Why reference to the past is difficult for agrammatic speakers

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Abstract
Many studies have shown that verb inflections are difficult to produce for agrammatic aphasic speakers: they are frequently omitted and substituted. The present article gives an overview of our search to understanding why this is the case. The hypothesis is that grammatical morphology referring to the past is selectively impaired in agrammatic aphasia. That is, verb inflections for past tense and perfect aspect are hard to produce. Furthermore, verb clusters that refer to the past will be affected as well, even if the auxiliary is in present tense, as in he has been writing a letter. It will be argued that all these verb forms referring to the past require discourse linking [Zagona, K. (2003). Tense and anaphora: Is there a tense-specific theory of coreference. In A. Barrs (Ed.), *Anaphora: A reference guide* (pp. 140–171). Oxford: Blackwell Publishing] and discourse linking is affected in agrammatic aphasia [Avrutin, S. (2006). Weak syntax. In K. Amunts, & Y. Grodzinsky (Eds.), *Broca’s region* (pp. 49–62). New York: Oxford Press]. This hypothesis has been coined the PAsT DIScourse LINking Hypothesis (PADILIH) [Bastiaanse, R., Bamyaci, E., Hsu, C.-J., Lee, J., Yarbay Duman, T., & Thompson, C.K. (2011). Time reference in agrammatic aphasia: A cross-linguistic study. *Journal of Neurolinguistics*, 24, 652–673]. The PADILIH has been tested in several languages and populations that have hardly been studied before in aphasiology: languages such as Turkish, Swahili and Indonesian were included, as well as monolingual and bilingual populations. In all these populations, the same test has been used: the Test for Assessing Reference of Time (TART) [Bastiaanse, R., Jonkers, R., & Thompson, C.K. (2008). *Test for assessing reference of time (TART)*. Groningen: University of Groningen] to enable reliable comparisons between the languages. The results show that the PADILIH predicts the performance of agrammatic speakers very well: discourse-linked grammatical morphemes expressing time reference to the past are hard to produce for agrammatic speakers, whereas non-discourse-linked verb inflections (for present and future) are relatively spared. In languages that use aspectual adverbs (free-standing and optional time reference markers), such as Chinese and Indonesian, time reference to all time frames is impaired, since all aspectual adverbs, regardless of the time frame they refer to, require discourse linking. Remarkably, the problems are not restricted to grammatical morphemes: the production of temporal lexical adverbs is impaired as well.

Keywords: agrammatic aphasia, time reference, PADILIH, tense, aspect

Introduction

According to standard definitions, agrammatic aphasia is characterized by non-fluent speech, mainly consisting of content words, whereas function words and grammatical morphemes are frequently omitted and substituted (Goodglass & Kaplan, 1972). Although this indeed superficially describes what the listener will hear, recent studies on production of agrammatic speech showed that this
characterization is an overgeneralization. Many studies showed that the terms “content word” and “function words” are not sufficiently precise. In spontaneous speech, production of verbs is impaired, whereas the production of nouns is relatively spared (Bastiaanse & Jonkers, 1998; Saffran, Berndt, & Schwartz, 1989; Thompson, Choy, Holland, & Cole, 2010). Some studies show that even within the class of verbs a more fine-grained distinction should be made (Thompson, Shapiro, Li, & Schendel, 1994). Not all function words are equally vulnerable either. It is true that many function words are deleted in agrammatic speech, but this seems to be highly dependent on the type of construction of the sentence. Ruigendijk, van Zonneveld, and Bastiaanse (1999) and De Roo (2003) showed that agrammatic speakers often omit subject pronouns in spontaneous speech. This is related to the realization of a (finite) verb. Even within some subclasses of function words, distinctions should be made. According to linguistic theory (Chomsky, 1981), preposition with a syntactic function, for example prepositions marking the agent in a passive (touched by an angel) or the recipient as beneficiary (give flower to the girl) should be distinguished from (the same) prepositions with a lexical function that are adjuncts (down by the river; walking to the river). Friederici (1982) and Bennis, Prins, and Vermeulen (1983) demonstrated that agrammatic speakers are sensitive to this distinction.

The omissions and substitutions in agrammatic speech are also dependent on their function. In 1958, Goodglass and Hunt in a classical study demonstrated that agrammatic speaker produce the “s” in plural nouns relatively well, whereas production of the genitive “s” is more impaired; the production of the third person singular “s” was most severely affected.

The pattern of omission and substitution of grammatical morphemes is also partially language dependent. According to Grodzinsky (1990), grammatical morphemes are omitted only in languages where such an omission results in an existing word, like omission of the –s of the third person singular finite verb resulting in the infinitive in English (eats → eat). Substitutions of grammatical morphemes occur in languages where omission would result in a non-word. In Italian, for example, omission of the third person singular inflection will result in a non-word (mangia: “he eats” → *mangi), and, following Grodzinsky (1990), agrammatic Italian speakers will substitute the verb inflection by, for example, the infinitive (mangiare: “to eat”). Additionally, there are several studies that show that not all grammatical inflections are equally impaired. Several noun inflections are relatively spared, including plurals (Goodglass & Hunt, 1958) and gender (De Bleser & Luzzatti, 1994; Luzzatti & De Bleser, 1996), whereas case inflection is impaired (Bastiaanse, Jonkers, Ruigendijk, & van Zonneveld, 2003; De Bleser, Bayer, & Luzzatti, 1996). However, the degree of case inflection impairment seems to depend on, again, the use of verbs: when the case assigning verb form is produced, then the correct case morphology is realized (Ruigendijk, van Zonneveld, & Bastiaanse, 1999).

