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Sentence production in Swahili–English bilingual agrammatic speakers

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Background: It has been argued that agrammatic speakers’ production of sentences in derived order is impaired (The Derived Order Problem Hypothesis, DOP-H), and that the underlying deficit in bilingual individuals with agrammatic Broca’s aphasia may cause different surface manifestations in the languages when they differ in terms of their grammatical morphology. The current study presents results of a study on sentence production in Swahili-English bilingual agrammatic speakers. The two languages, Swahili and English, differ significantly in terms of their verbal morphology.

Aims: The current study tested the production of sentences in base and derived orders of arguments in the two languages of Swahili-English bilingual agrammatic speakers.

Methods & Procedures: Eight agrammatic and eight non-brain damaged individuals participated in the study. A sentence elicitation test was used to examine the production of sentences in base and derived word orders in Swahili and English. The base order condition consisted of active and subject-cleft sentences, whereas the derived order condition tested passive and object-cleft sentences.

Outcomes & Results: The non-brain-damaged individuals performed at ceiling in both languages. The agrammatic speakers’ results, however, showed sentences in derived order condition and were more difficult to produce than those in base order, similarly across the two languages irrespective of their morphological differences. Moreover, the embedded sentences were also more difficult to produce than simple sentences for agrammatic speakers.

Conclusions: The current data partially support the DOP-H and provide new insight into sentence production deficit of bilingual individuals with agrammatic Broca’s aphasia. The findings are discussed with respect to the theories of sentence production in agrammatic speakers.

Keywords: Bilingual aphasia; Swahili; Base order; Derived order; DOP-H; Agrammatism.

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INTRODUCTION

Agrammatic speech production is generally characterised by problems with free and bound grammatical morphemes (Caramazza & Berndt, 1985; Goodglass, 1968; Marshall, 1986), specifically with verb inflections for tense (Bastiaanse, Hugen, Kos, & Van Zonneveld, 2002; Bastiaanse & Jonkers, 1998; Friedmann, 2000; Friedmann & Grodzinsky, 1997) and time reference (Bastiaanse, 2008; Bastiaanse, Bamyaci, Hsu, Lee, & Yarbay Duman, 2011; Yarbay Duman & Bastiaanse, 2009). Apart from these problems with the production of grammatical morphemes, syntactic deficits have also been described: verbs with complex argument structures (the Argument Structure Complexity Hypothesis, ASCH; Thompson, 2003) and sentences in derived word order (the Derived Word Order Problem Hypothesis, DOP-H; Bastiaanse & Van Zonneveld, 2005) have been demonstrated to be hard to produce in spontaneous speech (Bastiaanse et al., 2002; Thompson, Shapiro, & Schendel, 1995) as well as in sentence production tasks (Bastiaanse, Hugen, et al., 2002; Bastiaanse, Koekkoek, & Van Zonneveld, 2003; Bastiaanse & Thompson, 2003; Burchert, Meißner, & De Bleser, 2008; Yarbay Duman, Aygen, & Bastiaanse, 2008; Yarbay Duman, Aygen, Özgirgin, & Bastiaanse, 2007). To this end, a number of linguistic theories have been formulated to explain the source of agrammatic production problems (as discussed in the next section). However, all these theories are based on data from monolingual agrammatic speakers. Paradis (1988) argues that the same underlying deficit may cause different surface manifestations in an aphasic bilingual individual when the languages differ largely in terms of their grammatical morphology.

The current study was meant to test the Derived Order Problem Hypothesis (DOP-H) on Swahili-English bilingual agrammatic speakers to determine the pattern of impairment across the two morphologically different languages. In the next section, we discuss some of the theories of agrammatic production, followed by a description of Swahili word order. Then our previous studies on Swahili-English bilingual agrammatic speakers will be discussed, and we end with the predictions of the current study.

Theories of sentence production

According to syntactic theories within the generative tradition (e.g., Chomsky, 1995; Pollock, 1989), when we produce and understand sentences, they are represented as phrase structures known as syntactic trees. The highest phrasal node in the tree is the complementiser phrase (CP), which hosts complementisers, which are embedding elements like “that,” and wh-morphemes such as “where” and “what.” Thus, the construction of embedded sentences, or wh-questions, depends on the CP node being intact and accessible. Hagiwara (1995) was one of the first to claim that the top of the syntactic tree was hard to access for agrammatic individuals (but see Ouhalla, 1993). In 1997, Friedmann and Grodzinsky reported the results of a single case study of a Hebrew-speaking agrammatic woman who showed dissociation between tense and agreement morphology in her speech production: tense inflection was impaired while agreement inflection was intact. The authors, by assuming that tense and agreement are represented in separate nodes of the syntactic tree where the tense node is located above the agreement node, as proposed by Pollock (1989), proposed the Tree Pruning Hypothesis (TPH: Friedmann & Grodzinsky, 1997) to account for this dissociation. The TPH claims that the syntactic tree of agrammatic speakers is pruned and higher
nodes (from Tense node up, including the CP) are inaccessible. The consequence is that agrammatic speakers are unable to project the syntactic tree up to its highest nodes; hence, tense, wh-questions and embedded structures that require the high nodes should be impaired.

