# A neurolinguistic approach to pronominal resumption in Akan focus constructions

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Nathaniel Lartey

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by

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# CHAPTER 1

## General Introduction

# General Introduction

## 1.1 Background on Aphasia

Damage to different parts of the brain may result in various linguistic and cognitive deficits. Brain damage to the left hemisphere may cause deficits to language. The condition where an individual's language is affected as a result of brain damage is termed 'aphasia', which literally means 'without speech'. Aphasia may affect different modalities, from production to comprehension, with different levels of severity depending on the site and size of the brain damage. There are various types of aphasia; Broca's aphasia, Wernicke's aphasia, transcortical aphasia, conduction aphasia, global aphasia and so forth (Goodglass & Kaplan, 1972; Obler & Gjerlow, 1999). In broad terms, individuals with aphasia can be grouped into fluent and non-fluent speakers, but the focus of the present study will be on agrammatic aphasia. Agrammatic aphasia is a term used to categorize a group of symptoms, among which being unable to speak fluently (Nestor et al., 2003). The spontaneous speech of agrammatic speakers is characterized by phonemic distortions, word retrieval difficulties, effortful speech and grammatical errors (Bastiaanse & Jonkers, 1998). In other words, the speech of individuals with agrammatic aphasia is telegraphic, mainly consisting of content words and generally with preserved comprehension abilities.

Agrammatism is controversial, yet an interesting condition. Contrary to traditional assumptions, comprehension abilities have been found to be damaged in agrammatic aphasia (Caramazza & Zurif, 1976). In spite of this, research has shown that agrammatic speakers still have the capacity to comprehend many syntactic structures, with only specific aspects of syntax disturbed. Some studies have provided evidence of a retained knowledge of the theta criterion (Lapointe, 1985). Others have also shown that patients are sensitive to argument structure (Shapiro & Levine, 1990; Shapiro et al., 1991; Grodzinsky & Finkel, 1998). However, word-order derivation has been an exception. Agrammatic speakers also find it difficult to detect violations in relation to syntactic derivation (Schwartz et al., 1987).

In the current project, we examine syntactic derivation in Akan focus constructions, testing native Akan speakers with agrammatism. In addition, we investigate pronominal resolution and resumption in Akan, assessing different neurolinguistic theories. The subsequent section introduces the Akan language and explores features of the language relevant to the present project.

## 1.2 The Akan Language

Akan is a Kwa language of the Niger-Congo phylum and is a dominant language in Ghana. Akan has a cluster of dialects principally made of Fante, Akuapem, Asante, Agona, Bron, Wasa, Akyem, Kwahu. Akuapem (Ak.), Asante Twi (As.) and Fante (Fa.) are the only three that have attained literary status and are also mutually intelligible. The language is spoken by about 60 % of Ghanaians and 20 % of Ivorians. Akan is largely spoken in southern Ghana. The educational policy in Ghana allows a child to use his/her native language as a medium of instruction and communication until 3rd grade (Mfum-Mensah, 2005). Most children in the south are expected to read and write in Akan before grade 4, which is when English becomes the medium of instruction in schools. Akan has been studied for a comparatively longer time than the other Ghanaian languages.

*Akan word order and tonal system*

The base word order of Akan is Subject-Verb-Object (SVO; Saah, 1994). Examples 1a and 1b show that rearranging words in the base word order affects the grammaticality of the sentence.

1. a. Papa no ɛkɔ fie Grammatical

   Man the PROG.go home

   'The man is going home'

   b. * ɛkɔ fie papa no Ungrammatical

   PROG.go home man the

According to the word prosodic system of Hyman (2006), Akan can be classified as a [+tone] and [-stress] language. Akan has two main tones, high and low, transcribed as [ ´ ] and [ ` ] respectively (Dolphyne 1988). The tones in Akan make both lexical (2) and grammatical (3) distinctions. The grammatical function of Akan tones usually relates to the expression of the verb aspect and tense (3). In example 3, we see how variations in the tones on the vowels change the verb aspects from habitual (HAB) to stative (STAT).

2. a. p**á**p**á** ‘good’

   b. p**à**p**à** ‘fan’

   c. p**à**p**á** ‘father/man’

3. a. Kofi gy**í**n**á** hɔ

      Kofi stand.HAB there

      ‘Kofi stands there’

   b. Kofi gy**ì**n**à** hɔ

      Kofi stand.STAT there

      ‘Kofi stands there’ Dolphyne (1988:57)

*Information Structuring in Akan wh-Questions and Declaratives*

In Akan, ‘focusing’ is a linguistic process used to construct structures like clefts, relative clauses, and *wh*-questions. The focus particles, *na* and *deɛ* are used as morphological markers to indicate focus. Any constituent in an Akan sentence can be focused. The element being focused always precedes the focus marker. Any other arrangement makes the structure ungrammatical. This applies both to Akan declaratives and questions. In the present project, we investigate Akan focused structures comparable to *it*-clefts in languages like English and Dutch.

*Focusing in Akan declaratives*

Typically, the construction of structures like *it*-clefts in English, Dutch and German demands the focusing of elements in a sentence. In these languages, the cleft requires a main clause and a subordinate clause.

In English

4. a. I am thinking of John Simple declarative

   b. It is John who I am thinking of Cleft

In Dutch

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5. | Het | is | Jan | aan | wie | ik | denk | |
| | It | is | John | on | who | I | think | |
| | 'It is John who I am thinking of' | | | | | | | Cleft |

In Akan, lexical elements in the clause like predicates, noun phrases and adjectives can be focused, as in English and Dutch. There are two ways Akan *it*-clefts are formed. First, an Akan *it*-cleft (6b) is constructed as in Dutch and English (4 and 5), with two clauses. Second, clefts in Akan are also formed with just one clause (6c). Here, the focused element does not require a separate *it*-clause. The morphological marking of the focused element (*papa no* meaning 'the man' in 6c) with the focus marker '*na*' without a full *it*-clause (*εyε papa no* meaning 'it is the man') is still grammatical. Therefore from 6c, the highlighted phrase '*Papa no na*', would be translated in English as 'It is the man…' or 'The man is the one…' This clarifies the point that in Akan a full *it*-clause is not orthographically and phonetically required in the construction of *it*-clefts. The meaning of the sentence (6b or 6c) is unaffected with or without a full *it*-clause.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6. | a. Me | pia-a | **papa no** | | | | | |
| | I | push.PST | man the | | | | | |
| | 'I pushed the man' | | | | | | | Simple declarative |
| | b. **(εyε)** | **papa** | **no** | **na** | me | pia-e | | |
| | It.is | Man | the | FOC | I | push.PST | | |
| | 'It is the man that I pushed' | | | | | | | Object Cleft |
| | c. **Papa** | **no** | **na** | me | pia-e | | | |
| | Man | the | FOC | I | push.PST | | | |
| | 'It is the man that I pushed' | | | | | | | Object Cleft |

Semantically, there is a difference between Akan focused and unfocused constructions. The three structures in (6) essentially convey the same message, that is, the speaker pushed a man. However, in (6b and 6c) the speaker asserts that "*the man and only the man was the one I pushed*". The whole sentence can be paraphrased as; "*I, the speaker pushed someone and the*

*someone I pushed is the man (and no one else)*". This paraphrase points out the contrastive nature of focused structures in Akan. Henceforth, the current project identifies structures like 6c as *focused declaratives* to avoid theoretical controversies.

*Focusing in Akan questions*

*Wh*-questions in Akan are introduced with *wh*-words/phrases, except for those with the question word *in situ*. See Table 1.1 for a list of *wh*-words in Akan.

Table 1.1 *Wh*-words in the Akan language.

| Question Word | Meaning |
|---|---|
| (ɛ)hena (Ak.); hae(As.); wona(Fa.) | Who |
| (ɛ)he (Ak, As); hen(fa) (Fa.) | Where |
| ahe(Ak., As.); ahen(Fa.) | how much, how many |
| Sɛn(As.) | how much, how many |
| Dɛn | What |
| Adɛn | Why |
| dɛn ade (Ak., As.) | what/ what thing/what reason |
| bɛn(Ak.,As.), ebɛn(Fa.) | what/which |

Akan has two main ways of formulating its *wh*-questions. The *wh*-word can both be found *in situ*, in the base word order (7), and *ex situ* in the derived word order, where it is focus marked (8). The absence of the focus marker '*na*' when the *wh*-word is at the clause-initial position renders the question ungrammatical. The focus marker always follows the question word in the initial position. This is true for both subject and object questions.

7. Papa no$^{subj}$ e-pia$^{V}$ **hena**$^{Obj}$?

   Man the PROG-push who Object *who*-Question

   'Who is the man pushing/ the man is pushing who?'

8. **Hena**$^{Obj}$ na o-pia$^{V}$ papa no$^{Subj}$?

   Who FOC (s)he.PROG.push man the Subject *who*-Question

   'Who is pushing the man?'

In this section, we have seen how focus sentences are constructed in Akan questions and declaratives. In the formation of Akan focus sentences, there is another syntactic transformation process that can take place. This process is linguistically referred to as 'resumption'. In the next section, we explore the phenomenon of resumption and describe how it is realized in Akan focus construction.

### 1.2.1 Resumption in Akan

In syntax, resumption is depicted as the movement of a nominal element to construct focus, topic, relative, and question structures, which consequently allows a pronoun that refers to the moved nominal element to fill its original position (Rouveret 2002; McCloskey, 2006; Salzmann 2006). For illustrative purposes, see some English examples below.

9. I saw [the duck$_i$ [$_{CP}$ that John drew $t_i$]]

The original position of the NP 'the duck' in (9) is marked as *t* (trace) but this is not phonetically overt. Languages like English do not replace the moved element with a pronominal form. However, languages with the resumption phenomenon, such as Hebrew (10) and Akan (11), replace the moved element with a pronominal form, which matches the morpho-syntactic features of the moved element (McCracken 2013). In (10), which is the equivalent of (9) in Hebrew, the "*oto*" (him) is typically defined as a resumptive pronoun. For the Akan example in (11) the resumptive pronoun is the '*no*'.