All these data suggest that the disruption of grammatical morphology in agrammatic aphasia is highly selective. The present study focuses on a specific grammatical morphology, that is, grammatical morphology used for time reference. This type of morphology is quite diverse among languages. The performance of agrammatic speakers on typologically different languages will be presented, compared and interpreted in terms of linguistic distinctions.

Linguistic background

There are several ways to express the time frame in which an event takes place. For example, all languages have so-called “temporal lexical adverbs”, such as yesterday, now soon and lexical adverbial phrases, such as sometime ago and in a moment. In many languages, these adverbs and adverbial phrases, defining the time frame, require time reference agreement with the verb. In English, for example, yesterday cannot be combined with a present tense verb: *yesterday he writes or is writing a letter is ungrammatical. Yesterday should always be combined with a verb form that
refers to the past. This can be simple past (wrote), or a so-called “periphrastic” verb form (was writing).

Reference to the past is different from tense. Tense is a property of the finite verb (writes and wrote), whereas it is possible to refer to the past or to the future when the verb is in present tense. In he has written a letter this morning, the finite verb (has) is in the present tense, whereas the periphrastic verb form as a whole (has written) refers to an event in the past (Palmer, 1988). Similarly, in tomorrow he has a class at 9 am, has is present tense, but in combination with tomorrow, it refers to the future. In English, there are still other ways to refer to the future, for example by the periphrastic verb forms [will +infinitive] and [is going to +infinitive]. In other languages, such as Turkish and Swahili, reference to the future is done through simple verb forms. In Turkish, tense inflection is a suffix, as in yazacak: “he will write”, in Swahili it is a prefix, that is, the inflection is put before the stem, but it is preceded by another prefix: tagonga: “he/she will knock”.

Apart from tense, that expresses the time frame of the predicate, verbs and verb form can be inflected for aspect. Aspect denotes whether the event has been finished (perfect) or not (imperfect). In Dutch and German, for example, there is a difference between events in the past that have not been terminated or from which it is not clear whether that they have been terminated (imperfect) and events that were terminated (perfect). Reference to the first is done through the imperfect past, which is a simple verb form (gisteren schreef hij een brief, lit. yesterday wrote he a letter: “yesterday he was writing a letter”), reference to the latter by the present perfect (gisteren heeft hij de brief geschreven, lit. yesterday has he the letter written: “yesterday he wrote the letter”). Notice that the auxiliary heeft: “has” in the last sentence is in present tense, but that the event took place in the past. Aspect plays an important role in languages such as Greek and Russian. In these languages, perfect aspect is not expressed through periphrastic verb forms, but through simple verbs.

In some languages, mainly in South-East Asia and China, verbs are not inflected for tense and aspect and, hence, time reference is not expressed through verb inflection, but through optional free grammatical morphemes, so-called “aspectual adverbs”. This means that in these languages, the time frame is not necessarily expressed in each sentence. When the time frame is clear, no aspectual adverb is needed. In (1a), the Chinese sentence about reading does not express whether the action happened in the past, present or future or whether it has been finished. By adding an aspectual adverb as in (1b, perfect marker, post-verbally) and (1c, durative marker, pre-verbally) the time frame can be given, but again, this is not obligatory.

(1a) zhe ge ren du yi fong sin
the man read a letter
“the man reading the letter”
(1b) zhe ge ren du le yi fong sin
the man read [perfect] a letter
“the man read the letter”
(1c) zhe ge ren zai du yi fong sin
the man [dur] read a letter
“the man is reading a letter”

Like in languages with verb inflections, the languages that use aspectual markers also use temporal adverbs and adverbial phrases, but aspectual and temporal adverbs are not obligatorily combined.

In sum, time reference can be done through temporal adverbs and adverbial phrases, through tense and through aspect. In many languages, tense and aspect are expressed through verb inflection, both by simple and by periphrastic verbs. In South Eastern Asian languages, time reference is not done through verb inflection but through (optional) aspectual adverbs. What all these languages
have in common is that they can refer to the past, the present and the future through temporal adverbs and adverbal phrases and through grammatical morphology.

**Time reference and discourse linking**

Avrutin (2006), in his essay on agrammatic individuals and children acquiring language, argues that both populations have problems processing elements in the sentence that can only be understood when reference to information outside the sentence is made. He makes a distinction between non-referential and referential elements. Non-referential elements can be interpreted within the sentences or, Avrutin's (2006) terms can be processed by “narrow syntax”. Examples are reflexives, as in the man is washing himself, in which himself must refer to the man; and the question words who and what, as in who is running away? in which who does not refer to anyone specific. There are, however, elements for which narrow syntactic processing is not sufficient. These are “referential elements”. Examples are pronouns (the man is washing him) and which-phrases (which boy is running away?) Him refers to a man that is known, but not mentioned in the sentence; Which boy refers to a specific boy from a set of boys. In order to understand such elements, extra syntactic processing is required, to link the phrase to a referent outside the sentence. This world outside the sentence is called "discourse" and, thus, “discourse syntax” or “discourse linking” is needed to fully interpret these phrases. Studies with non-brain-damaged speakers have shown that, as predicted by Avrutin, it takes longer to process referential which-questions, that need discourse syntax processing than non-referential who-questions, that can be interpreted by narrow syntax alone (Shapiro, 2000).

