agrammatic problem to tense (TPH, TUH, TAUH). Of these hypotheses, the TUH is the only one that makes the link to the interpretable features of tense. However, the TUH still relates the problem to the tense node by assuming that tense at T\text{INFL} is underspecified whereas the present data show that the interpretable features of the participle are impaired as well. Hence, we assume that time reference through verb inflection is impaired in Turkish agrammatic speakers. The same has been shown for Dutch agrammatic speakers (Bastiaanse, 2008). The next topic to address is the differences in time reference frames where verb inflections refer to past and future.

4.2. Reference to past and future

Two agrammatic speakers out of the seven in this study and 4 agrammatic speakers out of the 10 in Bastiaanse (2008) have a selective deficit with reference to the past. Based on the above findings, we assume that it is not purely the morphosyntactic correlates of tense – neither the tense node itself, nor its position in the tree – but rather time reference through verb inflection – whether or not in the TP or AspP – that is the main problem. Therefore, we suggest that some aspects of verb inflections become more difficult when time reference to the past (perfect aspect) is involved. The following addresses the question of how the difficulties with past, which were found in the present study and were previously reported for Dutch (Bastiaanse, 2008) and Greek (Stavrakaki & Kouwava, 2003), can be accounted for.

The problem with reference to the past could be a problem with ‘perfectivity’. In other words, when reference time precedes event time, agrammatic speakers encounter a problem. A syntactic deficit could be assumed as well; that is, the Aspect node is impaired, but only for the ‘perfect’ aspect. Such an explanation could account for the Turkish data; however, it is incompatible with the Dutch data (Bastiaanse, 2008). In Dutch, past tense is imperfect (Jan liep op straat: Lit. ‘Jan walk-imperfect past on the street’, ‘Jan was walk-walking/walked on the street’) and the imperfect past is more difficult than the imperfect present tense (Jan loopt op straat: Lit. ‘Jan walk-imperfect on the street’, ‘Jan walks on the street’). Actually, the imperfect past is the most difficult verb form for Dutch agrammatic speakers, meaning that the imperfect is not relatively easy, at least when the reference is to the past. Hence, perfectivity is not a likely explanation for the Turkish data. Notice also that there is no consistency in the difficult structures as regards the temporal ordering relationships of reference time and event time. The event time and reference time are contemporaneous in imperfect past, but remain difficult. The event time and reference time are contemporaneous in the present as well, but this is significantly easier than the imperfect past. Hence, an ordering relationship that suggests that the patients have problems when reference time precedes event time is not a likely explanation for the Turkish agrammatic data either. We thus consider a remoteness model of time reference in the following sections.

Yarbay Duman, Aygen, Özgirgin, and Bastiaanse (2007) adopted Aygen’s theory (2004) which follows Lyons (1977) and defined tense as a specific kind of epistemic modality that holds the distinction between [-/+] past and [-/+] remoteness. According to Lyons’ approach (1977), present, past and future are defined in terms of remoteness in relation to the moment of utterance and factivity (whether a situation is close to reality). Fig. 3 reproduces Aygen’s schema (2004).

Past time encoded in verb forms makes the situation more remote [+ remote] than the present and future and, factive [+ factive]. Future events encode possibilities that are non-remote [- remote] by definition because remoteness to the utterance time is not relevant to an event that has not yet happened. Therefore, they are also inherently non-factual; that is, they are relatively remote from fact. Accordingly, the difference in the epistemic status between past and future (e.g., the past can be true or false, the future can be neither and future statements as opposed to factive ones have no truth-conditional value) has been captured. Aygen (2004) ex-

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### Table 6

Total number (percentages in round brackets) of time reference errors on finite verbs and participles.

<table>
<thead>
<tr>
<th>Tense (past ↔ future)</th>
<th>Past → future</th>
<th>Future → past</th>
<th>Participles (past ↔ future)</th>
<th>Past → future</th>
<th>Future → past</th>
</tr>
</thead>
<tbody>
<tr>
<td>(max = 210)</td>
<td>(max = 105)</td>
<td>(max = 105)</td>
<td>(max = 210)</td>
<td>(max = 105)</td>
<td>(max = 105)</td>
</tr>
<tr>
<td>47 (22.3)</td>
<td>39 (37.1)</td>
<td>8 (7.6)</td>
<td>40 (19.0)</td>
<td>23 (21.9)</td>
<td>17 (16.1)</td>
</tr>
</tbody>
</table>
tended Lyons’ model (1977) to cover not only tensed but all verb forms in Turkish.