In Hebrew:

| | | | | | | |
|---|---|---|---|---|---|---|
| 10. Ra'itit | et | ha-barvaz**ɪ** | she-John | ciyer | **oto** | |
| I-saw | ACC | the-duck**ɪ** | that-John | drew | **him** | (resumptive pronoun) |

I saw [the duck**ɪ** [$_{CP}$ that John drew. Friedmann (2008: 141)

In Akan:

| | | | | | | |
|---|---|---|---|---|---|---|
| 11. Mehuu | papa | no | a | John | drɔɔ | **no** |
| I.see.PST | man | the | that | John | draw.PST | **him**(resumptive pronoun) |

'I saw the man that John drew'.

The distribution of resumption varies across languages. In Akan, animacy is crucial in the correct realization and interpretation of resumption. For instance, when we compare the

Hebrew sentence in (10) to the Akan one (11), we see that the NP the resumptive pronoun refers to is different in the two languages. In Hebrew the coreferenced NP is 'the duck' but in the Akan it is 'the man'. This is because of the constraints animacy places on Akan resumption. In Akan, the resumptive pronoun '*no*' ('him/her') can only corefer to a human NP. This makes sentences like 12 ungrammatical because it corefers to a non-human NP (the duck).

12. *Mehuu dabobdabo no a John drɔɔ ***no**

I.see.PST duck the that John draw.PST **him/her** (RP)

'I saw the duck that John drew'.

The interpretation of the morpheme *no* in Akan is not always straightforward. It could also be processed as a clause determiner (CD). The clause determiner in Akan has two main functions. First, it functions as a clause boundary marker and secondly, it plays emphasis on the proposition that precedes it. The next section looks at the distribution of the morpheme *no* in relation to resumption in Akan.

*The morpheme no in Akan*

The morpheme *no* has three main representations depending on the structure within which it is used and the tone it bears. The morpheme *no* is used as: 1) a definite article (the); 2) a clause determiner (CD); and 3) a resumptive pronoun (RP: him or her; see the previous section). When used as a resumptive pronoun, the tone on the vowel is low (Arkoh & Matthewson, 2013; see 13a and 14a) but when used as a clause determiner, the tone on the vowel is high (Arkoh & Matthewson, 2013; see 13b and 14b).

13. a. Hene na papa nó epia **nò**?

Who FOC man the PROG.push him/her (RP)

'Who is the man pushing?' Object-focused *who*-question

b. Hena na papa nó epia **nó**?

Who FOC man the PROG.push CD

'Who is the man pushing?' Object-focused *who*-question

14. a. Papa nó na maame nó epia **nò**.
Man the FOC woman the PROG.push him/her (RP)
'It is the man that the woman is pushing' Object-focused declarative

b. Papa nó na maame nó epia **nó**
Man the FOC woman the PROG.push CD
'It is the man that the woman is pushing' Object-focused declarative

In Akan, a resumptive pronoun and a clause determiner can co-occur in a sentence. When this happens, the resumptive pronoun is expected to be produced before the clause determiner (15). It is unacceptable when the clause determiner is produced before the resumptive pronoun.

15. Hena na papa nó epia **nò** **nó**?
Who FOC man the PROG.push RP CD
'Who is the man pushing?'

### 1.2.2 Issues on resumption in Akan

There are controversies surrounding the description of pronominal prefixes such as resumptive pronouns in Akan (like "*o*" in "*o-pia*" in 16). However, the current work will not discuss the arguments (see Korsah 2017, for a detailed analysis on this matter). Our focus for the current project is on object pronouns (like the resumptive pronoun *nò* in 15). Table 1.2 shows the Akan pronouns and their distribution. See also Saah (1994), Osam (1994) and Korsah (2017).

16. Hena na o-pia papa nó
Who FOC (s)he.PROG.push man the
'who is pushing the man'.

Table 1.2 The distribution of subject and object pronouns in Akan

| **Subject Pronouns** | | | |
|---|---|---|---|
| **Person** | **Singular** | **Plural** | **Animacy** |
| 1 | me- | yɛ- | + |
| 2 | wo- | mo- | + |
| 3 (Animate) | ɔ- | wɔ- | + |
| 3 (Inanimate) | ɛ- | ɛ- | - |
| **Object Pronouns** | | | |
| 1 | Me | yɛn | + |
| 2 | Wo | Mo | + |
| 3 (Animate) | No | wɔn | + |
| 3 (Inanimate) | - | - | - |

From the table, we can identify those subject pronouns are bound morphemes (17) while the object pronouns are free morphemes (18).

17. a. **Me**-kɔ sukuu
1SG.go school
'I go to school'

b. **Wo**-kɔ sukuu
2SG.go school
'You go to school'

18. a. Ama pia **me**
Ama pushes 1SG
'Ama pushes me'

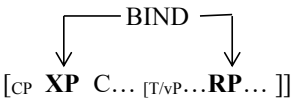
b. Ama pia **nò**
Ama pushes 3SG
'Ama pushes him/her'

The long-standing debate among linguists in relation to resumption has been on the origin or source of resumptive pronouns. Similar controversies are seen among Akan linguists (like

Saah 1994, Boadi 2005; Korsah 2017). In Akan these arguments have implications on whether *wh*-words in Akan *wh*-questions are derived or not and if similar claims can be made for structures like object relatives and object focused declaratives.

*Arguments for base generation*

According to some researchers (Salzmann 2009, 2011; McCloskey, 2011), the NP that appears displaced at the surface structure level is assumed to be the result of a direct base generation in the SpecCP. See illustration below:




It is on the basis of this claim that Saah (1994) argues that clause-initial *wh*-words in Akan questions are not the result of syntactic derivation (*wh*-movement). Saah (1994) further claims structures such as relative clauses, clefts and topicalized sentences in Akan do not show gaps or island constraints. These, he argues are basic tools used to identify syntactic derivation according to previous research (Chomsky 1977; Chung 1994). Saah (1994) in his attempt to provide a solution, writes:

> […] a plausible analysis of such constructions in Akan, therefore, is one that sees these structures as involving a base-generation of a constituent in [Spec, CP] and base-generation of a resumptive pronoun in the corresponding argument positions within the complement clause. (Saah 1994:173)

According to Saah (1994), sentences like (19) make it impossible to analyze resumptive pronouns in Akan as trace spellouts. He argues that the distribution of resumptive pronouns in these structures cannot possibly make them a saving device or a last resort strategy.

19. a. Abofra a Kofi huu **nò** nó …
Child REL Kofi see.PST **RP** CD Object relative
'The child that Kofi saw (him/her)'

b. *Abofra a Kofi huu _ nó …
Child REL Kofi see.PST _ CD

20. a. Hena na Kofi huu **nò** nó?
Who FOC Kofi see.PST **RP** CD Object who-question
'Who did Kofi see (him/her)?

b. *Hena na Kofi huu _ nó?
Who FOC Kofi see.PST _ CD

The absence of the resumptive pronoun in structures like (19b) and (20b) render such sentences ungrammatical. Saah (1994) adopts the *Barriers* theory (Chomsky 1986), which states that NPs in object positions are L-marked, which implies that they can be licitly extracted. Thus, the use of resumptive pronouns in such a position is unnecessary. He asserts then that, the gaps seen in (19b) and (20b) are illicit because as observed, the gap is filled with a pronoun which makes L-marking unnecessary. The question that arises from this claim is whether resumptive pronouns in structures like *wh*-questions, relative clauses and object focused declaratives are always expected to be realized (whether overtly or covertly) in Akan.

*Arguments for movement*

Proponents of pronominal resumption as a result of movement suggest that, unlike the base generation accounts, the displaced DP has been moved from an original position at the deep structure level to a position where its A-bar feature is checked. This implies that the resumptive pronoun is a phonetic representation of the moved element (Pesetsky 1998; van Urk 2018). See illustration below:


[$_{CP}$ **XP** C… [$_{vP}$…t **(=>RP)**… ]]

In the Akan context, Korsah and Murphy (2016) examined Akan focus structures (including *ex situ wh*-questions) and relative clauses and concluded both constructions as involving derivation. They claim that when a comparison is made between constructions like focus structures (22) and their non-A-bar counterpart (21), the tone on the verbs of the former (focus constructions) is typically high.

21. Kofi **kàn-n** krátáá nó mprɛnsa
Kofi read.PST book DEF thrice
'Kofi read the book thrice'

22. [**krátáá nó**] na Kofi **Kán-n** mprɛnsa.
Book the FOC Kofi read.PST thrice
'Kofi read THE BOOK thrice.' Korsah (2017)

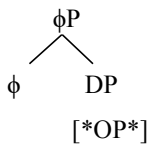
In (21) we can observe that the tone on the verb is non-high but once the object (*krataa*) is focused in (22), the tone on the verb *kann* changes from low to high. The argument here is, the change in tone on the verb in A-bar constructions suggests that the tonal feature of the focused element is reflected in the structures on its path during derivation. See other examples below (23-24), but this time with a longer A-bar extraction. Again, if the extraction of *krátáá nó* in (23), which crossed two CPs is observed, it is clear that all the verbs on its path that were marked non-high in tone change to high (compare verbs in 23 and 24).

23. Kwaku **nìm** [sɛ Amma **hù-ù** [sɛ Kofi **kàǹ-n** krátáá nó mprɛnsa]]
Kwaku know COMP Amma see.PST COMP Kofi read.PST book the thrice
'Kwaku knows that Ama saw that Kofi read the book thrice'.

24. [**krátáá nó**] na Kwaku **ním** sɛ Amma **húú** sɛ Kofi **káń-n** no mprɛnsa
Book the FOC kwaku know COMP Amma see.PST COMP Kofi read.PST 3SG thrice
'Kwaku knows that Ama saw that Kofi read THE BOOK thrice'

Korsah (2017) also adopts Klein's (2017) 'Big DP' approach to resumption. This approach assumes that a resumptive pronoun and its antecedent DP or NP are part of the same structure. This is to say that an A-bar marked nominal is, in fact, a ϕP with an embedded DP (25) (Klein 2017).

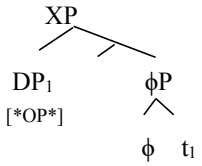
25. *Base structure*




According to Klein (2017), the DP is merged as a complement of a head. This claim also presumes that the two syntactic elements share features because they are sufficiently local. Thus, a justification for morphological dependency is given. Klein (2017) argues that an A-bar movement causes the ϕ head to be stranded, resulting in a structure like (26). This also

explains the anaphoric relationship between a resumptive pronoun and its antecedent in Akan (27a).