There are other syntactic elements that must be processed by discourse syntax. One of them is tense. In order to interpret verb tense, one must refer to the time specified in the discourse context. Tense, thus, refers to a specific time frame, which is set by the previous context (Aronson, 1977; Enç, 1987; Partee, 1973; Reichenbach, 1947). Therefore, tense requires discourse linking or, in terms of Avrutin (2006), processed by “discourse syntax”. Zagona (2003), however, points out that the present tense is less dependent on discourse context than past tense. According to her, in present tense the moment of speaking and the event coincide and, hence, no discourse linking is needed. Figure 1 illustrates the discourse linking in reference to the past.

According to Zagona (2003), only the past tense needs to be discourse-linked. Several studies have shown that past tense verbs, that need to be discourse-linked, take longer to process than present tense verbs (Faroqi-Shah & Dickey, 2009; Jonkers, Boers, Koopmans, Menninga, & Zoodsma, 2007) and that past tense violations yield different ERP-waves that present tense violations (Dragoy, Stowe, Bos, & Bastiaanse, 2012).

![Figure 1. Graphical expression of Zagona's (2003) idea about the need for discourse linking in past tense.](image-url)
It is not entirely clear, however, why Zagona (2003) assumes that discourse linking is needed for past tense only and not for all verb forms that refer to the past. Bastiaanse et al. (2011) adapted Zagona’s theory and extended the discourse linking requirement to all verb forms that refer to the past, including perfect aspect, even when the finite auxiliary is in present tense. In order to interpret the Dutch sentence de man heeft een brief geschreven: lit. “the man has a letter written”, discourse linking is required, because the cluster [auxiliary + participle] is perfect tense and, thus, refers to the past. Bos, Dragoy, Stowe, and Bastiaanse (2012), in a Dutch ERP study, showed that the brain reactions of healthy individuals are the same for past tense and present perfect violations, that is, a P600 is elicited. This implies that brain-wise, the present perfect pairs with the past imperfect when it comes to time reference violations. Thus, it was concluded that not tense, but time reference is the critical issue.

We will come back to this theory on time reference and discourse linking after we have discussed time reference in agrammatic aphasia.

Aphasiological background

As said at the beginning of this paper, verbs and verb inflection are particularly vulnerable in agrammatic aphasia. Although there seems to be a strong relationship between verb retrieval and verb inflection (Anjarningsih & Bastiaanse, 2011; Bastiaanse & Jonkers, 1998; Miceli, Mazzuchi, Menn, & Goodglass, 1983), here only the problems with verb inflections are discussed. There are many theories why verb inflection is vulnerable, but it is remarkable that most findings go into one direction: tense and/or aspect are impaired, agreement and/or mood are relatively spared (Clahsen & Ali, 2009; Faroqi-Shah & Thompson, 2007; Fyndanis, Varlokosta, & Tsapkini, 2012; Lee, Milman, & Thompson, 2008). However, the distinction seems to be more fine-grained: SimonSEN and Lind (2002) reported a Norwegian agrammatic speaker who only used present tense and never past tense in his spontaneous speech. Stavrakaki and Kouvava (2003) presented two Greek agrammatic speakers who had more problems with producing perfect than imperfect aspect in their spontaneous speech, whereas tense was relatively spared. This finding was replicated by Nanousi, Masterson, Drucks, and Atkinson (2006) who tested Greek agrammatic speakers with a large battery of verb inflection tests. In 2008, Bastiaanse published the results of a Dutch study that showed that verb forms referring to the past were more difficult to produce for agrammatic speakers than verb forms referring to the present. This did not only hold for finite verbs (simple past compared to simple present), but also for periphrastic verb forms (past: [auxiliary + participle] compared to present: [auxiliary + infinitive]). This was followed by a study of Yarbay Duman and Bastiaanse (2009) on Turkish. They showed that reference to the past was more difficult or agrammatic Turkish speakers than reference to the future, a result that was confirmed by a study to two Swahili–English bilingual agrammatic speakers (Abuom, Obler, & Bastiaanse, 2011). In order to shed light on these cross-linguistics findings, Bastiaanse, Jonkers, and Thompson (2008) developed the Test for Assessing Reference of Time (TART) that has been adapted to a large number of languages. It systematically tests reference to past, present and future in comprehension and production. Before turning to the results, we will present a hypothesis that integrates the linguistic literature on discourse linking and the aphasiological data mentioned so far.