However, the TPH has been challenged by data from several languages based on verb inflection (e.g., Burchert, Swoboda, & De Bleser, 2005; Nanousi, Masterson, Druks, & Atkinson, 2006; Stavrakaki & Kouvava, 2003 for Greek; Wenzlaff & Clahsen, 2004, 2005 for German). Other studies showed that it is not only the top of the syntactic tree that is inaccessible: operations low in the syntactic tree are impaired as well (e.g., Bastiaanse et al., 2003; Burchert et al., 2008).

Other key theories relate the agrammatic production difficulties to the complexity of sentence structures. Kim and Thompson’s (2000) study on English agrammatic speakers’ production of one argument verbs (e.g., “to run”) with two-place (e.g., “to read”) and three-place (”to give”) verbs showed that three-place verbs were more difficult to produce than two-place verbs, which are more difficult than one-place verbs. A follow up study by Thompson (2003) on agrammatic performance on unergative (e.g., “to sleep”) and unaccusative (e.g., “to fall”) verbs revealed a significantly better performance on unergative than on unaccusative verbs. To account for these data, Thompson (2003) provided the Argument Structure Complexity Hypothesis (ASCH), attributing the sentence production deficits in agrammatic aphasia to the complexity of the argument structure of the verb: both the number of arguments and movement operations taking place at the surface level directly affect the ability to retrieve verbs and to construct sentences. Bastiaanse and Van Zonneveld (2005) tested the production of sentences with verbs with alternating transitivity, that is, verbs that have a transitive and an unaccusative reading (e.g., to break: “he breaks the glass” vs “the glass breaks”) in Dutch agrammatic speakers. Agrammatic performance dropped significantly when sentences had to be produced with unaccusative verbs that require derived word order, that is, that the theme should be in subject position. Bastiaanse and Van Zonneveld (2005) interpreted these results in terms of the DOP-H. The DOP-H is, although inspired by generative grammar, relatively theory-free. It assumes that all languages have a base order and that all other word orders are derived. The DOP-H predicts more problems for agrammatic speakers on producing and comprehending sentences when constituents are in a derived order than when they are in a base order. It has been supported by production studies in several languages. Bastiaanse, Hugen, et al. (2002) reported that Dutch agrammatic speakers showed greater difficulty with a finite verb production in the matrix clause (derived order) than an embedded clause (base order). Bastiaanse and Thompson (2003) reported that English agrammatic speakers had more problems with auxiliaries in yes/no questions (derived order) than auxiliaries in declarative sentences (base order). In recent studies involving object scrambling (the grammatical object changes places with one of its adjacent constituent, resulting in derived order; this is a frequent structure in Dutch, German and Turkish, but it does not exist in English with its strict word order), both Burchert et al. (2008) and Yarbay Duman et al. (2007, 2008) reported that German and Turkish agrammatic speakers have more difficulties producing sentences in which the object is in derived position. Interestingly, Anjarningsih, Haryadi-Soebadi, Gofir, and Bastiaanse (2012) found that agrammatic speakers of Standard Indonesian use a substantial number of passives with derived order in their spontaneous speech, contrary to what the DOP-H predicts. Anjarningsih et al. (2012) suggest that this can be explained by the high frequency of passive sentences in Standard Indonesian. Passive sentences are as frequent as, if not more frequent than, active constructions, and...
the passive construction is the polite form to address people. Therefore the passive construction is firmly anchored in the language system.

As mentioned, the DOP-H is an overarching theory that makes predictions for both production and comprehension. Bastiaanse and Van Zonneveld (2006) showed that it correctly predicts the performance on active and passive sentences in Dutch. However, there is more at stake in comprehension as two other studies from our group have demonstrated. Yarbay Duman, Özgirgin, Altinok, and Bastiaanse (2011) tested comprehension of sentences with base and derived order in Turkish agrammatic individuals. Turkish uses case to denote syntactic roles. In simple declarative sentences, the subject gets nominative case and the object accusative case, but in structurally complex sentences, case assignment is marked. In object relatives, for example, the subject gets genitive case, and the object gets nominative case. The agrammatic individuals had problems with derived order, as predicted by the DOP-H, but there was an interaction effect with a case assignment. Derived order sentences were harder to comprehend when a case assignment was marked. Similarly in our study on Swahili-English sentence comprehension, Abuom, Shah, & Bastiaanse, 2013), the agrammatic individuals performed poorly on the sentences with a derived order of the arguments but there was an interaction with the factor embedding: subject relatives (base order of the arguments + embedding) were more difficult than simple actives (base order of the arguments − embedding), and object relatives (derived order of the arguments + embedding) were more difficult than passives (derived order of the arguments − embedding). This was taken as support for a processing disorder that increases when more linguistic operations are required. Processing derived word order is such an operation, as well as embedding.

Many theories on agrammatism are primarily developed to describe the problems with comprehension of semantically reversible sentences (e.g., the boy is chased by the girl), such as the trace deletion hypothesis (Grodzinsky, 1995, 2000) or the mapping theory (see, e.g., Linebarger, Schwartz, & Saffran, 1983; Schwartz, Linebarger, Saffran, & Pate, 1987). The DOP-H has a larger domain: it predicts agrammatic problems with, for example, verb position in Dutch (Bastiaanse et al., 2002); auxiliaries in English yes/no questions (Bastiaanse & Thompson, 2003), clitics in Italian (Rossi, 2007) and object scrambling in Dutch (Bastiaanse et al., 2003) and German (Burchert et al., 2008).