26. ϕ stranding

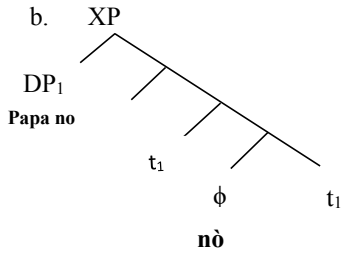



27. a. Mehuu **papa nó** aa Kwame piaa **nò**.

1SG.see.PST man the REL Kwame push.PST RP

'I saw the man who Kwame pushed'

b.




In (27), we depict a resumption relation between *papa no* and *nò* according to Klein's (2017) approach. The A-bar bound object DP is displaced from its base position as the complement of ϕ to its derived position in [spec, XP].

In this section, we have looked at the issues and controversies around resumption in Akan. However, the current study argues that the resumptive pronoun and the clause determiner are not obligatory in Akan, contrary to assertions by Saah (1994). The production or omission of the clause determiner or the resumptive pronoun does not render the sentence ungrammatical. Saah (1994) posits that when the resumptive pronoun is not phonetically produced, it is still covertly represented. One thing that Saah (1994) fails to consider in his theory is the effect of time reference on resumption. I argue here that if the event is in the present continuous tense, resumption can be omitted (28). However, Saah's (1994) claims hold when reference is being made to the past (29).

*Time reference (Present)*

| | | | | | |
|---|---|---|---|---|---|
| 28. a. Hena | na | papa nó | **epia** | **nò** | Grammatical |
| Who | FOC | man the | PROG.push | him/her(RP) | |
| 'Who is the man pushing?' | | | | | |
| b. Hena | na | papa nó | epia | _ | Grammatical |
| Who | FOC | man the | PROG.push | (empty gap) | |
| 'Who is the man pushing?' | | | | | |

*Time reference (Past)*

| | | | | | |
|---|---|---|---|---|---|
| 29. a. Hena | na | papa nó | **piaa** | **nò** | Grammatical |
| who | FOC | man the | push.PST | him/her (RP) | |
| 'Who did the man push?' | | | | | |
| b. * Hena | na | papa nó | **piaa** | _ | Ungrammatical |
| who | FOC | man the | push.PST | (empty gap) | |
| 'Who did the man push?' | | | | | |

The current work does not seek to thoroughly investigate this issue. However, from this point on, I argue that pronominal resumption in Akan is not obligatory. In Akan, these arguments have implications on whether *wh*-words in Akan *wh*-questions are derived or not and whether similar claims can be made for declaratives like object focused declaratives. We conducted a pilot study to address the issue of *wh*-derivation in Akan (we will come back to this study later). In the next sections, we assess sentence comprehension and production in agrammatism.

### 1.3 Summary of previous sections

1. The current project investigates agrammatism in native Akan speakers.
2. We examine two main Akan linguistic features:

a. Focus constructions

- We examine Akan focus constructions, looking specifically at questions and declaratives.
- The formation of Akan focus constructions also entails a linguistic phenomenon described in the previous sections as 'resumption'.

b. Resumption

The distribution of resumption in Akan consists of two elements of interest to the current work. They are:

i) Resumptive pronouns (*nɔ̀* meaning 'him/her')
ii) Clause Determiner (*nó* meaning 'the')

The two elements are orthographically similar but phonologically realized differently.

3. There are long-standing debates on the origin or source of resumptive element like the resumptive pronoun and clause determiner in Akan. We argue that the resumptive pronoun and/or the clause determiner are not base generated contrary to Saah (1994).

### 1.4 Neurolinguistic background on sentence comprehension in agrammatism

The focus of studies investigating comprehension of constructions involving syntactic derivation in individuals with aphasia has so far been on active and passive structures, *who* and *which* questions, clefts, relative clauses, and semantic reversibility. However, there are other constructions with syntactic movement that have barely been investigated and even when they were, the results of investigating these constructions are contradictory. Agrammatic speakers can comprehend simple active declaratives but encounter difficulties in comprehending passive sentences (Caplan & Futter, 1986; Sherman & Schweikert, 1989; Grodzinsky, 1995), something attributed to the violation of the base word order. Studies have revealed that the comprehension of object relative clauses and object clefts is also impaired in agrammatic speakers (Caplan & Futter, 1986; Sherman & Schweikert, 1989; Hickok & Avrutin, 1995; Burchert, et al., 2003). A meta-analysis by Berndt et al. (1995) indicated that semantically reversible and irreversible active voice sentences are less problematic compared to passive voice sentences. One of the explanations for their observation was a syntactic transformation from deep to surface structure. In contrast to the large amount of data on the comprehension of declaratives by agrammatic speakers, *wh*-questions comprehension in the same population has been given little attention. Gallagher and Guilford (1977) highlighted deficits in understanding *wh*-questions in aphasia.

Studies by Hickok and Avrutin (1996) and Thompson et al. (1999) examined comprehension of *wh*-questions in English-speaking agrammatic speakers. Findings from these studies show that the comprehension of *wh*-questions in agrammatism differs from other structures involving syntactic movement. Hickok and Avrutin (1996) examined the comprehension of subject and object *wh*-questions (30).

30. a. Who $t_i$ hit the boy? *Above chance-level performance*

b. Who did the boy hit $t_i$? *Above chance-level performance*

Their study showed no difference between subject and object *who*-questions. The performance of their patients on both question types (30) was above chance. The result from Hickok and Avrutin (1996) is unusual, considering the performance of patients on object-first sentences. Similar to constructions such as object relative clauses and object clefts, these structures are derived through *wh*-movement and so one would expect a deficit in 30b. Thompson, et al. (1999) replicated the study of Hickok and Avrutin (1996) and tested *what*-

questions (31) to see if the observation made by Hickok and Avrutin (1996) with *who*-questions would be seen in other question types.

31. a. What followed the giraffe?

    b. What did the giraffe kick?

They described a different profile from what was obtained by Hickok and Avrutin (1996). Only 1 out of their 4 patients showed the asymmetries as reported by Hickok and Avrutin. The picture becomes less clear for the comprehension of a subject as compared to object *who*-questions. Some studies have failed to show diverging effects (Hickok & Avrutin, 1996; Stavrakaki & Kouvava, 2003; Fyndanis, et al., 2010; Cho-Reyes & Thompson, 2012), whiles others have found dissociations (Salis & Edwards, 2008; Neuhaus & Penke, 2008; Kljajevic & Murasugi, 2010; Hanne et al., 2015). These contradictory findings are partially due to methodological issues. In the next section, different accounts examining deficits in the comprehension of questions are looked at and the accounts relevant for the current study assessed.

### 1.4.1 Accounts on Comprehension Deficits in Agrammatic Speakers

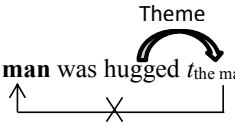
The comprehension deficit in agrammatic aphasia has been intriguing and several theories have been proposed to account for it. These accounts can be divided into two groups: representational/structural deficit accounts (e.g., Grodzinsky, 1986) and processing accounts (Frazier & Friederici, 1991; Hickok & Avrutin, 1996; Caplan, et al., 2013). The common assumption for the structural deficit accounts is that comprehension of agrammatic speakers is a reflection of syntactic incompetence. As a result, the linguistic representation when a sentence is heard by an agrammatic speaker is different from what is generated by a non-brain damaged speaker when the same sentence is heard. This in turn, results in comprehension deficits. The term ‘structural deficit hypothesis’ was used by Lukatela et al. (1995) to expound the same phenomenon. Defendants of the processing accounts claim that a comprehension deficit is a disruption in the process of implementing the knowledge of syntax in real-time (Avrutin, 2000; 2006; Thompson, 2003; Burchert, et al., 2005; Bastiaanse & Van Zonneveld, 2005). This implies that the grammar of the agrammatic speakers is intact but the aphasic individuals have difficulties using their grammatical knowledge during the act of comprehension because of brain damage. This limits their computational abilities.

Over the years, different hypothesis have been proposed, such as the Trace Deletion Hypothesis (TDH: Grodzinsky, 1986), Discourse-Linking Hypothesis (Hickok & Avrutin, 1996), Complexity Limitation Hypothesis (Frazier & Friederici, 1991), Derived Order Problem Hypothesis (DOP-H: Bastiaanse & Van Zonneveld, 2005), Mapping Hypothesis (Linebarger, et al., 1983; Linebarger, 1995) and Argument-Linking Hypothesis (Piñango, 2000).

*Trace Deletion Hypothesis*

The Trace Deletion Hypothesis (TDH) was proposed by Grodzinsky (1986) and was the first to use notions of theoretical linguistics to explain neurolinguistic data. The TDH has undergone revisions over the years (Grodzinsky, 1986; 1995; Drai & Grodzinsky, 2006). The TDH is based on the Government and Binding Theory (Chomsky, 1981). According to the TDH, agrammatic speakers' traces of moved items are missing from the syntactic representation of a sentence. We know that predicates assign thematic roles to arguments in their base position. Items that have been moved receive their thematic roles through the connection to their trace position. This is apparent in passive sentences (32). The TDH predicts a breakdown in the construction of the trace (the man) from the base position. This eventually leads to comprehension deficits since assigning the correct thematic role is problematic.

32. **The man** was hugged $t_{\text{the man}}$ by the boy.




According to the TDH, the verb correctly assigns the agent role to the by-phrase, but since the trace is deleted, the verb cannot assign a theta role to the first NP. It gets an agent role by default, resulting in representation with two-agent roles. Hence, the patient resorts to a guessing strategy which leads to chance performance.

*Discourse-Linking Hypothesis*

A different approach to the deficit is that of the Discourse Linking Hypothesis, which states that Discourse-linked (D-linked) questions are more difficult to comprehend by agrammatic speakers than non-Discourse-linked (non-D-linked) questions. This has been investigated in a

study by Hickok and Avrutin (1996), where different types of *wh*-questions (*who*-subject, *who*-object, *which*-subject, and *which*-object questions; see 33) were tested.

33. a. Who chased the giraffe?

    b. Who did the giraffe chase?

    c. Which horse chased the giraffe?

    d. Which horse did the giraffe chase?

The results from Hickok and Avrutin (1996) showed that *which*-NP questions (D-linked and referential) were more problematic for the agrammatic speakers than *who*-questions (non-D-linked and non-referential). They proposed the Differential Chain Deficit Hypothesis which characterizes deficits involving binding chains, with a relatively intact government chain.