Agrammatic aphasia and discourse linking: a hypothesis

Avrutin’s (2006) idea is that processing at the level of narrow syntax, is relatively spared in agrammatic aphasia, as shown by good comprehension on reflexives and who-questions (that can be processed by narrow syntax alone) and reflexives. However, sentences that require processing by discourse syntax as well, such as personal pronouns and referential which-questions, are harder to
comprehend, because additional discourse syntactic operations require additional processing load. If this is true and if it is true, as suggested by Zagona (2003) and Bastiaanse et al. (2011), that reference to the past is discourse-linked and reference to the present is not, then the following can be hypothesized: Reference to the past through verb inflection is impaired in agrammatic aphasia because discourse linking is required; for reference to the present through verb inflection, less discourse linking is needed, and, hence, it will be relatively spared. Following Zagona (in press), reference to the future pairs with reference to the present, because they are both “non-past”. Therefore, it is assumed that reference to the future is intact. This is coined the PAst DiSCourse LiNking Hypothesis (PADILIH), the PADILIH in Bastiaanse et al. (2011).

The present overview will compare the data collected for several languages that use different verb forms for time reference: verb inflection and aspectual adverbs. The production of aspectual adverbs in Indonesian will be compared to the production of temporal adverbs. It will be shown that the PADILIH is supported by these data, in monolingual and bilingual agrammatic speakers.

**Methods**

**Participants**

For all languages, the **TART** (see “Materials” section) was first administered with at least 10 non-brain-damaged speakers. In all languages, they performed at ceiling. This means that the **TART** is very easy and straightforward. Hardly ever were more than one or two errors made. The data of the healthy speakers will, therefore, be ignored.

For all languages, we aimed to test agrammatic speakers suffering from Broca’s aphasia, meaning that they should produce non-fluent agrammatic speech and that their auditory comprehension should be intact. Agrammatic speakers with moderate to severe articulation disorders were excluded, because the verb inflections are often hard to differentiate when articulation disorders exist.

In several countries, it is hard to recruit aphasic individuals. We aimed at 10–15 participants per language, but, this was not possible for Indonesian. For all of the languages, tests were available to classify the aphasia type except for Swahili and Kenyan English. We only included individuals who had Broca’s aphasia, but we do realize that this does not always guarantees that they are agrammatic speakers. For Indonesian and Chinese, languages with very limited grammatical morphology, it is hard to define agrammatism. In these languages, we relied on the expertise of the speech therapists and ourselves. For Indonesian and Swahili, we first did spontaneous speech analyses to define agrammatism in these languages, as this had been done before. The results have been reported in separate papers (Abuom & Bastiaanse, 2012 for Swahili; Anjarningsih, Hayradi-Soebadi, Gofir, & Bastiaanse, 2012 and Anjarningsih & Bastiaanse, 2011 for Indonesian). We will mention the number of the agrammatic speakers for each of the studies. For more information, we refer to the original articles.

For a rough assessment of auditory comprehension, the word comprehension test of the **Boston Diagnostic Aphasia Examination (BADE)** (Goodglass & Kaplan, 1972; Goodglass, Kaplan, & Baresi, 2001) was used, that tests the comprehension of nouns, verbs, numbers, letter, colors and geometrical forms. Where necessary pictures were replaced (e.g. in Kenya the concept of a hammock is unknown).

**Materials**

The **TART** was used in each of the languages (a modified version was used for Indonesian). The **TART** consists of a comprehension and a production part. Here, only the production results are presented.
Eleven verb pairs were selected that could be contrasted (e.g. *pushing* – *pulling; ironing* – *folding*). Photographs were made on which a woman or a man was performing (present), had performed (past) or started (future) an action. The agrammatic speakers were presented with two contrasted pictures with the verb printed above (see Figure 2 for the “western” version).

The experimenter read two sentences to the aphasic speaker who was asked to complete the second sentence. For example, for Figure 2, the sentence was

Experimenter: (pointing to the left photo): for this picture, you can say the man just ate an apple; (pointing to the right photo) for this picture you can say the man just ……
Agr. speaker: …… peeled an apple.

In all languages, reference to the past, present and future was tested with several constructions. For example, for English we tested a neutral condition (wants + infinitive), simple past [have + infinitive], simple present, present continuous and future (will + infinitive). Here, we only present the most frequent form for reference to past, present and future. For English that is simple past, present continuous and future.

For each condition, there are 20 items. A short description of the morphological time reference paradigm for each language will be given in the “Results” section, before the results are given.

**Procedure and scoring**

All agrammatic individuals were tested by a researcher of our neurolinguistic group who was a native speaker of the language. First, spontaneous speech was recorded and the subtest *Auditory Word Discrimination* of the *BDAE* (Goodglass & Kaplan, 1972; Goodglass Kaplan, & Baresi, 2001) was administered. Then, the *TART* production test was presented and video or audio taped. The *TART* started with an example photo set of *reading* and *writing*. All constructions that were tested were practiced and if necessary repeated, until it was clear that the agrammatic individual understood the procedure of the test. Then, the experimental items were presented, without a break, unless the agrammatic individual asked for it.

A simple correct – incorrect scoring was used for quantitative analysis. Errors were classified for qualitative analyses.

![Figure 2](image_url)
Results

The results are presented per language, to take the reader systematically through the data. The data of all languages were tested statistically. Different statistical tests were used to answer different research questions and to obey the statistical rules (sometimes parametric and sometimes non-parametric tests have been used). Here, it is only mentioned whether the results are significant, meaning that the $p$ value is smaller than 0.05. The reader is referred to as the original articles for more statistic details.