The present study focuses on word order in Swahili–English bilingual agrammatic speakers. The emphasis is on the order of the arguments to enable testing of the “overarching” aspect of the DOP-H. In a previous study (Abuom et al., 2013), comprehension of actives, passives and subject and object relatives has been tested in this population. The current study uses similar sentence types. Before formulating the predictions for this study, we describe some relevant characteristics of Swahili grammar.

Swahili word order

Swahili is a Bantu language spoken mainly in Africa, including Kenya, where all participants in this study were drawn from. In Kenya, a multilingual society where an average person speaks at least three languages, the two most dominant languages across the population are Swahili and English. Apart from the two dominant languages, an average Kenyan uses one of the 42 native languages that linguists term “ethnic languages” mostly at home with family members. Each of the 42 languages has been classified as Bantu, Nilotic, Indo-Aryan or Cushitic. Swahili and English
share the same status as second languages since both are acquired around the age of 4, after native language acquisition by the majority of Kenyans. Whereas Swahili is taught as one of the subjects from kindergarten to university and also functions as the national language and the language of politics, business and daily interactions of people from different ethnic backgrounds, English functions as the official language of instruction in all educational institutions from primary school to university, and also as the language of news broadcasts, parliamentary proceedings and business. Therefore, a Kenyan with over 12 years of uninterrupted education is generally expected to be equally and highly proficient in both languages.

Swahili is an agglutinative language, with a fairly fixed base word order (SVO) at the sentence level, where the subject precedes the verb and the object, see (1a) (Ashton, 1982). Usually, the agent is in subject position and the theme in object position, like in English. Similarly, (1b) is a subject cleft sentence, a structure that allows the speaker to emphasise the agent while maintaining the base word order (agent–verb–theme). Other word orders are also possible in Swahili. For example, in the passive sentence (2a), the theme is in subject position in the sentence resulting to a derived order (theme–verb–agent). The final vowel of the verb complex also changes from “-a” to passive marker “-wa.” As in English, the phrase “na” (by) is included only if the information about the agent is important for clarity purposes to the reader or the listener. In an object cleft sentence (2b) the theme is in a position preceding the agent, resulting in derived order of the arguments (theme—agent—verb).

(1a)  
Mama a-na-m-gonga baba Ag-V-The  
Mother s/he-PRESENT-him/her-hit father  
“The mother is hitting the father”

(1b)  
Ni mama ambaye a-na-m-gonga baba Ag-V-Th  
It is mother who s/he-PRESENT-him/her-hit father  
“It is mother who is hitting the father”

(2a)  
Mama a-na-gong-wa na kijana Th-V-Ag  
Mother s/he-PRESENT-hit-PASSIVE by boy  
“The mother is hit by the boy”

(2b)  
Ni baba ambaye mama a-na-m-gonga Th-Ag-V  
It is father who mother s/he-PRESENT-him/her-hit  
“It is the father who the mother is hitting”

In both passive and object cleft sentences, operations have been applied resulting in arguments that are no longer in their base positions.

It is also clear from the examples (1–2) that the Swahili finite verb form is more complex than that of English. It consists of several affixes that are both inflectional and derivational morphemes, attached to the verb root. These affixes (prefixes and suffixes)

---

1 In both Swahili and English, the passive sentence is not simply an inversion of the thematic roles, like in sentences with object scrambling: the verb morphology changes into [auxiliary + participle], and the Subject NP becomes a PP (by-phrase). Theories on how this derivation takes place differ largely. What is important for the current study is the fact that thematic roles are not in base order.

2 $\text{Ag} =$ agent, $\text{V} =$ verb, $\text{Th} =$ theme.
must occupy specific positions and perform specific functions. The general position
scheme of the affixes in relation to the verb root is shown in (3a). Some illustrations
from Abuom, Obler, and Bastiaanse (2011) are given in (3b–d).

(3a)
Pre-prefix (Pp) + Subject prefix (Sp) + Tense marker (T) + Object prefix (Op) +
ROOT + derivation (d) + Suffix (s) + Post-suffix (Ps).

(3b)
A + li + m + gong + a
Sp + T + Op + ROOT + d
“S/he hit him/her”

(3c)
Ha + tu + ta + m + gong + a
Pp + Sp + T + Op + ROOT + d
“We will not hit him/her”

(3d)
Tu + na + gong + a + n + a
Sp + T + ROOT + d + S + Ps
“We are hitting each other”

The Swahili verb, unlike that of English, can function as a complete sentence. The verb
paradigm consists of: subject prefix (subject–verb agreement), tense marker (includes
tense and aspect) and verb root, which are generally obligatory in every grammat-
ical Swahili sentence. However, the object prefix is usually not obligatory when the
object of the sentence is overtly present. The subject prefix and object prefix must
always agree in number with the subject and the object of the sentence respectively, as
illustrated in (1–2) above.