*Complexity Limitation Hypothesis*

In their postulation of the Complexity Limitation Hypothesis, Frazier and Friederici (1991) indicated that there is no problem with the patients' grammar and processors but the problem has to do with the lack of computational resources to perform all operations in time. This deficiency is usually seen in complex structures. According to Frazier and Friederici (1991), complexity depends on the length of a chain (34). There is however empirical evidence suggesting that the length of the chain does not affect patients' comprehension (e.g., Friedmann & Gvion, 2003).

34. a. I see the boy who $t_{who}$ kisses the girl

    b. I see the boy who the girl kisses $t_{who}$.

*Derived Order Problem Hypothesis*

Agrammatic speakers have difficulties comprehending sentences with derived order. Van der Meulen, et al. (2005) investigated French *wh*-questions and how the movement of the *wh*-word in its questions affects comprehension in French speakers with agrammatism. French offers a good opportunity because of the unique character of its *wh*-questions. In French, the *wh*-word can be found in derived position with no influence on semantics (35).

35. a. Tu as vu **qui**?
You have seen who
'Who did you see?'

b. **Qui** tu as vu $t_{qui}$?
Who you have seen
'Who did you see?'

A comprehension test showed that structures with the *wh*-word in clause-initial position were more difficult to comprehend than those with the *wh*-word *in situ*. The movement hypothesis (Van der Meulen, et al., 2005) was proposed and claimed that *wh*-questions where *wh*-words undergo syntactic derivation are difficult to comprehend. The current work investigates a similar phenomenon in Akan (36).

36. a. Papa nó e-pia **hena**?
Man the PROG-push who Object who-Question
'Who is the man pushing?'

b.**Hena** na John ɛ-bo nò?
Who FOC John PROG-beat him/her (RP) Object who-Question
'Who is John beating?'

The movement hypothesis (Van der Meulen, et al., 2005) evolved into the Derived Order Problem Hypothesis (DOP-H; Bastiaanse & Van Zonneveld, 2005). The DOP-H states that for agrammatic individuals, sentences (declaratives and questions) in derived order (37b) are difficult to produce and comprehend than sentences in base order (37a), with the assumption that each language has a basic word order (subject-verb-object (SVO) in Akan) and that all other word orders are derived.

37. a. Who $t_{who}$ pushed the man? Basic word order

b. Who did the man push $t_{who}$? Derived word order

The DOP-H is based on cross-linguistic data (Dutch, Italian, Turkish, English, for example, Bastiaanse, et al., 2003; Bastiaanse and Thompson, 2003; Bastiaanse and Van Zonneveld,

2005, 2006; YarbayDuman, et al., 2007; 2008; 2011). Furthermore, the hypothesis has a broader scope than most neurolinguistic accounts because it is meant to characterize both the comprehension and production deficiencies in speakers with agrammatism. The DOP-H accounts for and is meant to describe all word order problems in agrammatic individuals. Therefore, the DOP-H is suitable to investigate focus structures in Akan to check whether those constructions undergo syntactic derivation or not.

### 1.4.2 Sentence Production in Agrammatism

In agrammatism, speech production is generally characterized by difficulties in producing free and bound grammatical morphemes (Goodglass, 1968; Caramazza & Berndt, 1985; Marshall 1986). Agrammatic speakers specifically have problems with verb inflection for tense (Friedmann & Grodzinsky, 1997; Bastiaanse & Jonkers, 1998; Friedmann 2000; Bastiaanse, et al., 2002). The production of grammatical morphemes is not the only difficulty found in agrammatic speech. Research has indicated that speakers with agrammatism have syntactic deficits. Verbs with complex argument structure (Thompson 2003) and sentences in derived order (Bastiaanse & van Zonneveld, 2005) are difficult to produce, both in spontaneous speech (Thompson, et al., 1995; Bastiaanse, et al., 2002) and in speech production experiments (Bastiaanse, et al., 2002; Bastiaanse & Thompson, 2003; Bastiaanse, et al., 2003; Burchert, et al., 2008).

### 1.4.3 Accounts on Production Deficit in Agrammatic Speakers

Syntactic theories within the generative grammar tradition (Pollock, 1989; Chomsky, 1995) stipulate that sentence production and comprehension are represented as phrasal structures called *syntactic trees.* The complementizer phrase (CP) is the highest phrasal node on the tree and hosts complementizers like “that”, and *wh*-elements (where, what). The accessibility of the CP node is critical in the construction of embedded sentences and *wh*-questions. Hagiwara (1995) was one of the first to argue that agrammatic speakers have problems accessing the top of the syntactic tree. Friedmann and Grodzinsky in a single case study in 1997 found that a Hebrew native speaker with agrammatism showed a dissociation between tense and agreement morphology, that is, agreement inflection was intact and tense inflection was impaired. As a result, Friedmann and Grodzinsky assumed the two nodes, tense and agreement to be separately represented in the syntactic tree, and the agreement node to be located below the tense node. The Tree Pruning Hypothesis (TPH: Friedmann & Grodzinsky, 1997) was then formulated to account for the dissociation that was observed. The hypothesis

argues that agrammatic speakers are unable to access elements on the syntactic tree from the tense node upwards, including the CP node because these nodes have been pruned as a result of brain damage. In effect, agrammatic speakers are unable to formulate structures like *wh*-questions and embedding sentences which require higher nodes.

However, other cross-linguistic studies have challenged the claims of the TPH based on verb inflection (Wenzlaff & Clahsen, 2004; 2005; Burchert, et al., 2005 for German; Stavrakaki & Kouvava, 2003; Nanousi, et al., 2006 for Greek). Syntactic transformations low in the tree have also been found to be impaired in other studies (Bastiaanse, et al., 2003; Burchert, et al., 2003)

There have been other theories linked to the complexity of sentence structure. In a study by Kim and Thompson (2000), English agrammatic speakers' production of intransitive, transitive and ditransitive verbs were analyzed. Their results showed that ditransitives were more difficult to produce than transitives, which were more difficult than intransitives. A follow-up study by Thompson (2003) compared unaccusative with unergative verbs and found that the agrammatic speakers performed significantly better on the unergative than the unaccusative verbs. The Argument Structure Complexity Hypothesis (ASCH) was formulated to account for the observation made. The hypothesis posits that the production deficit in agrammatism should be attributed to the complexity of the argument structure of the verb. According to the authors, both the number of arguments and the syntactic movement affect the construction of sentences, hence the deficit in production. Verbs with transitive and unaccusative reading (i.e., verbs with alternating transitivity) were tested on Dutch speakers with agrammatism in a study by Bastiaanse and Zonneveld (2005). The findings indicated that the performance of the agrammatic speakers plummeted when unaccusative verbs had to be used in sentence structures that required a derived order, that is, the theme of the predicate had to be in the subject position.

So far, an overview of the comprehension and production of sentences in agrammatism and the accounts proposed to explain the deficiencies observed have been made. Since tone is integral in Akan, specifically for the processing of focus constructions, we analyze tone processing in the subsequent sections.

### 1.5 Tone perception and production in agrammatic speakers

Generally, researchers recognize the need for elaborate investigation in tone languages other than East Asian languages (Gandour, 2006; Moen, 2009). Fromkin and Rodman (1993) also acknowledged that most languages in the world are tonal. In fact, they point out that Africa alone has over 1000 tonal languages, yet, tonal languages in Asia like Thai and Chinese (Thai: Van Lanker, 1980; Gandour, et al., 1992; Chinese: Yiu & Fok 1995; Liang & Heuven, 2004) and Norwegian (Moen, 2009) have dominated previous studies. Most tonal African languages have not been explored from a neurolinguistic perspective. A cross-linguistic approach to the study of tonal languages is important because tone inventories and rule systems vary across languages (e.g., Gandour 2006). Previous studies on tone processing in brain-damaged individuals focused mainly on the perception and production of lexical tones.

#### 1.5.1 Lexical Tone perception in aphasia

Brain damage affects lexical tone perception (Kadyamusuma et al., 2011). Gandour and Dardarananda (1983) reported that Left Hemisphere Damaged (LHD) aphasic patients found the perception of Thai tones difficult. However, Right Hemisphere damaged (RHD) patients in the same study had no such difficulties. They showed that damage to the language dominant hemisphere and not just damage to the brain causes tone perception problems. Huges (1983) reiterates the relevance of the left cerebral hemisphere in tone discrimination.

Yiu and Fok (1995) examined Cantonese individuals with aphasia, dysarthria patients and healthy speakers. They observed that RHD patients had no problems in tone identification and their performance was comparable to the healthy speakers. They asserted based on their findings that there was no direct correlation between aphasia type and the kind of tonal disruption observed in patients. In a study involving Chinese speaking individuals with Broca's aphasia, Eng, Obler, Harris, and Abramson (1996) demonstrated the inability of the patients to identify tones relative to normal speakers. The patients were expected to match pictures to words they listened to.

Most studies on linguistic tone processing have been on either production or perception. Studies that investigate a single-mode do not represent a complete relationship between tone perception and production. Casserly and Pisoni (2010) explained that the perception of a speaker's own speech is fundamental in the planning and execution of intended speech. This implies that investigating both production and perception in a clinical population opens an avenue for a better understanding of the relationship between the perception and production

of tones. Packard (1985) established an association between lexical tone production and perception whilst other studies have not (Naesar & Chan, 1980; Gandour & Dardarananda, 1983; Sidtis & Van Lancker, 2003).

### 1.5.2 Lexical tone production in aphasia

All aphasiological investigations on tonal languages have been about lexical tones. The consensus in studies examining lexical tone production in brain-damaged individuals is that the left hemisphere (LH) is more induced in tone processing than the right hemisphere (RH). Brain damage in the left hemisphere has been found to cause tone production problems (Naesar & Chan, 1980; Packard, 1986; Ryalls & Reinvang, 1986; Gandour et al., 1988; Gandour et al., 1992). Gandour et al. (1992) examined stroke patients in the acute stage of aphasia and observed tone production deficits. Prior to this, Gandour (1988) reported tone production deficiencies in six Thai speakers with aphasia tested after the acute stage. They concluded that tone production problems in individuals with aphasia are manifest only in the acute stage. It is worth noting that results in tone production studies across aphasic individuals are inconsistent.