**English**

The English data have been reported in Bastiaanse et al. (2011). The data were collected in Thompson’s lab in Evanston, IL, USA. Twelve agrammatic speakers participated. We compared the simple past, the present continuous and the future, that is, *he wrote*, *he is writing* and *he will write*, respectively. The PADILIH predicts a selective impairment of the simple past and this is what we found (see Figure 3).

The simple past is significantly more impaired than present continuous and the future, supporting the PADILIH. Most of the errors are substitutions: The past verb form is replaced by a present for. However, omission of the inflectional morpheme also occurred, but to a lesser extend.

In English, the simple past is a represented by one word and the forms for present and future are periphrastic verb forms. It maybe the case that simple verb forms are more difficult than periphrastic verb forms. This alternative explanation can be excluded when similar results are found in a language that uses simple forms in each of the time frames. Turkish is such a language.

**Turkish**

Turkish is an agglutinative language, meaning that it has a very rich morphological system. Most verb forms in Turkish are simple words and they are inflected for tense/aspect and for person and number. Periphrastic forms do not occur, as shown in (2a–c).

![Figure 3. Percentage correct on the production of past, present and future verb inflection for English.](image-url)
Therefore, the Turkish verb inflection paradigm is very rich, but also completely regular. The three forms in (2a–c) have been tested with the TART on eight agrammatic Turkish speakers (reported in Bastiaanse et al., 2011). The results are shown in Figure 4.

Like in English, the past is selectively impaired. Performance on the past tense is significantly worse than on the present and future tenses. There is no difference between present and future. The majority of the errors in Turkish are substitutions of inflectional morphemes. Omissions do not occur, as expected, since these would result in non-words. Sometimes, the past verb is replaced by the infinitive (that was printed above the picture).

These data provide an answer to the question in the previous section. The English data cannot be explained by the difference between a simple verb form versus two periphrastic verb forms, since the patterns in English and Turkish are similar: past is selectively impaired.

In sum, the results in English and Turkish are remarkably similar, both quantitatively and qualitatively (substitutions form the majority of the errors). However, the data come from different groups, and it is not at all sure that the groups are equally impaired. The way to find out whether two typological different languages are similarly or differently affected is by testing bilingual agrammatic speakers, who are agrammatic in both languages.

**Swahili–English bilingualism**

The data for this part of the study have been collected in Kenya and were reported in Abuom and Bastiaanse (in press). In Kenya, there is a large variety of languages that are acquired as “native language”. All children, however, learn Swahili and English at school from 4 years onwards. English is the language of instruction at school, Swahili is taught as a foreign language. This
means that all Kenyans are at least trilingual in early life. In adult life, English and Swahili are usually spoken on daily basis and the mother tongue is only spoken with family and relatives.

Swahili is, such as Turkish, an agglutinative language. The verb inflection paradigm is complex, but inflection for time reference is simple and completely regular. There is a verb root or stem that is surrounded by prefixes and suffixes. The complete verb form is given in (3).

(3) Swahili verb inflection
pre-prefix # subject prefix # tense marker # subject infix # \textbf{ROOT} # derivation # suffix # post-suffix

Usually, not all positions are filled, but the subject prefix and tense marker are obligatory. If any of these is left out, a non-word is the result. There are three tenses: past, present and future. In (4a–c) the three tenses are illustrated.

(4a) mwanamme [a # na # andika] barua
man [subject present write] letter
prefix
"the man is writing a letter"

(4b) mwanamme [a # li # andika] barua
man subject past write letter
prefix
"the man wrote a letter"

(4c) mwanamme [a # ta # andika] barua
man subject future write letter
prefix
"the man will write a letter"

These three tenses have been tested on 13 agrammatic speakers. For testing in Kenya, an African version of the \textit{TART} was made, because we thought it inappropriate to use a test depicting white models. This African version used the same verbs as the original \textit{TART}, but some items were adjusted. For example, “the man is eating/peeling an apple” was changed into “the man is eating/
peeling an orange”, since apples are fairly uncommon in Kenya. An example of the Swahili version of the test is shown in Figure 5.

Since Kenyan people frequently switch between the languages, the experimenter was very careful to speak consistently in one language. The participants were instructed to do so as well. To minimize the risk of switching, the English and Swahili versions were administered in different sessions.

Since English is not the native language in a strict sense, we first compared the American English data presented above with the Kenyan-English data. The results are shown in Figure 6 (right and middle).

The data show that the Kenyan-English agrammatic pattern is similar to the American-English pattern: Reference to the past is significantly impaired and there is no difference between present and future. Like in the American-English data, in Kenyan English both substitutions and omissions occur. Most of the substitutions are made in the past conditions where the past tense morpheme is replaced by a form that refers to the present. This means that the Kenyan agrammatic speakers who learned English from 4 years behave similarly as American native speakers of English (although the Kenyan agrammatic speakers score higher).

In Figure 6 on the left, the Swahili data are given and, again, the pattern is similar, a selective deficit for reference to the past. Interestingly, there is a significant difference between the performance on the English and Swahili past condition: the bilingual agrammatic speakers are significantly better in Swahili. We will come back to this issue in the “Discussion” section.