Previous studies on Swahili–English bilingual agrammatic speakers

Among the several theories of agrammatic production mentioned above, only a few
have been tested in bilingual speakers of structurally different languages to determine
whether the same underlying deficit may cause different surface manifestations in the
different languages of a bilingual (Paradis, 1988). Abuom and colleagues showed in
several studies that Swahili–English agrammatic speakers have a selective deficit for
production and comprehension of verb forms that refer to the past both in experi-
mental settings (Abuom & Bastiaanse, 2013; Abuom et al., 2011) and in spontaneous
speech (Abuom & Bastiaanse, 2012). Moreover, this impairment is more promi-
nent in English with its relatively simple verb inflection paradigm than in Swahili
with its extensive, but entirely regular paradigm. These findings show that these
agrammatic bilinguals demonstrate the same pattern as agrammatic monolinguals (for
an overview, see, Bastiaanse, 2013; Bastiaanse et al., 2011).

Having noted that Swahili-English agrammatic speakers, in the severity range
tested, have no problems with the present time-frame constructions in a base word
order, Abuom et al. (2013) tested their comprehension of present time constructions
in a derived word order. We compared the comprehension of sentences in two con-
ditions: base order and derived order, in both languages (Swahili and English). The
results demonstrated that Swahili–English agrammatic speakers had greater difficulty
comprehending derived order constructions (passive and object relative sentences)
compared to base order conditions (simple active and subject relative sentences).
Furthermore, the performance on both languages was strikingly similar irrespective of the morphological differences between the two languages. The findings are compatible with the DOP-H. The DOP-H makes the same predictions for an agrammatic comprehension and production, but so far, it has not been tested for similar constructions in both modalities. Moreover, the participants of the current production study are the same as those in the earlier comprehension study. This enables us to analyse whether comprehension and production are affected to the same extent, a finding that would point to central deficit. A final unique point of the current study is that the agrammatic speakers are early balanced bilinguals who were tested in both languages.

The current study

We tested the production of different sentence structures, in which two factors were varied: word order (base and derived) and sentence type (simple declarative and embedding). Thus, we tested simple sentences with the base and derived orders of the arguments (actives and passives, respectively) and sentences with embeddings in the base and derived orders (subject and object cleft sentences, respectively). The DOP-H predicts more problems with the derived order sentences. However, it is likely that, as in comprehension, the problems increase when embedded sentences have to be produced. It is, therefore, predicted that subject clefts are more difficult than simple actives, although in both sentence types the arguments are in base order and that object clefts are more difficult than passives:

\[
\text{Active sentences} > \text{subject clefts} \geq \text{passive sentences} > \text{object clefts}.
\]

It is unknown yet whether word order and embedding will have a similar complicating effect, making it unsure whether subject clefts will be more difficult than or equally difficult as passives.

Studying these questions in a bilingual population enables us to evaluate whether other factors further complicate a sentence production and whether word order and embedding are affected in the same way in two languages from two different language families. As described above, the verb system in Swahili is morphologically very extensive but also highly regular compared to English verbs. Such a complex system requires further processing resources, and may result in poorer performance in Swahili. It may also be the case that there will exist qualitative difference in the responses in the two languages. Thus, it may be that one language is more impaired than the other or that different error patterns are observed.

METHODS

Participants

There were 16 participants in this study: eight bilingual agrammatic speakers of Swahili and English\(^3\, 4\) from the Aga Khan University hospital (Nairobi Kenya) and

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\(^3\)The eight agrammatic participants had previously participated in a study on sentence comprehension a year earlier (Abuom et al., 2013).

\(^4\)The term “bilingual” has been used in this study to refer to all those people who use two or more languages or dialects in their everyday lives (Grosjean, 1994).
eight non-brain damaged bilingual speakers (NBDs). All were aged between 26 and 51 years, with over 12 years of education. In seven participants, aphasia was caused by a stroke, in one by traumatic brain injury. The agrammatic speakers were early balanced bilinguals equally proficient in English and Swahili pre-morbidly, and none had any history of neurological, hearing or vision problems. The non-brain-damaged participants were matched to the agrammatic speakers based on age, years of education, occupation and native language. Although there are no tests available to establish the aphasia syndrome in Kenya, the aphasic speakers were assessed and diagnosed by neurologists as suffering from aphasia. They were, further, judged by a speech therapist as agrammatic based on their spontaneous speech production that was perceived as being slow, effortful and “telegraphic” (short phrases consisting of mainly content words), but with relatively spared auditory comprehension of single words on an adapted version of the BDAE-test (*Boston Diagnostic Aphasia Examination*: Goodglass, Kaplan, & Barresi, 2001). Their demographic details and percentage scores on the test for auditory comprehension of words (on an adapted version of the BDAE-test) in Swahili and English are given in Table 1.