Most lesion studies have found tone production in RHD patients to be relatively spared. However, Moen and Sundet (1996) examined a RHD patient who performed at chance level in a lexical tone production test. Unfortunately, there was no explanation as to what might be going on with the patient. Instead, they concluded that the production of lexical tone was near normal in the RHD patients based on the intact participants.

In tone production studies, a concern has been whether certain tones are more difficult to produce than others. Gandour, et al. (1992) reported that dynamic tones (e.g., rising and falling tones) were more easily impaired than static tones (e.g., high, mid and low tones). However, this finding is yet to be replicated. The production of grammatical tones has not been explored in brain-damaged individuals. This is partly because most of the tone languages studied do not have the grammatical tone feature. Interestingly, the Akan language makes both lexical and grammatical tonal distinctions.

As already discussed in the previous section, tone is crucial for the distinction between a resumptive pronoun and a clause determiner in Akan, even though both are represented orthographically as *no*. The current work examines the production and comprehension of the tone on the *no* morpheme (on RPs and CDs) in Akan focus constructions. This is also the first time tone becomes a variable to consider in the investigation of pronominal resolution. We

want to better understand the effect of the grammatical tone on resumptive pronouns and clause determiners in the processing of resumption. In the following section, we look at how agrammatic speakers process pronominal forms.

### 1.6 Interpretation of pronominal forms in agrammatic speakers

In addition to syntactic movement, individuals with agrammatism show difficulty processing pronouns, more specifically, discourse-linked pronouns, whereas bound pronouns such as reflexives are relatively spared (Grodzinsky, et al., 1993; Love, et, 1998; Edwards & Varlokosta, 2007). Grodzinsky et al., (1993) examined agrammatic comprehension of binding relations using a yes/no judgment paradigm. As a group, the agrammatic speakers performed worse on sentences containing an object pronoun (38a) than on sentences with a reflexive (38b). Other studies (Love et al., 1998; Edwards & Varlokosta, 2007) have made similar observations.

38. a. Is Mama Bear touching her?

    b. Is Mama Bear touching herself?

The Government and Binding Theory (Chomsky, 1981) has been adopted to explain observations in individuals with agrammatism on pronominal resolution. The theory with its two structural principles, Principle A and Principle B, regulate the interpretation of reflexives and personal pronouns. Principle A states that reflexives must be locally bound and Principle B specifies that pronouns must not be locally bound. Chomsky (1981) frames the two binding principles as:

**Principle A**: An anaphor is bound in its governing domain

**Principle B**: A pronominal is free in its governing domain

In linguistics, binding is determined by c-command and co-indexation. Syntactically and for the purpose of the current work, the government category is defined as the domain with the anaphor, its governor and a subject. In 39 we show classic instances of anaphora.

39. a. $_{IP}$[Philip$_i$ hopes that $_{IP}$[Martin$_j$ likes him$_i$]]

    b. $_{IP}$[Philip$_j$ hopes that $_{IP}$[Martin$_i$ likes himself$_i$]]

According to Chomsky, *him* in (39a) cannot be bound to *Martin* in the lower IP. The pronoun *him* is bound to *Philip* because *Philip* is not in the same governing domain as "*him*". In (39b),

*himself* is bound to *Martin* and not *Philip* because reflexives are supposed to be bound to noun phrases within their local governing domain. Chomsky (1981, 1986) also mentions that personal pronouns regardless of their antecedent, should be categorized under Principle B. Hence, Principle B introduces limitations on personal pronoun interpretations.

Reinhart (1983; 1986) argued that different modules govern coreferencing and binding. In Reinhart's further explanation of this claim, she indicates that personal pronouns are classified strictly under Principle B in connection to their bound variable interpretation, which is different from their coreferential reading. According to Grodzinsky and Reinhart (1993), coreference relations are restricted by a pragmatic principle formulated as 'Rule 1'. This principle is linked to intrasentential coreferencing.

Rule 1:

NP $\alpha$ cannot corefer with NP $\beta$ if replacing it with $y$, $y$ a variable A-bound by β yields an indistinguishable interpretation.

In other words, intrasentential coreferencing with a c-commanded antecedent can only occur when it gives an interpretation distinct from the bound variable reading.

Personal pronoun interpretation has been found to be difficult for agrammatic speakers. The Delayed Principle B Effect (DPBE: Chien & Wexler, 1990; Avrutin & Wexler, 1992) was found in young children who had difficulties processing intrasentential coreferencing. Grodzinsky and Reinhart (1993) asserted that the DPBE in relation to pronouns with their referential antecedents, such as in (39a), is difficult for young children to process because of their inability to execute Rule 1. This assertion is also made by Grodzinsky et al. (1993) for agrammatic speakers' deficiency in processing coreferential personal pronouns. In their observations, Grodzinsky et al. (1993) indicated that, by applying Rule 1, a listener is expected to hold two structural representations in memory at the same time. One of the held representations is an interpretation of the pronoun as a reflexive (bound variable) and the other as a non-reflexive (coreferential). Thus, agrammatic speakers are unable to hold both representations for long in their memory, due to limitations in their working memory capacity. Speakers with agrammatism then employ a guessing strategy in processing coreferential structures (between the pronoun and its antecedent), resulting in chance level performance.

Resumptive pronouns are another class of pronouns but these have been understudied in agrammatic speech. Friedmann et al., (2008) assessed Hebrew speaking children with hearing

impairments and found that the presence of resumptive pronouns served as a compensatory strategy in the production of object relative clauses. Friedmann (2008) further investigated the effect of the resumptive pronouns in the comprehension of object relative clauses in Hebrew speakers with agrammatism in a sentence-picture-matching task. Friendmann (2008) reported that the presence of the resumptive pronoun did not enhance performance on comprehension. The distribution of resumptive pronouns varies across languages. Akan presents the opportunity to investigate other forms of resumption in agrammatic speakers. The questions that arise then are, whether Friedmann's (2008) results can be replicated in Akan and whether similar observations will be made in a production study?

### 1.7 Summary of neurolinguistic approach to agrammatism

1. Sentence comprehension and production in agrammatism:
- Studies have shown that the processing of structures like passives, relative clauses and clefts is difficult for agrammatic speakers because of their complexity.
- There are mixed results for agrammatic comprehension of *wh*-questions even though the general observation is that *who*-questions are easier to comprehend that *what*-NP.
- Different theories have been proposed to account for the deficits in agrammatic comprehension. Among the influential ones are; the Derived Order Problem Hypothesis, the Trace Deletion Hypothesis Discourse Linking Hypothesis, and the Complexity Limitation Hypothesis.
- Generally, sentence production is known to be more problematic for agrammatic speakers than sentence comprehension. Like comprehension studies, there are conflicting results on *wh*-questions production.
- Some of the theories propounded to explain production deficits; the Tree Pruning Hypothesis and the Derived Order Problem Hypothesis

2. Tone perception and production in agrammatism
- The main focus of tone perception and production studies in agrammatic speakers has mainly been about lexical tones. Grammatical tone is yet to be investigated.
- Cross-linguistic studies on lexical production show that left hemisphere damaged individuals have problems comprehending and producing lexical tones

3. Pronominal resolution in agrammatism.
- The processing of reflexives is relatively spared compared to personal pronouns.

- Chomsky's binding theory has been adopted to explain impairment on pronominal resolution. Personal pronouns are relatively impaired because agrammatic individuals are unable to construct binding chains between the pronoun and its antecedent.
- Resumption has been understudied in agrammatism. Fridmann (2008) investigated Hebrew agrammatic speakers and indicated that resumptive pronouns made no difference in sentence comprehension. Will similar observations be made in Akan? We still do not know the effect of resumption on sentence production in agrammatism.

The methodology most often adopted to investigate pronominal resolution in agrammatism has been through offline testing. All studies discussed in the previous paragraphs employed offline techniques. In the current work, we use electroencephalography (EEG) to investigate pronoun resolution in Akan. EEG offers a good temporal resolution to help us understand the processing of Akan pronominal resumption. The next section gives an overview of previous studies that employed EEG to investigate filler-gap dependencies and pronominal resolution in the brain.

**1.8 EEG studies on pronominal resolution**

Electrical brain activities can be recorded when electrodes are placed on an individual's scalp. Event-related potentials (ERPs) are obtained when a participant in an experiment is presented with stimuli and the recording of their electrical brain activity is time-locked to the stimulus. Researchers have employed ERPs in the study of language for decades. Kutas and Hillyard (1980) made a major discovery of a semantic processing component, termed "N400". For this, they compared semantically plausible sentences (40a) and semantically anomalous sentences (40b).

40. a. He spread the warm bread with butter

    b. He spread the warm bread with socks Kutas and Hillyard (1980)

They reported a negative deflection peaking 400 ms, after the semantically anomalous word in the sentence was presented, in the centro-parietal brain areas. Other language-related components, besides the N400, have also been identified: the left anterior negativity (LAN) and the P600. Linguistically, the two components are related to morphosyntax and are often elicited by morphosyntactic violations (Friederici, et al., 1993; Molinaro et al., 2011). The

LAN usually peaks 300-500 ms post-stimulus onset and is known to be a response to morphosyntactic violation (Hahne & Friederici, 1999; Gunter et al., 2000). The LAN is often elicited in the left anterior scalp regions (Neville, et al., 1991), although other studies have reported a bilateral activation (Hahne & Jescheniak, 2001; Hahne & Friederici, 2002). The P600 component is believed to reflect the repair and processes involving reanalysis or structural integration (Friederici, et al., 2002; Gouvea, et al., 2010). In recent times, some researchers have argued that the mapping of the N400 and the P600 to semantic and morphosyntactic violations respectively, is an oversimplification. Brouwer et al. (2012) argued the N400 is not restricted to semantic features but also serves as a representation for the retrieval of both semantic and syntactic features from the long term working memory. For the P600, some scholars suggest that it is sensitive to the tension between what is expected and what is actually perceived (Kolk & Chwilla, 2007; Vissers, et al., 2008). In other words, if the disparity between what is expected and what is perceived is mild, the N400 is elicited but if the disparity between the two is high, the P600 is elicited. This is because the P600 is expected to initiate a reanalysis process to check for the possible errors perceived (Vissers, et al., 2008).