In Swahili, as predicted, mainly substitutions occurred, that is, the past tense morpheme was replaced by the present tense morpheme. It was predicted that omission of the tense morpheme would not occur, since that would result in a non-word. However, there were a few instances in which the past tense morpheme was omitted, but always in combination with omission of the subject prefix. The resulting form is an existing word, that is, the imperative.

So far, the data presented have been of languages in which the verb is inflected for time reference. The data show that reference to the present and future is relatively well spared, regardless of whether the present and future are expressed through simple verb forms (Turkish and Swahili) or periphrastic verb forms (English). The next question to be answered is whether reference to the past through periphrastic verb forms is impaired. Dutch is an interesting language in this respect, because reference to the past can be done both through a simple past form or through a periphrastic verb form in which the auxiliary has present tense.

![Figure 6](image-url) Percentage correct on the production of past, present and future verb inflection for American English, Kenyan English and Swahili.
Dutch

These are preliminary data of Bos et al. (2012). Sixteen agrammatic speakers participated in this study. In Dutch, like in English, reference to the past can be done in several ways. The two most frequent and common forms are the past imperfect, which is a simple verb form, and the present perfect, which is a periphrastic verb form ([auxiliary + participle]) in which the auxiliary is a form of hebben: “to have” or zijn: “to be”. Reference to the future can only be done through a periphrastic form, for example [gaan: “to go” + infinitive]. The PADILIH predicts that the present perfect – that refers to the past – will be impaired, even though the auxiliary is in present tense. The results are given in Figure 7.

As predicted by the PADILIH, both forms that refer to the past are significantly impaired compared to present, even though the periphrastic verb form has present tense. Interestingly, the error types for both past forms are similar: the majority are substitutions by a present form. Substitutions by the other past form are hardly ever produced. Omissions of the inflectional morpheme, which would result in the verb stem, which is used for the first person singular, present tense, do not occur.

Interim discussion

The data so far support the PADILIH: reference to the past is selectively impaired compared to reference to the non-past (present and future). This is irrespective of the form of the verb, that is, it holds for both simple and periphrastic forms. Interestingly, it also holds for verb forms referring to the past with present tense, as the Dutch study showed.

The data of the Swahili–English bilingual agrammatic individuals showed that within the same set of speakers, time reference through verb inflection can be more impaired in one language than in the other. In the original paper (Abuom & Bastiaanse, in press), this is extensively discussed. We follow Goral (2011) in her explanation for relatively preservation of inflectional morphology in highly inflected languages, such as Swahili, in bilingual aphasic speakers. These languages have complete regular morphology, unlike English, that has irregular past forms and different phonological realizations of one and the same suffix. This is further supported by data from Catalan and Spanish bilingual agrammatic speakers: they show the same pattern of a selective deficit for reference to the past in both languages and there is no difference between the languages, which have a comparable inflection paradigm in terms of regularity (Martínez Ferreiro & Bastiaanse, 2012).

Figure 7. Percentage correct on the production of past imperfect, present perfect and present imperfect inflection for Dutch. Past imperfect and present perfect refer to the past. (Notice that the scale on the Y-axis is different from the other figures.)
Interestingly, the error patterns are the same in all languages: The past forms (whether in past or present tense) are replaced by present forms. Omissions occur to a far lesser extent, but this never results in a non-word. This is in line with Grodzinsky (1990): his prediction is correct that omissions do not occur in languages in which they would result in a non-word. However, his prediction that substitution errors do not occur in languages that do allow omissions is not true: in those languages (for the current study English and Dutch), substitutions are also the dominant error type.

In sum, we can conclude that the PADILIH is supported by the data from languages that use verb inflection for expressing the time frame in which the event takes place. The question is what happens in languages that use aspectual adverbs instead of verb inflection. For that, we studied Chinese and Indonesian agrammatic speakers.

**Chinese**

Chinese is a language without verb inflection. Time reference is done through aspectual adverbs (1a–c). These aspectual adverbs are optional and this turned out to be a problem for the TART. Ten Chinese agrammatic speakers were tested and their performance was very poor (see Figure 8), due to the fact that they frequently omitted the aspectual adverb.

In order to understand what happened, consider the probe sentences:

Experimenter: (pointing to the left photo): for this picture, you can say the man just ate an apple; (pointing to the right photo) for this picture, you can say the man just ……

Agr. speaker: …… peeled an apple.

Since the aspectual adverb was mentioned in the first sentence, in combination with a temporal adverb, and the temporal adverb was repeated in the target sentence, the production of the same aspectual adverb is, at least, superfluous. In hindsight, it is not surprising that the agrammatic speakers left out the aspectual adverb (although the non-brain-damaged speakers did produce it): The result was a perfectly grammatical sentence with the time frame in which the event takes place expressed.

In order to circumvent this problem, we adapted the TART when testing Indonesian agrammatic speakers, to find out whether it is time reference to the past through aspectual adverbs that is impaired.

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**Figure 8.** Percentage correct on the production of past, present and future aspectual adverbs in Chinese.
Indonesian

The data of this study have been collected and documented by Anjarningsih (2012). In Indonesian, verbs are not inflected for tense and aspect. In order to indicate whether the event has been completed (perfect), is still going on (durative) or still has to commence (future), aspectual adverbs are used before the predicate. These are free-standing grammatical morphemes as illustrated in (5a–c).