### Materials and procedure

A sentence production test for Swahili and English, developed using pictures from Verb and Sentence Test (Bastiaanse, Edwards, & Rispens, 2002; VAST; Bastiaanse, Edwards, Maas, & Rispens, 2003) was used to test whether word order, embedding and size of the verb inflection paradigm (morphological complexity) influence a sentence production differently in the two languages of bilingual agrammatic speakers. The test in each language included 36 semantically reversible sentences distributed over two conditions: base order and derived order. The base order consisted of: nine simple active sentences (e.g., *the man is rescuing the woman*) and nine subject cleft sentences (e.g., *it is the man who is rescuing the woman*) with embedding, but arguments in base order—that is, the agent precedes the theme. For derived order, there were nine passive sentences (e.g., *the woman is rescued by the man*) with order of the arguments derived, that is, the theme precedes the agent and is in subject position (and the agent in the

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Gender</th>
<th>Handedness</th>
<th>Education (years)</th>
<th>Years post-stroke/head trauma</th>
<th>Native Language</th>
<th>Swahili BDAE-subtest scores</th>
<th>English BDEA-subtest scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA</td>
<td>43</td>
<td>M</td>
<td>R</td>
<td>16</td>
<td>18</td>
<td>Nilotic</td>
<td>100</td>
</tr>
<tr>
<td>JN</td>
<td>51</td>
<td>F</td>
<td>R</td>
<td>13</td>
<td>11</td>
<td>Bantu</td>
<td>100</td>
</tr>
<tr>
<td>SS</td>
<td>31</td>
<td>F</td>
<td>R</td>
<td>12</td>
<td>18</td>
<td>Indo-Aryan</td>
<td>100</td>
</tr>
<tr>
<td>PN</td>
<td>37</td>
<td>F</td>
<td>R</td>
<td>14</td>
<td>2</td>
<td>Bantu</td>
<td>100</td>
</tr>
<tr>
<td>MM</td>
<td>48</td>
<td>F</td>
<td>R</td>
<td>16</td>
<td>11</td>
<td>Nilotic</td>
<td>100</td>
</tr>
<tr>
<td>MW</td>
<td>51</td>
<td>F</td>
<td>R</td>
<td>16</td>
<td>2.5</td>
<td>Bantu</td>
<td>98.6</td>
</tr>
<tr>
<td>HJ</td>
<td>46</td>
<td>F</td>
<td>R</td>
<td>14</td>
<td>11</td>
<td>Nilotic</td>
<td>100</td>
</tr>
<tr>
<td>VK</td>
<td>26</td>
<td>F</td>
<td>R</td>
<td>16</td>
<td>3</td>
<td>Bantu</td>
<td>100</td>
</tr>
<tr>
<td>Mean</td>
<td>41.63</td>
<td></td>
<td>14.63</td>
<td>9.56</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
by-phrase), and nine object cleft sentences (e.g., *it is the woman who the man is rescuing*) with derived order of the arguments, the theme precedes the agent and an embedding.

The influence of size of the verb inflection paradigm was controlled by the two languages that the agrammatic individuals speak: Swahili has an extensive verb inflection paradigm that consists of the subject, object, tense, aspect and passive markers (for passive sentences). In English the verb is only inflected for tense and agreement.

There were 36 pairs of pictures, a pair on each page, depicting the same action but the agent in the first picture was the theme in the second and vice versa. The infinitive of the verb was printed on top (See Table 2 for the sentence types and Figure 1 for an example picture).

The pictures were shown to the participant who was asked to look at them both. The experimenter named the people and animals in the pictures to ensure a proper recognition. He then constructed a sentence using the printed verb to describe the first picture and asked the participant to construct a sentence of a similar structure to describe the second picture. For example, for Figure 1:

Experimenter: (pointing to the picture on the left): for this picture, you can say “The woman is rescuing the man” (pointing to the second picture on the right): and for this picture, you can say

Participant: “The man is rescuing the woman”

<table>
<thead>
<tr>
<th>Sentence type</th>
<th>Target sentence in English</th>
<th>Target sentence in Swahili</th>
<th>Word order</th>
<th>Embedding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>The man is rescuing the woman</td>
<td>Mwanamme anamuokoa mwanamke</td>
<td>base</td>
<td>–</td>
</tr>
<tr>
<td>Subject cleft</td>
<td>It is man who is rescuing the woman</td>
<td>Ni mwanamme ambaye anamuokoa mwanamke</td>
<td>base</td>
<td>+</td>
</tr>
<tr>
<td>Passive</td>
<td>The woman is rescued by the man</td>
<td>Mwanamke anaokolewa na mwanamme</td>
<td>der.</td>
<td>–</td>
</tr>
<tr>
<td>Object cleft</td>
<td>It is the woman who the man is rescuing</td>
<td>Ni mwanamke ambaye mwanamme anamuokoa</td>
<td>der.</td>
<td>+</td>
</tr>
</tbody>
</table>

Figure 1. An example of a pair of pictures used in sentence production task (VAST: Bastiaanse et al., 2002).
Four practice trials (one for each sentence type) preceded the experiment. During the practice trials the participant got feedback, and when needed, the sentence was corrected and the participant was asked to repeat the correct sentence, to ensure that the task was properly understood. No help was given during the experiment and only neutral feedback was provided. There was no time limit for participant’s response, and repetitions of the prompting sentence were made as many times as requested. Self-corrections were allowed and only the last answer was scored.

Scoring

All answers were transcribed in orthographic script and analysed both quantitatively (correct/incorrect) and qualitatively (error analysis).

RESULTS

There were no errors made by the NBDs on either test. The results of the agrammatic speakers are shown in Tables 3 and 4.