ERP components have been used in various language studies, investigating concepts like filler-gap dependencies, pronominal resolution and tone processing. The processing of filler-gap dependencies has been associated with the LAN (Müller et al., 1997; Kluender & Münte, 1998). There have been studies on English and German (both *wh*-movement languages), examining *wh*-questions (Kluender & Kutas, 1993a,b; McKinnon & Osterhout, 1996; Müller et al., 1997; Kluender & Münte, 1998; Kaan et al., 2000; Fiebach et al., 2001, 2002; Felser et al., 2003; Phillips et al., 2005). For instance, King and Kutas (1995a) examined English relative clause sentences and found a negative slow wave between the filler and the gap. They also observed a phasic LAN effect after the gap. The P600 component was also found in Kaan, et al. (2000) at the pre-gap position of *wh*-questions.

A number of ERP studies have investigated tone processing (Hruska, et al., 2001; Johnson, et al., 2003; Magne, et al., 2005). Hruska et al. (2001) investigated the correlation between information systems and pitch in German. They presented spoken sentences to participants and asked focus questions about a noun or a verb in the target sentences. They found that focused words in the target sentences that lacked pitch accent elicited a negative peak, within 200-400 ms after the onset of the focused word. Later, Johnson, et al. (2003), also examined the mapping between information system and pitch in English. Focused words in the

Johnson, et al. (2003) study elicited early negativity but the presence of superfluous pitch accent on given information elicited no ERP response.

**1.9 Back to Focus Construction in Akan**

As already indicated, focus constructions in Akan are used in both questions (41a) and declaratives (42). For questions, if the *wh*-word is not *in situ* (41b), then it is focused marked in the clause-initial position (41a).

41. a. **Hena na** o-pia John?

Who FOC (s)he.PROG.push John Subject-focused *who*-Question

'Who is pushing John?'

b. John e-pia **hena**?

John PROG-push who Object *who*-Question (*in situ*)

'Who is John pushing/ John is pushing who?'

42. John na o-pia papa no

John FOC (s)he.PROG. push man the

'It is John that is pushing the man' Subject-focused declarative

We also discussed controversies among theoretical linguists, the source of resumptive pronouns. Some argue that resumptive pronouns are base generated, while others say they are derived. However, the claims of base-generation (Saah 1994) and derivation (Korsah, 2017) do not properly analyze the distribution of resumptive pronouns and clause determiners in Akan focus constructions. A clause determiner can co-occur with a resumptive pronoun. The clause determiner can also be realized without the resumptive pronoun and vice versa. In addition, the gap filled with the RP and/or CD can also be left phonetically empty. See example below:

43. a. John na papa no epia **(nò) (nó)**

John FOC man the PROG.push (RP) (CD)

'It is John that the man is pushing' Object-focused declarative

One other thing that has not been discussed in the literature on Akan resumptive pronouns and clause determiners is the tone on these words (RP and CD). In a focus construction like (43), the tone on the resumptive pronoun is low and the tone on the clause determiner is high. This is a relevant aspect of the analysis of resumption in Akan that has been ignored. For neurolinguistic research, there has not been any study assessing tone as a variable for resumption yet.

In the present project, we employ neurolinguistic research methods to investigate resumption in Akan focus constructions. We adopt behavioral and neuroimaging approaches to examine the processing of resumption in Akan agrammatic speakers and non-brain-damaged individuals. However, an understanding of how Akan focus structures are formed is fundamental to the current project. We explored derivation in Akan focus structures, examining *wh*-questions. The next section provides details of a pilot study conducted to answer this question. Once the question of derivation in Akan focus structures has been addressed, we will proceed to investigate the issues around the processing of resumption in Akan agrammatic speakers.

### 1.9.1 Pilot Study

In the pilot study (Lartey, 2016), we investigated Akan *wh*-questions and reported on the derivation of *wh*-words in Akan. This was necessary to ascertain how filler-gap dependencies in Akan were processed by Akan native speakers with agrammatism.

There were 2 participant groups, 3 individuals with neurological damage and a non-brain-damaged (NBD) group of 5 participants. The individuals with neurological damage suffered from agrammatic aphasia. The aphasia group consisted of 1 male and 2 females with a mean age of 57.3 (range: 53-60). The NBD group consisted of 3 females and 2 males with a mean age of 49.6 (range: 39-57). Participants with neurological damage were recruited from a group of stroke patients, undergoing treatment at the Stroke Unit of the Korle Bu Teaching Hospital in Accra (Ghana). They were all right-handed and had no problems with vision, hearing or any psychological disease. All patients reported to have suffered from a single stroke and right side paralysis clearly manifested, that is, hemiplegia was present among all patients. The time post-onset of stroke ranged from 8 to 17 months. All participants were native Akan speakers, who used Akan as their primary language since birth. All participants signed informed consent forms before testing began.

The study was meant to address the debate between Akan linguists on whether focused *wh*-words in Akan *wh*-questions are derived or not. Also, knowledge on how focus constructions were formed would provide a strong theoretical foundation for further studies on Akan filler-gap dependencies. We administered a picture-pointing task on 3 Akan agrammatic speakers; testing *who*- and *what*-questions (see Table 1.3 below)

Table 1.3 Experimental conditions with examples

| Conditions | Word order | Sentences |
|---|---|---|
| A. Subject *who*-question (Baseline) | Base | **Hena** na o-pia papa no?<br>Who FOC he/she-PROG-push man the<br>Who is pushing the man? |
| B. Object *who*-question (*wh*-word in situ) | Base | Maame no e- pia **hena**?<br>Woman DET PROG-push who?<br>The woman is pushing who/who is the woman pushing? |
| C. Object *who*-question (with a resumptive pronoun) | Derived | **Hena** na maame no e-pia **no**?<br>Who FOC woman DET PROG-push him/her<br>Who is the woman pushing? |
| D. Object *what*-question (No resumptive pronoun) | Derived | **Dɛn** na papa no e-pia _?<br>What FOC man DET PROG-push<br>What is the man pushing? |

The subject *who*-condition was the only condition we could confidently say was in a canonical order because there is no controversy on its derivation. However, Akan linguists do not agree on how question types C and D are derived. There are different schools of thought on the derivation of object *who*-questions (C) in Akan and the source or origin of resumptive pronouns.

From the table, we see that there was a question with the question word in situ (B). There was another one with the question word in the sentence-initial position and a resumptive pronoun at the clause-final position (C). We also used a question (D), where the question word is at the clause-initial position with no resumptive pronoun at the clause-final position.

We assessed different question types to test the DOP-H (Bastiaanse & Van Zonneveld, 2005). Our prediction for the pilot study was: if *wh*-words in Akan questions are not syntactically derived then the comprehension of all question types (A-D) is expected to be relatively spared in agrammatic speakers. This prediction is in line with the arguments of Saah (1994) for *no movement*. However, if focused object *wh*-words in Akan are derived, then agrammatic speakers are expected to perform worse on (C) and (D) than on (A) and (B). This is also in line with the argument for *movement* (Korsah 2017; Boadi 2005). See Table 1.4 for the mean accuracy score of patients.

Table 1.4 Performance on Target Conditions Based on Derivation.

| **Agrammatic Speakers** | Target Questions (_/10) | | | |
|---|---|---|---|---|
| | Subject Question | Object Question *In situ* | Object Question With Resumptive Pronoun | Object Question Without Resumptive Pronoun |
| **A1** | 9 | 10 | 3 | 5 |
| **A2** | 10 | 9 | 3 | 6 |
| **A3** | 10 | 8 | 4 | 5 |
| **Average** | **9.7** | **9** | **3.3** | **5.3** |

Our results showed that questions in the base order were less problematic than those in derived order (see Table 1.5). We found the performance of the agrammatic individuals on the object *who*-question with the resumptive pronoun was the worst.

Table 1.5 Average performance on target conditions based on word-order in percentages.

| Word order | Base order | | Derived order |
|---|---|---|---|
| Target Conditions | Subj. Q | Obj.Q. *In situ* | Obj.Q. without Res.Pro. |
| Mean accuracy (%) | **93.3** | | **43.3** |

Subj. Q.; Subject Question; Obj.Q. *In situ*; Object Question with wh-word in situ; Obj. Q. with Res.Pro.; Object Question with Resumptive Pronoun clause-final; Obj. Q. without Res. Pro.; Object Question with Resumptive Pronoun clause-final.

It was not clear from the results why the agrammatic individuals performed worst on the condition with the resumptive pronoun at the clause-final position. The explanation we gave was that the insertion of the resumptive pronoun after the *wh*-word was derived increased the cognitive demands for processing, hence, the impairment observed. Researchers who argue resumption as a saving strategy would disagree with our claim because they assert that resumptive pronouns should rather aid comprehension and not worsen it.

In our analysis, we did not consider variables like;

i) The possibility of a clause determiner instead of a resumptive pronoun in the gap
ii) The possibility of the resumptive pronoun and the clause determiner co-occurring in the gap
iii) The possibility of the gap not realized phonetically.
iv) The different tones on the RP and the CD in focus structures and how that can influence comprehension in relation to their distribution.

### 1.9.2 Focus of the current project

In the current project, we address the above-highlighted issues from the pilot study. We explore the concepts; derivation, filler-gap dependencies, and resumption in Akan focus structures, testing native speakers with agrammatism. We also employ electroencephalogram (EEG) to further examine the role of tone and animacy in the processing of resumption in Akan focus construction. See the main research questions below:

1. How do Akan speakers with agrammatism comprehend and produce Akan focus constructions;

a) With only a resumptive pronoun
b) With only a clause determiner
c) With both a resumptive pronoun and a clause determiner
d) With the gap left empty

2. Which neurolinguistic account(s) explain(s) the processing of focus constructions in Akan best?
3. Are native Akan speakers sensitive to the tonal differences between RPs and CDs in focus constructions?
4. How can ERPs help us better understand the effect of tone and animacy on resumption in Akan?

So far the neurolinguistic data from the pilot study have established that topicalized elements in Akan focus constructions undergo syntactic derivation. We will answer the above research questions with two behavioral studies on agrammatism and one neuroimaging study, using event-related potentials.

In chapters 2 and 3, the comprehension and production of the resumption phenomenon are investigated respectively. Akan agrammatic speakers are examined on the four resumption variations and their performance assessed in relation to neurolinguistic theories.

The phonological and animacy aspects of resumption in Akan are explored in Chapter 4. We seek to better understand the processing of pronominal resumption using ERP components. The scalp recordings collected are analyzed in relation to the phonological and animacy violations tested.

So, we will first present a comprehension study, followed by a production study and lastly an ERP study. Finally, the results of all studies will be discussed (in Chapter 5) in light of the research questions above.