When the remoteness model is applied to the agrammatic data, we see that agrammatic speakers have more problems with remote structures with certainty of past, past tense/perfect aspect, than the non-remote structures future tense/imperfect aspect. Interestingly, the present tense, defined as non-remote in this approach, is also less of a problem for the agrammatic speakers (see Bastiaanse, 2008; Stavrakaki & Kouvava, 2003). The remoteness model has several advantages in accounting for the agrammatic data. The first is that it does not focus only on the tense inflection of the verbs but on any verb or verb complex that has time reference characteristics such as participle with or without an auxiliary. Therefore, it can explain why two agrammatic speakers who have more difficulties with reference to the past with a verb inflected for tense/perfect aspect also have more difficulties with reference to the past with a non-tensed verb with the perfect aspect. Both of them are [+ remote] in the present study. The second advantage is that it predicts difficulty with a particular verb inflection based on whether the temporal interpretation of the verb is remote or not in the context used. For example, the –DIK participle in Turkish can refer to the present or the past. If the temporal interpretation is non-remote, as in ‘benim su anda üstül-ediğim etek,’ the skirt that I am ironing now’, fewer problems are expected than when the temporal interpretation is remote, i.e. past, as in the present study. In this way, any deviant performance for a particular verb inflection used in different contexts can be accounted for. Moreover, notice that the lack of a significant difference between –DIK and –EcEK participles at the group level could stem from the fact that –DIK is not necessarily remote, as opposed to –DI, which is necessarily remote (e.g., ‘ben su anda eteği üstüledim’, ‘I have ironed the skirt now’). Another possibility is that full interpretation of participle clauses might depend on a higher main clause verb.12

Finally, the remoteness model is economical in that it combines different findings across languages, where different time frames were tested, into a single account. In Dutch, the past is more difficult than the present (Bastiaanse, 2008). In Greek, past tense is more difficult than present tense and past tense with perfective aspect is more difficult than past tense with imperfective aspect (e.g., Stavrakaki & Kouvava, 2003; but see Varlokosta et al., 2006). We show for Turkish that past/perfect verb forms are more difficult than future/imperfect verb forms. Taken together, the easier structures found across languages (Dutch, Greek and Turkish) are the non-remote ones – the present and future are products of non-remoteness. Notice that while a distance account of tense with respect to utterance time – the past is more distant than present – fails to explain why the past is difficult – since the past is as distant as future – the remoteness account survives. A distance analysis in time and the notion of remoteness are different, since the former claims to identify the ‘distance’ between the event time and the utterance time, whereas the latter merely identifies whether the event time is or is not the same as the utterance time.13

A factivity account alone – positing the possibility that factive clauses are more difficult than non-factive clauses – fails because there is no consistency of factivity on easier structures; or in other words, that the present is factive whereas the future is non-factive. Factivity can be further tested by comparing the ‘future’ with ‘counterfactual conditional’ (e.g., ‘if you joined the party, we would dance’) since they are both non-factive. If remoteness alone were the difficult factor, more difficulties with counterfactuals would be expected because they are remote, following Lyons’ (1977) approach. To the best of our knowledge, no study has so far compared the future with counterfactuals as such. An important question is what makes [+ remote] more difficult for the agrammatic speakers. We do not have a straightforward answer but consider some possibilities. The temporal interpretation of epistemic modality (the degree of certainty that a speaker has with respect to his proposition) could become more difficult when certainty of past (certainty that something has happened or certainty that an event has been completed) is an issue.14 If this is true, adverbs such as ‘yesterday’ and ‘last month’ that necessarily introduce an event with the certainty of past, are also expected to add an extra level of interpretation for the agrammatic speakers. This is because the adverb and the event time expressed by the verb need to be tuned for the past – i.e. both have to receive the [+ remote] interpretation (see Aygen-To-sun, 1998). Bastiaanse (2008) only used temporal adverbs such as ‘yesterday’ and ‘last month’ for the past tense items. She found that the past tense was more difficult than the present tense for Dutch agrammatic speakers. Yarbay Duman et al., (2007) tested the morphology of the past tense without testing temporal interpretation – the agrammatic speakers were not required to refer to a particular point in time through verb inflection or an adverb. The latter study showed that past morphology as such is not deficient in Turkish when no temporal interpretation is involved (Yarbay Duman et al., 2007). This accords with the present findings in that the problems with tense lie at the interpretational level. Accordingly, it could well be that the adverb ‘yesterday’ with certainty of past fails to retrieve the required [+ remote] morphology, for example, ‘listened’, which results in even more problems with

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11 In Turkish, the present tense is expressed by the –tyor progressive aspect morpheme, which is continuous. It could be before, during or after the moment of utterance.

12 We did not use a higher main clause verb (e.g., adamın dikiştiği ceketi gördüm ‘I saw the jacket that the man has sewn’) for two reasons: (1) subordinate clauses as such imply embedding, which is known to be difficult for agrammatic speakers (Friedmann, 2001); (2) embeddings as such make it difficult to understand whether it is time reference on the participle or on the tensed verb that makes expressing time reference difficult to the patients. From the present results however we can conclude that time reference problem is reflected in participles as well.

13 Remoteness is identified in terms of ‘not overlapping’ with the utterance time (UT), UT and event time (ET) overlap in the present whereas UT and ET do not overlap in the past. The future, however, is a different category since it is non-factive – the future expresses an implication and not an actual event in that it is hypothetical though the speaker can make forecasts about it with varying degrees of certainty. Accordingly, even though UT and ET do not overlap for the future as opposed to the present, the future is interpreted as non-past in the same way as the present in this theory.