A repeated measures analysis of variance was performed to investigate main effects of language (English and Swahili), word order (base and derived) and embedding (simple and embedded) on agrammatic performance. There was a significant effect for language: $F(1, 7) = 8.430$, $p = .023$; word order: $F(1, 7) = 149.075$, $p < .000$; and embedding: $F(1, 7) = 62.906$, $p < .000$. There were no interaction effects for language x word order ($F(1, 7) = 0.023$, $p = .885$), nor for language x embedding ($F(1, 7) = 0.955$, $p = .361$) (see Figure 2). However, there is a significant interaction effect for the word order x embedding ($F(1, 7) = 8.188$, $p = .024$). Overall there is no interaction for: language x word order x embedding ($F(1, 7) = 0.549$, $p = .483$).

We performed $t$-tests to explore the significant effects further. The agrammatic speakers performed significantly poorer in English than in Swahili ($t(7) = 2.903$, $p = .027$). They also showed significant difficulty producing sentences in a derived order (condition) compared to those in a base order condition (Swahili: $t(7) = 8.450$, $p < .0001$; English: $t(7) = 11.180$, $p < .0001$); They performed poorly on passives compared to active sentences (Swahili: $t(7) = 9.379$, $p < .0001$; English: $t(7) = 6.675$.

### TABLE 3

Individual agrammatic speakers’ correct raw scores on Swahili test

<table>
<thead>
<tr>
<th>Agrammatic participant</th>
<th>Actives</th>
<th>Subject clefts</th>
<th>Passives</th>
<th>Object clefts</th>
<th>Total base order</th>
<th>Total derived order</th>
<th>Total simple</th>
<th>Total embedded</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA</td>
<td>7</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>9</td>
<td>9</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>JN</td>
<td>9</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>12</td>
<td>6</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>SS</td>
<td>9</td>
<td>7</td>
<td>6</td>
<td>3</td>
<td>16</td>
<td>9</td>
<td>15</td>
<td>10</td>
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<tr>
<td>PN</td>
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<td>3</td>
<td>2</td>
<td>15</td>
<td>5</td>
<td>12</td>
<td>8</td>
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<tr>
<td>MM</td>
<td>9</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>14</td>
<td>9</td>
<td>14</td>
<td>9</td>
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<tr>
<td>MW</td>
<td>9</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>12</td>
<td>4</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>HJ</td>
<td>8</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>13</td>
<td>10</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>VK</td>
<td>9</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>16</td>
<td>9</td>
<td>14</td>
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<tr>
<td>Mean</td>
<td>8.6</td>
<td>4.8</td>
<td>4.4</td>
<td>2.6</td>
<td>13.4</td>
<td>7</td>
<td>13.3</td>
<td>7.4</td>
</tr>
</tbody>
</table>
TABLE 4
Individual agrammatic speakers’ correct raw scores on English test

<table>
<thead>
<tr>
<th>Agrammatic participant</th>
<th>Actives Subject clefts Max = 9</th>
<th>Passives Max = 9</th>
<th>Object clefts Max = 9</th>
<th>Total base order Max = 18</th>
<th>Total derived order Max = 18</th>
<th>Total simple order Max = 18</th>
<th>Total embedded order Max = 18</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA</td>
<td>5</td>
<td>2</td>
<td>7</td>
<td>3</td>
<td>8</td>
<td>2</td>
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<td>2</td>
<td>3</td>
<td>11</td>
<td>4</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>SS</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>15</td>
<td>8</td>
<td>10</td>
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<td>3</td>
<td>4</td>
<td>2</td>
<td>12</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
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<td>4</td>
<td>5</td>
<td>0</td>
<td>12</td>
<td>5</td>
<td>4</td>
</tr>
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<td>3</td>
<td>5</td>
<td>2</td>
<td>12</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>HJ</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>11</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>VK</td>
<td>9</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>14</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Mean</td>
<td>7.9</td>
<td>3.9</td>
<td>4.1</td>
<td>1.5</td>
<td>11.8</td>
<td>5.5</td>
<td>11.9</td>
</tr>
</tbody>
</table>

Figure 2. Illustration of the interaction effects for word order x embedding in Swahili and English.

\( p < .0001 \), and worse on object clefts than on subject clefts (Swahili: \( t(7) = 4.123, p = .004 \); English: \( t(7) = 5.158, p = .001 \)). Finally, the performance on embedded sentences (subject clefts and object clefts) was worse than on the declarative sentences (actives and passives) in both languages (Swahili: \( t(7) = 6.666, p < .0001 \); English: \( t(7) = 7.021; p < .0001 \)).

Error types

The distribution of error types of the agrammatic speakers is presented in Tables 5 and 6.

Errors produced by the agrammatic speakers were distinguished into four categories: word order (when the arguments are not in the correct position: “The man is rescuing the woman” Target: “The woman is rescued by the man”); embedding (when the relative marker “who” or “ambaye” is omitted in the sentence: “the man is hitting the woman” Target: “It is the man who is hitting the woman”); both word order and...
TABLE 5
Individual agrammatic speakers’ distribution of error types (raw scores) on Swahili task

<table>
<thead>
<tr>
<th></th>
<th>Word order</th>
<th>Embedding</th>
<th>Word order and embedding</th>
<th>Others: repetition of given verb form</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>JN</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>SS</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>PN</td>
<td>6</td>
<td>3</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>MM</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>MW</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>HJ</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>VK</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Mean</td>
<td>4.6</td>
<td>4.3</td>
<td>6.4</td>
<td>0.4</td>
</tr>
</tbody>
</table>

TABLE 6
Individual agrammatic speakers’ distribution of error types (raw scores) on English task