# CHAPTER 2

# Comprehension of Pronominal Resolution and Resumption in Akan Speakers with Agrammatism

# Comprehension of Pronominal Resolution and Resumption in Akan Speakers with Agrammatism

**Abstract**

Results on pronominal resolution in agrammatism have been conflicting. This is because the distribution of pronouns varies cross-linguistically. The current work investigates an understudied pronominal resolution mechanism termed *resumption* in Akan focus constructions (*who*-questions and focused declaratives). Akan adds two dimensions to the study of resumption in agrammatism. First, there are four structural variations of resumption realization. Second, grammatical tone is used to define the four variations. The goal of the current study is to investigate how Akan speakers with agrammatism comprehend the four structural variations of resumption. The predictions of neurolinguistics theories were examined in relation to our observations. Also, we aimed to assess the effect of grammatical tone on performance. We tested seven Akan speakers with agrammatism, administering picture-pointing tasks. Our results indicate that the four variations of resumption were unevenly comprehended in *who*-questions but not in focused declaratives. We take this to imply that, grammatical tone makes a difference in the processing of resumption in *who*-questions but not in focused declaratives. Amongst the neurolinguistic theories of interest to the current work, the DOP-H gives a holistic account of what is observed in both who-questions and focused declaratives.

## 2.1 Introduction

Linguistic and cognitive deficits may be caused by damage to different parts of the brain. Brain damage to the left hemisphere accounts for varying patterns of language deficits. Aphasia is the term for the condition where an individual's language is affected as a result of acquired focal brain damage. Aphasia has different manifestations; Broca's aphasia, Wernicke's aphasia, transcortical aphasia, conduction aphasia, global aphasia and so forth (Goodglass & Kaplan, 1972; Obler & Gjerlow, 1999). However, individuals with aphasia are broadly categorized into fluent and nonfluent speakers. The current study will focus on the nonfluent speakers, also referred to as 'agrammatic speakers' henceforth. Agrammatic aphasia is a term used to classify brain-damaged individuals who are unable to speak fluently (Nester et al., 2003). The current work investigates Akan agrammatic individuals. The next section highlights essential features of the Akan language for the study of pronominal resolution and resumption.

### 2.1.1 Relevant features of Akan for current work

Akan is a Kwa language of the Niger-Congo phylum and is a dominant language in Ghana. Akan is spoken by about 18 million Ghanaians and 4 million Ivorians but is predominantly spoken in the south of Ghana. The educational policy in Ghana allows the use of a native language as a medium of instruction and communication until the 3rd Grade (Mfum-Mensah, 2005). Children from the south of Ghana are expected to read and write in Akan before 4th Grade when English becomes the medium of instruction in schools from thereon.

*Word order and Focus Constructions in Akan*

The base word order of Akan is Subject Verb Object (Saah, 1994). See example below (1):

1. a. [Papa no]$^{Subject}$ [ɛkɔ]$^{Verb}$ [fie]$^{Object}$
   Man the PROG.go home
   'The man is going home'

Any constituent in an Akan sentence can be focused (2). Semantically, focused and unfocused structures essentially convey the same message. Akan has two focus markers, *na* and *deɛ*. The element being focused is realized before the focus marker at the sentence-initial position. Any other arrangement would make the structure ungrammatical. This applies to both focused declaratives (2) and *wh*-questions (3).

2. a. Me piaa **papa no**
   I push.PST man the
   'I pushed the man' Simple declarative
   b. **Papa no** **na** me piae
   Man the FOC I push.PST
   'It is the man that I pushed' Object-focused declarative
   c. * Papa no me ***na** piae
   Man the I FOC push.PST
   'It is the man that I pushed' Ungrammatical

Object questions are formed either with (3a) or without (3b) fronting of the *wh*-word. Like the focused declarative, when the *wh*-word is fronted, it must be followed by the focus marker *na*. Any other arrangement makes the sentence ungrammatical (3c).

3. a. **Hena** **na** papa no piaa no?
   Who FOC man the push.PST him/her
   'Who did the man push?' Object *who*-question

   b. Papa no piaa **hena**?
   Man the push.PST who
   'Who did the man push?' Object *who*-question (in situ)

   c. * **Na** **hena** papa no piaa no?
   FOC who man the push.PST him/her
   'Who did the man push' Ungrammatical

*Grammatical tone and the morpheme 'no' in Akan*

Akan is a tonal language and has two main tones, high and low, transcribed as [ ´ ] and [ ` ] respectively (Dolphyne, 1988). The tones in Akan make both lexical and grammatical distinctions. The grammatical function of Akan tones is usually realized in the expression of the verb aspect and tense. See Dolphyne (1988) for in-depth assessment of the Akan tonal system and Tsiwah et al. (in press) for time reference and grammatical tone in agrammatic aphasia.

The morpheme *no* in Akan has three realizations. It is orthographically realized as a definite article, a clause determiner (CD)[1] and also as a resumptive pronoun (RP: meaning 'him' or 'her'). Grammatical tones are used to make a distinction between them. When used as a resumptive pronoun, the tone on the vowel is low but when used as a definite article or clause determiner, the tone on the vowel is high (Arkoh & Matthewson, 2013; See 4).

4. Hena na papa **nó** epia **(nò)** **(nó)**?
   Who FOC man the PROG.push RP (him/her) CD
   'Who is the man pushing?'

The resumptive pronoun *nò* in (4) can be replaced with a clause determiner (CD), that only differs in tone from the resumptive pronoun: *nó*. A combination of both is also possible. In

[1] In Akan, a clause determiner is a morpheme used to mark the end of a clause. Semantically, it does not add any extra information to the sentence.

these structural variations, the meaning of the sentence is not affected. It is ungrammatical when the clause determiner is produced before the resumptive pronoun. Notice that neither the resumptive pronoun nor the clause determiner is obligatory.

### 2.1.2 Issues on Pronominal Resumption



In theoretical linguistics, resumption is defined as the derivation of a nominal element in a sentence to construct focus, topic and question structures, which allows a pronoun that corefers to the derived nominal element to fill its original position (McCloskey, 2006; Rouveret, 2002; Salzmann, 2006). For illustrative purposes, see English examples below:

5. a. [Who$_1$ did [ the man push $t_1$]]?
   b. [Who$_1$ [ t$_1$ pushed the man]]?

According to generative grammar (Chomsky, 1986), the original position of the *wh*-word in (5a) is marked *t* (trace) but this is not phonetically produced. Languages like English do not replace the derived element with a pronominal form as seen in (5a). However, languages with the resumption phenomenon, like Akan, Hebrew, and Hausa, fill the trace position with a pronominal form (6), which matches the morpho-syntactic features of the derived element (Saah 1994; McCracken 2013). In the Akan version of example (5a), the resumptive pronoun is represented orthographically as *nò* in (6).

Co-refers

| | | | | | | |
|---|---|---|---|---|---|---|
| 6. | Hena | na | papa | no | pia-a | **nò**? |
| | Who | FOC | man | the | push.PST | him/her (Resumptive Pronoun) |

'who did the man push?'

There is a long-standing debate among theoretical linguists on the origin and source of resumptive pronouns (Chung 1994; Pesetsky 1998; McCloskey 2011; Salzmann 2009; 2011; van Urk 2018; Klein, 2017). Similar controversies are seen among linguists working on Akan (Saah 1994; Boadi 2005; Korsah 2017).

In the current project, we argue that the resumptive pronoun and the clause determiner are not obligatory in Akan, contrary to assertions by Saah (1994). The production or omission of the clause determiner or the resumptive pronoun does not render the sentence ungrammatical. Saah (1994) posits that when the resumptive pronoun is not phonetically produced, it is still covertly represented. One thing Saah (1994) fails to consider in this assertion is the effect of

time reference in resumption. I argue that if the verb is in the present continuous tense, resumption can be omitted (7). However, Saah's claims hold when reference is being made to the past (8).

(7) *Time reference (Present)*

| | | | | | |
|---|---|---|---|---|---|
| a. Hena | na | papa no | **epia** | **nò** | Grammatical |
| Who | FOC | man the | PROG.push | him/her(RP) | |
| 'Who is the man pushing?' | | | | | |
| b. Hena | na | papa no | epia | _ | Grammatical |
| Who | FOC | man the | PROG.push | (empty gap) | |
| 'Who is the man pushing?' | | | | | |

(8) *Time reference (Past)*

| | | | | | |
|---|---|---|---|---|---|
| a. Hena | na | papa no | **piaa** | **nò** | Grammatical |
| Who | FOC | man the | push.PST | him/her (RP) | |
| 'Who did the man push?' | | | | | |
| b. *Hena | na | papa no | **piaa** | _ | Ungrammatical |
| who | FOC | man the | push.PST | (empty gap) | |
| 'who did the man push' | | | | | |

The current work does not seek to extensively investigate this issue but henceforth we argue pronominal resumption in Akan is not obligatory. In Akan, these arguments have implications on whether *wh*-words in *wh*-questions are derived or not and if similar claims can be made for focused declaratives.

Akan has been studied for a comparatively longer time than the other Ghanaian languages. It presents the opportunity to assess the role of tone in the processing of pronominal resolution and resumption. In the present study, we examine syntactic derivation in Akan focus constructions, testing *who*-questions and focused declaratives in Akan speakers with agrammatism. The phenomenon of resumption is understudied in agrammatism. The current work adds a new dimension to the discourse on resumption in the literature. In addition, different neurolinguistic theories are assessed in relation to the observations made in the

current work. The current work gives us a better understanding of resumption effects on sentence processing in agrammatic speakers.

### 2.1.3 Tone perception in agrammatic individuals



In languages like Akan, Chinese, Thai, and Yoruba, tone plays a crucial role in sentence comprehension. Gandour and Dardarananda (1983) investigated the perception of lexical tones in Left Hemisphere Damaged (LHD) Thai-speaking individuals. They found Thai tone perception problematic. The authors also asserted that damage to the language dominant brain area and not just damage to the brain causes tone-perception deficiencies. Huges (1983) reiterates the significance of the left cerebral hemisphere in lexical-tone discrimination. Eng et al. (1996) also investigated Chinese-speaking individuals with Broca's aphasia and observed their inability to identify lexical tones. Although extensive work has been done on the perception of lexical tone in individuals with agrammatism, grammatical tone perception has been understudied. This is partly because most studied languages do not have a grammatical tone feature. The current study explores the processing of grammatical tone on Akan resumption in the constructions of focus structures.