(5a) Dia sudah menyapu lantai
She perfect sweep floor
“She swept the floor”

(5b) Dia sedang menyapu lantai.
She durative sweep floor
“She is sweeping the floor”

(5c) Dia akan menyapu lantai.
She future-aspectual sweep floor
“She will sweep the floor”

The use of these aspectual adverbs is optional. They are only used when the time frame of the event is not clear from discourse. This implies that all these aspectual adverbs, including the ones for present and future are referential, that is, they are used to link the event time to the discourse; hence, they must be processed by discourse syntax. If the PADILIH correctly supposes that discourse linking is a problem in agrammatic aphasia, then the time reference problems in Indonesian should not be restricted to the past time frame, although this is what the name PADILIH suggests. In other words, if time reference through grammatical morphology is vulnerable when it requires discourse syntax, then all time frames should be equally affected in Indonesian agrammatic aphasia.

The TART was slightly changed, to avoid the problems that occurred in Chinese. Instead of contrasting two actions within the same time frame, we contrasted one action in two time frames, as shown in Figure 9.

The participants had to be very carefully instructed, in order to use the targeted aspectual adverb. The experimenter described the picture on the left and the agrammatic speaker was supposed to describe the picture on the right.

![Figure 9. Example of the production test in Indonesian.](image)
The results are shown in Figure 10. There is no difference between the agrammatic speakers’ performance in the three different time frames. The data are in line with the idea that aspectual adverbs in Indonesian are used for discourse linking and are, therefore, equally impaired. We tried to avoid omission errors by contrasting two time frames. This was successful in the sense that hardly any omission errors were made. The vast majority of the errors were substitutions with aspectual adverbs for a different time frame.

Because of the freestanding optional aspectual adverbs, there is another interesting issue that can be addressed in Indonesian. In all the languages that were mentioned above, the use of temporal lexical adverbs is directly linked to the use of time reference inflection on the verb. This is not the case for Indonesian. Temporal lexical adverbs, such as just, now and soon can be used (and are most frequently used) without aspectual adverbs, see (6a–c).

(6a) *Baru saja* dia menyetrika baju
    Just now she iron shirt
    “She just ironed the shirt”
(6b) *Dekarang* dia menyetrika baju
    Now she iron shirt
    “Now she is ironing the shirt”
(6c) *Sebentar lagi* dia menyetrika baju
    Soon she iron shirt
    “In a moment she will iron the shirt”

This allowed us to test whether the production of temporal lexical adverbs is also impaired. This is an interesting issue, because temporal lexical adverbs are considered to be lexical morphemes, whereas aspectual adverbs are, such as verb inflection, grammatical morphemes. Generally, it is assumed that grammatical morphology is impaired in agrammatic aphasia, whereas lexical morphology if relatively spared. This is even captured in the definition of agrammatic speech (see above). However,
it has been argued that lexical adverbs are referential and, thus, require discourse linking, just like aspectual adverbs (see for argumentation Anjarningsih, 2012). If it is true that that discourse linking is impaired, rather than word class, it is to be expected that the production of temporal lexical adverbs is also impaired.

The same materials were used as for the experiment of aspectual adverbs, but the sentences were changed. Temporal lexical adverbs were used in the sentence initial position (the most frequent position for this word class) as illustrated in (6a–c).

The results are shown in Figure 11.

The agrammatic speakers were impaired in producing temporal lexical adverbs, in all three time frames, even more than in the production of aspectual adverbs. Moreover, there is a strong and significant correlation between the performances on both tests. Agrammatic speakers who are poor in the production of aspectual adverbs are also poor in the production of temporal lexical adverbs. These data, once more, support the idea that discourse linking is the critical factor influencing agrammatic performance on time reference, rather than word class or the status of free and bound morphemes.

Discussion

Three issues will be addressed in this section. First, it will be illustrated how the data relate to the idea of discourse linking and discourse syntax. Then, it will be argued that the problems with past time reference are due to a central deficit. Finally, the error patterns of the agrammatic speakers will be discussed.

Discourse linking and time reference in agrammatic aphasia

The data from all these languages are rather uniform: production of verb morphology referring to the past is impaired in agrammatic aphasia. It was argued that non-past verb morphology is rather easy, because it only needs to be processed at the level of narrow syntax, whereas for past time reference processing at the level of discourse syntax is required as well. But what is this discourse linking? What does it mean that an element needs to be “linked to the discourse”? In Figure 12, an illustration is given.

For reference to the present, the moment of speaking and the moment of the event coincide. However, in order to interpret reference to the past, the moment of speaking needs to be hooked
up to some moment or period in the past. This can be the very recent past (a moment ago, just) or the remote past (in pre-historical times), it can be one moment in the past (when the lightning struck) or during an extended period (before the Second World War), but this linking is needed when a verb form referring to the past is involved. The future is unknown and never sure: it is impossible to link the moment of speaking to an event that has not taken place yet, so no discourse linking is needed. In that sense, it pairs with present (Zagona, in press).