<table>
<thead>
<tr>
<th></th>
<th>Word order</th>
<th>Embedding</th>
<th>Both word order and embedding</th>
<th>Others: omissions of ‘is’; repetition of given verb form</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA</td>
<td>6</td>
<td>7</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>JN</td>
<td>6</td>
<td>7</td>
<td>8</td>
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<tr>
<td>SS</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>PN</td>
<td>5</td>
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<td>7</td>
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<tr>
<td>MM</td>
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<td>HJ</td>
<td>5</td>
<td>4</td>
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<tr>
<td>VK</td>
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<td>4</td>
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<td>0</td>
</tr>
<tr>
<td>Mean</td>
<td>5</td>
<td>5.1</td>
<td>7.5</td>
<td>1.1</td>
</tr>
</tbody>
</table>

embedding (when the sentence produced is the reverse of the target sentence and the relative marker is missing: “The man is guarding the woman” Target: “It is the woman who the man is guarding”); and other (repetition of the given form of the verb: “*Man rescue woman,” omission of “is” for English: “*Man rescuing woman”). Errors of word order and embedding combined occurred equally often in Swahili and English ($r(7) = 1.843; p = .108$). Other errors, such as repetition of the given verb form in both languages and the omission of “is” in English, hardly occurred.

In sum, the results show that Swahili–English agrammatic speakers have more problems producing sentences in a derived order—passives and object cleft constructions—than in a base-order condition. However, within both orders, base and derived, the embedded variant is more difficult than the variant with simple sentence structures. The most common errors are production of sentences with arguments in a base position where derived orders were required and of sentences without embedding in the embedded condition. In object clefts, both the order and the embedding were often avoided. These findings imply that it is not only the derived order that is a problem to agrammatic speakers, but also embedded constructions.

Swahili and English compared

The Swahili version of the test was easier for the agrammatic speakers than the English version. In order to find out whether the grammatical disorder influences a word order and embedding in Swahili and English in the same way, the correlation between the
scores in the two languages was calculated. The results show that a common underlying impairment is very likely: there is a strong and significant correlation between the scores in the two languages ($R = 0.885$, $p < .0001$). Notice that performance is better in Swahili than in English, despite the larger verb inflection paradigm in Swahili. We will come back to this in the Discussion.

**Production and comprehension compared**

The DOP-H aims to be an overarching theory and has been supported in several studies with production and comprehension data, however, never in the same population. In order to claim a theory to be overarching, the same structures should be impaired to the same degree in the same individuals. To test this, correlations between comprehension and production were calculated. Each of the eight agrammatic speakers of the current study participated in the comprehension study as well. There is a strong and significant correlation between the production and comprehension scores, both in Swahili ($R = 0.759$, $p < .0001$) and in English ($R = 0.692$, $p < .0001$).

**DISCUSSION**

The primary goal of the current study was to test the DOP-H, which predicts difficulty in production of derived order sentences by the agrammatic speakers. However, an interaction with linguistic complexity other than word order was found. Moreover, by testing bilingual agrammatic speakers of two structurally different languages, we were able to measure whether the size of the verb inflection paradigm played a role. Finally, by comparing the data with those on a similar comprehension test, the overarching aspect of the DOP-H could be tested.

**The DOP-H and linguistic complexity**

The data show that Swahili–English bilingual agrammatic speakers’ performance on a sentence production is affected by a word order. Sentences with a base word order are produced better than those with a derived word order: relatively few errors were made on active and subject cleft sentences compared to passive and object cleft sentences, respectively. This is exactly what the DOP-H predicts. Several studies on production involving monolingual agrammatic speakers have supported this hypothesis as well: Bastiaanse, Huguen, et al. (2002) for Dutch; Bastiaanse and Thompson (2003) for English; Burchert et al. (2008) for German; and Yarbay Duman et al. (2007, 2008) for Turkish. However, two comprehension studies showed that the DOP-H alone does not sufficiently predict the observed patterns. When statistical comparisons are made, it is evident that there is an interaction between a derived word order and other levels of linguistic complexity. Yarbay Duman et al. (2011) showed that for Turkish agrammatic individuals, the derived order sentences are hard to interpret, and within the derived order structures, there is also a hierarchy. Performance on derived order sentences with unmarked case assignment (subject $\rightarrow$ nominative case and object $\rightarrow$ accusative case, as in sentences with object scrambling) is better than when case assignment is marked (subject $\rightarrow$ genitive case and object $\rightarrow$ nominative case, as in Turkish object relative sentences). A similar interaction effect was reported by Abuom et al. (2013) for comprehension in Swahili-English bilingual agrammatic individuals. Derived order sentences were harder to comprehend than base-order sentences, but there was an interaction with embedding. For both languages, the order of difficulty was: simple
actives > subject relatives > passives > object relatives. The same is observed in the present study on agrammatic production (for the same individuals who were tested on comprehension). Derived order is indeed a problem, but embedding is as well, and sentences with both derived word order and embedding are hardest to produce: simple actives > subject clefts > passives > object clefts.