14 The future is never a purely temporal concept and necessarily involves a kind of predication (Lyons, 1977) rather than certainty. Certainty of the past is only involved in the perfect aspect, and the present study shows that the imperfect aspect that is an implication of an incomplete and/or ongoing event (–) is less of a problem than the perfect aspect that bears certainty of the past (+ remote).
the past. The agrammatic speakers know what ‘yesterday’ is but they fail to retrieve the required verb inflection.

4.3. The time reference problems in relation to other agrammatic phenomena

The problems with time reference through verb inflection suggest that it is difficult for agrammatic speakers to express a semantic notion (time reference) through verb inflection, implying that integration of semantic and morpho-syntactic information is difficult for them. In other words, extrasentential information is hard to express at the grammatical level. This phenomenon has been observed before, but mainly for comprehension. Grodzinsky, Wexler, Chien, Marakovitz, and Solomon (1993) found that the interpretation of object pronouns (him, her) is difficult for individuals with Broca’s aphasia. The same has been reported for Dutch by Vasic (2006). Pronouns have an extrasentential referent. Hickok and Avrutin (1995) reported that comprehension of which-questions is problematic to the patients as well. Again, an extrasententially bound computation is needed to comprehend which-questions. Hence, there is a relation between the present findings on time reference and earlier findings on comparable phenomena that shows that integration of extrasentential and morpho-syntactic information is difficult to agrammatic speakers.\textsuperscript{15}

However, this does not explain why reference to the past is particularly affected, that is, more affected than reference to the present (Bastiaanse, 2008) and future (for the tensed verbs in the present study). Above we argued that this might be caused by the notion of ‘remoteness’. The past is [+ remote] and the present and future are not. However, it is still not clear yet why inflecting a [+ remote] verb would be more difficult than inflecting a [− remote] verb.

It could be that [+ remote] verb forms are more difficult overall for agrammatic speakers, in which case these problems should show in both comprehension and production. Another possibility is that remoteness as such is difficult, in which case the problems should also be observed in languages that do not express time reference through verb inflection, but through lexical and/or aspectual adverbs, such as Chinese and Indonesian. We recently started a project that focuses on this issue, by testing comprehension and production in a large number of languages.

In summary, we suggest that agrammatism is neither a specific tense problem nor a specific aspect problem. The agrammatic speakers have problems with time reference, which is also reflected in participles. Not only is time reference in general difficult, but reference to remote structures that express the past is even more problematic for agrammatic speakers. A finer grained theory is needed to explain these findings.

Acknowledgments

This work was supported by the Mosaic Program of the Netherlands Organization for Scientific Research (NWO) under Grant No. 017.001.164 to Tuba Yarbay Duman. The authors thank members of the Ankara Physical Medicine and Rehabilitation Centre (Turkey), particularly Neşe Özgirgin and Nermin Altınok for their collaboration. We thank Gülşat Aygen for her useful comments and discussions on the paper.

Appendix A

A.1. Individual scores (number correct) on the test (maximum score in each condition is 15).

<table>
<thead>
<tr>
<th></th>
<th>SOV-past tense (perfect aspect)</th>
<th>SOV-future tense (imperfect aspect)</th>
<th>SVO-past participle (perfect aspect)</th>
<th>SVO-future participle (imperfect aspect)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>9</td>
<td>11</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>B2</td>
<td>1</td>
<td>14</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>B3</td>
<td>12</td>
<td>13</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>B4</td>
<td>11</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B5</td>
<td>11</td>
<td>13</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>B6</td>
<td>12</td>
<td>15</td>
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</tr>
<tr>
<td>B7</td>
<td>2</td>
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<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>58</td>
<td>91</td>
<td>19</td>
<td>17</td>
</tr>
</tbody>
</table>

\textsuperscript{15} Avrutin (1999) accounts for data on pronouns and which-questions by a syntax-discourse model. The model discusses difficulties with time reference as well; however it does not predict that reference to the past can be more affected than reference to the present/future in agrammatic speech.
Appendix B

B.1. Time reference errors per agrammatic speaker.

<table>
<thead>
<tr>
<th></th>
<th>Past</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Finite</td>
<td>Participle</td>
</tr>
<tr>
<td></td>
<td>Reference</td>
<td>Ref. + order</td>
</tr>
<tr>
<td>B1</td>
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<td>B2</td>
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<td>B3</td>
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<td>3</td>
<td>0</td>
</tr>
<tr>
<td>B7</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>0</td>
</tr>
</tbody>
</table>

Appendix C

C.1. Individual errors to past and future for the finite verb and the participle.

<table>
<thead>
<tr>
<th></th>
<th>Finite (past ↔ future)</th>
<th>Past → future</th>
<th>Future → past</th>
<th>Participle (past ↔ future)</th>
<th>Past → future</th>
<th>Future → past</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(max = 30)</td>
<td>(max = 15)</td>
<td>(max = 15)</td>
<td>(max = 30)</td>
<td>(max = 15)</td>
<td>(max = 15)</td>
</tr>
<tr>
<td>B1</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>B2</td>
<td>15</td>
<td>14</td>
<td>1</td>
<td>7</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>B3</td>
<td>3</td>
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