In Indonesian, no verb inflections but aspectual adverbs are used for time reference. Although these adverbs more or less serve the same function as verb morphology, the distribution is different: they are only used to link an event to a time frame, that is, they are referential in all the three time frames: past, present and future. This can also be done through temporal lexical adverbs, but whatever way is chosen to refer to a time frame, it is always referential. That explains why all time frames are equally impaired in Indonesian (and it may also be the explanation for the lack of a selective deficit for past aspectual adverbs in Chinese).

The data also support the idea that discourse linking is not only required for tense in general (Avrutin, 2006), nor solely for past tense, as suggested by Zagona (2003), but also for those verb forms that refer to the past, such as the present perfect in Dutch. The Dutch agrammatic speakers are significantly impaired in producing the (highly frequent) present perfect, although the auxiliary is in present tense. This is in line with the slower and differential processing of verb forms referring to the past rather than to the present by healthy individuals (Dragoy et al., 2012; Faroqi-Shay & Dickey, 2009; Jonkers et al., 2007).

Production and comprehension

Avrutin’s (2006) idea that processing at the level of discourse syntax requires extra computational load is based on comprehension experiments with agrammatic individuals. He does not assume that representations are wiped from the brain, but rather that despite the brain damage, there are sufficient resources left for narrow syntactic processes, but not for additional discourse syntactic processes. The current studies, however, are on agrammatic production. The results show that it is not the case that the agrammatic individuals cannot produce verb forms referring to the past at all (which would have been the case if the representations had gone), but they cannot do it correctly all the time. Apparently, they do not have the sufficient resources available to perform the test at a normal level.

The question is whether there is a central deficit with discourse linking that causes the comprehension and production problems. According to Avrutin (2006), it is an input deficit that causes the problems with referential which-questions and personal pronouns. The studies above show that there is also an output deficit when it comes to time reference morphology. Fortunately, the TART has a comprehension part as well. The original papers of the studies presented above, all provide the comprehension data. In each of the languages, except Indonesian (but including Chinese), there is a significant deficit for reference to the past on the comprehension test.
This provides evidence for a central deficit for dealing with elements that require discourse linking: individuals with agrammatic Broca’s aphasia fail to comprehend and produce time reference elements that require discourse linking. These may be verb forms in past tense, verb forms in perfect aspect, aspectual adverbs or temporal lexical adverbs. However, it still needs to be found out what exactly “processing resources” are, why they are limited, and when brain damage results in agrammatic aphasia. In fact, it still needs to be found out whether only agrammatic individuals have problems with reference to the past. There is preliminary evidence that fluent aphasic speakers encounter the same problems (Bos, Brederoo, & Bastiaanse, 2011). We are currently developing an fMRI study that aims to find the areas are involved in producing discourse-linked elements. The hypothesis is that when discourse-linked elements (e.g. past tense) are produced, Broca’s area, its homologue in the right hemisphere and, possibly, the connection between these areas will be more activated than when elements are produced that do not require discourse syntax (e.g. present tense).

The implication of the errors that were produced

In all languages that use verb morphology for time reference, one error was dominant: substitution of the past verb form by a present verb form. Omissions did also occur, although to a lesser extent and, just as Grodzinsky (1990) predicted, only in languages in which omissions do not result in non-words. However, his claim that substitutions only occur in languages that do not have bare stems is not correct.

The data in Dutch, in which two different verb forms referring to the past were tested, are particularly revealing. In both conditions, the majority of the errors were substitutions by verb forms that refer to the present (simple present and infinitive). This shows that discourse linking is, indeed, the problem: instead of a discourse-linked element, an element that is processed by narrow syntax only is produced.

In fact, the agrammatic error pattern is opposite to the pattern fluent aphasic speakers displayed, which were also included in the Dutch study. They also performed more poorly on the two past verb forms, but the majority of their substitutions were within the past time frame: simple past ←→ periphrastic past. This suggests that the errors produced by the fluent aphasic speakers may stem from another underlying deficit, or at least the fluent aphasic speakers have a different solution.

Conclusion

Agrammatic individuals have no problems producing verb forms referring to the non-past (present and future) because for these elements only narrow syntactic processing is required. Verb forms referring to the past are selectively impaired, because for these additional discourse syntactic processing is required.

The problems with verb morphology referring to the past are furthermore supported by the error pattern: the majority of the errors are substitutions by verb forms referring to the present, for which no discourse linking is required.

In some languages, such as Indonesian, aspectual adverbs are used for time reference, but only when the time frame of the event is not clear from discourse. Thus, aspectual adverbs are typically used to link the event time to discourse. This explains why the production of aspectual adverbs is equally impaired in the three time frames in Indonesian.

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Notes

1 Some non-brain-damaged speakers did score below 90% correct on the Indonesian TART, which was slightly adapted to the idiosyncratic time reference features of the language. However, also in Indonesian, the agrammatic speakers performed significantly worse than the non-brain-damaged speakers.

2 Some languages, such as English, have regular and irregular verb inflections or have several verb declinations. Since we used the same verbs in all languages, it was impossible to match the items on regularity. For these languages, it was analyzed post hoc whether these variables played a role. That was nowhere the case.

3 The difference between the two forms that refer to the past is also significant. Since this is not essential to the current paper, this finding is further ignored.

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