The error analysis showed that in both languages, the agrammatic speakers frequently omitted the relative pronoun “who” in English and “ambaye” in Swahili, suggesting a general difficulty in producing embedded clauses. This is an aspect that is not included in the DOP-H. The question is why embeddings are difficult. Of course, embedding is a difficult operation that is usually introduced by a complementiser. The complementiser itself, being a function word, may be the problem. However, if it is the production of the function word, rather than the linguistic operation, that is difficult, then one expects agrammatic speakers to produce embedded sentences in which optional complementisers are omitted (such as “I think he will come home” and “the boy reading the newspaper is absent-minded”). However, agrammatic spontaneous speech data show that hardly any embeddings are produced, suggesting that it is embedding that is the problem, rather than the production of the complementiser per se (see, e.g., Abuom & Bastiaanse, 2012, for data on Swahili-English agrammatic spontaneous speech, Bastiaanse, Hugen, et al., 2002, for Dutch spontaneous speech and Saffran, Berndt, & Schwartz, 1989, for English spontaneous speech).

The problem with embedding in agrammatic speech production is a robust phenomenon that has previously been reported in several studies in aphasiology literature. Data from spontaneous speech in various languages show that agrammatic speakers have severe difficulties with the production of embedded sentences that manifest in their avoidance of complex sentences and in errors they make when they try to produce them. This was reported for English (Bates, Friederici, Wulfeck, & Juarez, 1988; Thompson et al., 1996, 1997), for Italian and German (Bates et al., 1988), French (Nespoulous, Dordain, Perron, Jarema, & Chazal, 1990; Nespoulous et al., 1988), Japanese, (Hagiwara, 1995) and Dutch, Swedish, Polish, and Finnish in Menn and Obler’s (1990) corpora. The theory of Hagiwara (1995) and the TPH Friedmann and Grodzinsky (1997) attribute this difficulty to a pruned syntactic from the T-node up, including the CP, in agrammatic speakers’ syntactic representation. Since the relatives “who” and “ambaye” are in complementisers, the TPH correctly predicts these omissions. When the TPH assumes that the subject of a passive sentence is in the specifier of the complementiser phrase, it can also explain the problems with passive sentences. However, the TPH is not an adequate alternative to explain the current data. First, the TPH does not predict that object clefts are more difficult than subject clefts. Second, the TPH predicts tense problems and the agrammatic speakers in the current study did not make one single tense error. The TPH, therefore, partly explains the problem with embedded structures observed in the current data, but it does not account for the difficulties with derived order sentences.

We, thus, conclude that both the DOP-H and the TPH can only account partly for the current data. While the DOP-H explains the difficulty with derived order sentences, the TPH can account for the difficulty with embedded structures. A unifying theory that can combine both problems is still lacking.

Production in Swahili and English

One of the questions was whether the extensive Swahili verb forms would result in a poor performance compared to the relatively simple English verb forms we used.
We deliberately used those forms that were most accurately produced in an earlier study (Abuom & Bastiaanse, 2012, 2013) on time reference: present imperfect for Swahili and the gerund for English. In these studies, the same pattern was observed as in the current study: performance in Swahili, with its extensive verb morphology, was significantly better than in English. Hence, we can conclude that the complexity of the verb form does not influence production. However, like in two studies on time reference through verb inflection and in the study of Abuom et al. (2011), performance was better in Swahili. Given the relatively poor but irregular morphological system of English in contrast with the stronger and more regular system in Swahili, the current finding is in line with Menn and Obler (1990). They suggest that in languages with a small paradigmatic system (such as Swahili) fewer errors in grammatical morphology are made than in languages with a broader range of choices within the paradigm (such as English). It cannot be excluded, of course, that the agrammatic speakers are (all) more proficient in English than in Swahili. However, this is quite unlikely, because both languages are used on a daily basis—both before and after the brain damage. An alternative explanation is that embeddings and derived word order are more frequent in Swahili than in English. Such frequency counts are not available for Swahili. However, in our spontaneous speech study, both the bilingual non-brain-damaged and the bilingual agrammatic speakers used more embedded sentences in English than in Swahili (Abuom & Bastiaanse, 2012). Also, Bastiaanse, Bouma, and Post (2009) showed that the frequency of sentence structures does not influence agrammatic performance. In Dutch, for example, the order Subject–Verb–Object is 50% more frequent than the structure Subject–Object–Verb. However, agrammatic speakers are significantly better in producing the latter order, which is the base order in Dutch. SVO is, despite being more frequent, derived.

However, the similar pattern of performance across the two languages irrespective of their morphological differences, even though Swahili appears slightly better preserved than English, suggests one central deficit underlying the general performance patterns.

DOP-H: An overarching processing theory

As mentioned in the introduction, the DOP-H is an overarching theory predicting more problems for agrammatic speakers on both production and comprehension of sentences whose arguments are in a derived position. It has been supported by not only production studies in several languages (Bastiaanse, Huguen et al., 2002; Bastiaanse & Thompson, 2003; Burchert et al., 2008; Yarbay Duman et al., 2007, 2008) but also several comprehension studies (Bastiaanse & Van Zonneveld, 2006; Yarbay Duman et al., 2011). The current data on production as well as the previous finding on comprehension study of bilingual agrammatic speakers (Abuom et al., 2013) further support this theory; and provide new insight into a sentence production deficit of bilingual individuals with agrammatic Broca’s aphasia. However, the DOP-H does not cover problems with embedding also found in the current study.
REFERENCES