### 2.1.4 Neurolinguistic background on sentence comprehension in agrammatism

Studies investigating sentence comprehension in agrammatism focus on structures involving syntactic derivation, like clefts, passives, and relative clauses in the form of semantically reversible structures. English agrammatic speakers have demonstrated problems comprehending passive sentences (Caplan & Futter, 1986; Sherman & Schweikert 1989; Grodzinsky, 1995). In a meta-analysis by Bendt et al. (1995), semantically reversible and irreversible active voice sentences were found to be less problematic compared to passive voice sentences. Other studies revealed that the comprehension of object-relative clauses and object clefts is also impaired in agrammatic speakers (Hickok et al., 1993; Burchert et al., 2003). In all these studies, the common explanation attributed to the observed deficiencies has been problems with the syntactic transformation from base to derived word order.

In contrast to the large amount of data on the comprehension of declaratives in individuals with agrammatism, *wh*-questions comprehension in the same clinical population has received little attention from researchers. Gallagher and Guilford (1977) highlighted deficits in understanding *wh*-questions in aphasia. The picture becomes less clear for the comprehension of a subject as compared to object *who*-questions. Some studies have failed to show diverging effects (Stavrakaki & Kouvava, 2003; Fyndanis et al., 2010; Cho-Reyes & Thompson, 2012;

Arslan et al., 2017), whilst others have found dissociations (Neuhaus & Penke, 2008; Salis & Edwards, 2008; Kljajevic & Murasugi, 2010; Hanne et al., 2015). Sometimes this is due to methodological issues.

Apart from the difficulties processing sentences with syntactic derivation, individuals with agrammatism show difficulty processing binding constructions, like personal pronouns (Grodzinsky et al., 1993; Love et al., 1998; Rigalleau & Caplan, 2004; Edwards & Varlokosta, 2007). Grodzinsky et al. (1993) examined agrammatic comprehension of binding relations using a grammaticality judgment paradigm in combination with a picture. As a group, the individuals with agrammatism performed worse on sentences containing an object pronoun (9a) than on sentences with a reflexive pronoun (9b) because of binding difficulties.

9. a. Is Mama Bear touching her?

   b. Is Mama Bear touching herself?

Other studies (e.g., Love et al., 1998) have made similar observations. Generally, the Government and Binding Theory (Chomsky, 1981) has been adopted to explain observations in individuals with agrammatism on pronominal resolution.

As mentioned above, certain pronoun types such as resumptive pronouns have been understudied in agrammatism. Friedmann (2008) tested native Hebrew speakers with agrammatism on object relatives, with and without resumptive pronouns, to check if the presence of these forms had a beneficial effect on the grammaticality of items tested. She found that the presence of the resumptive pronoun neither increased nor decrease performance. The agrammatic speakers performed poorly on both structures.

### 2.1.5 Comprehension deficit accounts in agrammatism

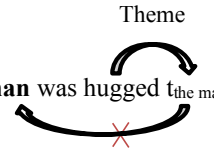
Several theories have been proposed to account for the above-mentioned comprehension deficits in agrammatic aphasia. These theories can be broadly divided into two categories: representational/structural accounts and processing accounts. The structural account proponents (e.g., Grodzinsky, 1986) argue that comprehension deficits in agrammatic speakers are due to a damaged syntactic framework. Proponents of the processing accounts, on the other hand, claim that a comprehension deficit is a disruption in the process of implementing the knowledge of syntax in real-time (Avrutin, 2000; 2006; Bastiaanse & Van Zonneveld, 2006; Burchert et al., 2005; Thompson, 2003). Among the most influential theories proposed are the Trace Deletion Hypothesis (TDH: Grodzinsky, 1986, 2000), the

Derived Order Problem Hypothesis (DOP-H; Bastiaanse & Van Zonneveld, 2005,2006), the Discourse Linking Hypothesis (Hickok & Avrutin, 1996) and the Complexity Limitation Hypothesis (Frazier & Friederici, 1991).

*Trace Deletion Hypothesis*



Grodzinsky originally proposed the Trace Deletion Hypothesis (TDH) in 1986, although it has undergone revisions over the years (Grodzinsky, 1986; 1995; Drai & Grodzinsky, 2006). The TDH is based on the Government and Binding Theory (Chomsky, 1981). According to the TDH, agrammatic speakers' traces of derived items are missing from the syntactic representation of a sentence. This is apparent in passive sentences (10). The TDH predicts a breakdown (10) in the construction of the trace (the man) from the base position.




10. **The man** was hugged $t_{\text{the man}}$ by the boy.

According to the TDH, the verb correctly assigns the agent role to the by-phrase, but since the trace is deleted, the verb cannot assign a theta role to the first NP. In that scenario, the NP gets a thematic role according to its position in the sentence, which in (10) is the agent role. Hence, the agrammatic speaker resorts to a guessing strategy which leads to chance performance. According to the TDH, agrammatic individuals perform at chance on object clefts, object-relative clauses, object questions, and passives.

*Derived Order Problem Hypothesis*

Agrammatic speakers have difficulties comprehending sentences with derived word order. Van der Meulen et al. (2005) investigated *wh*-questions and how the derivation of the *wh*-word in these questions affects comprehension in French speakers with agrammatism. In French, the *wh*-word can be found in situ (11a) or derived position (11b) with no influence on semantics.

11. a. Tu as vu **qui**?
You have seen who
'Who did you see?'

b. **Qui** tu as vu $t_{qui}$
Who you have seen
'Who did you see?'

A comprehension test showed that structures with the *wh*-word in clause-initial position (11b) were more difficult to comprehend for French agrammatic individuals than those with the *wh*-word in situ (11a). According to the movement hypothesis (Van der Meulen et al., 2005), when *wh*-words undergo syntactic derivation, they render *wh*-questions difficult to comprehend.

The movement hypothesis evolved into the Derived Order Problem Hypothesis (DOP-H; Bastiaanse and Van Zonneveld, 2005; 2006). The DOP-H assumes that all languages have a base word order, for example, SVO in English and SOV in Dutch and German. According to the DOP-H, sentences in derived order (e.g., 12b) are more difficult to produce and comprehend for agrammatic individuals than sentences in base order.

12. a. Who $t_{who}$ pushed the man? Basic word order
b. Who did the man push $t_{who}$? Derived word order

The Derived Order Problem Hypothesis (DOP-H) has been extensively tested cross-linguistically (Dutch, Italian, Turkish, English, for example, Bastiaanse, et al., 2003; Bastiaanse & Thompson, 2003; Bastiaanse & Van Zonneveld, 2005, 2006; Yarbay Duman et al., 2007; 2008; 2011). The DOP-H has a broader scope than most neurolinguistic accounts because it is meant to characterize both the comprehension and production deficiencies in speakers with agrammatism.

Just like the TDH, the underlying assumption of the DOP-H is that agrammatic speakers resort to a default strategy (first NP is the agent) when processing structures with derived word order. However, the difference between the TDH and the DOP-H is that the DOP-H does not assume that the individual with agrammatism cannot parse a sentence with derived order. The DOP-H simply posits that agrammatic speakers do not always parse derived-order sentences correctly given that more cognitive resources are required to parse such a sentence. In essence, the higher the cognitive demand, the more errors individuals with agrammatism will make. This relationship implies that the DOP-H predicts more impairment in comprehending (and producing) sentences with derived order than on sentences with arguments in the base order and a further decrease in performance when other complexities

are included (Yarbay Duman et al., 2011). The TDH however, is specific about the performance level: It predicts chance level performance on all structures once the order of arguments is derived because the linguistic framework is broken down.

*Discourse Linking Hypothesis*

The Discourse Linking Hypothesis (Avrutin, 2006) states that questions with discourse-linked (D-linked) elements are more difficult to comprehend by agrammatic individuals than non-Discourse-linked (non-D-linked) questions. This distinction has been investigated in a study by Hickok and Avrutin (1996), where different types of wh-questions (*who*-subject, *who*-object, *which*-subject, and *which*-object questions) were tested.

The results from Hickok and Avrutin (1996) showed that *which*-NP questions (D-linked and referential) were more problematic for the agrammatic speakers than *who*-questions (non-D-linked and non-referential). Hickok and Avrutin (1996) proposed the Differential Chain Deficit Hypothesis which characterizes deficits involving binding chains, with a relatively intact government chain. In this way, the hypothesis predicts comprehension of object *who*-questions to be spared because they are not discourse linked, for which evidence was provided in their paper.

*Complexity Limitation Hypothesis*

In the postulation of the Complexity Limitation Hypothesis, Frazier and Friederici (1991) indicated that there is no problem with the grammar and processors of individuals with agrammatic aphasia. In their estimation, the problem has to do with the lack of computational resources to perform all operations in time. This deficiency is usually seen in complex structures. According to Frazier and Friederici (1991), the complexity depends on the length of the chain (13).

13. a. I see the boy who $t_{who}$ kisses the girl
    b. I see the boy who the girl kisses $t_{who}$.

The complexity limitation hypothesis thus suggests that, if the length of the chain in a sentence is constant with semantics left intact, there is no variation in the outcomes. Empirical evidence from Friedmann and Gvion (2003) suggests that the length of the chain does not affect agrammatic speakers' comprehension.

### 2.1.6 The goal of the current study

So far, we have looked at features of Akan in relation to focus constructions and the role of tone in the different realizations of pronominal resolution and resumption. A neurolinguistic summary was given on sentence comprehension (including lexical tone perception) in agrammatism and the assertions of some accounts highlighted to help us understand the deficits observed in individuals with agrammatism. With the background presented, the questions that arise are:

1. a. How do Akan agrammatic speakers comprehend the different variations of resumption in Akan focus constructions?
   b. What is the effect of tone in the processing of pronominal resolution and resumption in Akan speakers with agrammatism?

2. Which neurolinguistic theories best describe what is observed in Akan agrammatic sentence comprehension?

## 2.2 Methods

*2.2.1 Participants*

The current study involved 2 participant groups, 7 individuals with neurological brain damage and a non-brain-damaged (NBD) group of 10 participants. The individuals with neurological damage suffered from agrammatic aphasia. The aphasia group consisted of 3 males and 4 females, with a mean age of 49.4 (range: 19 - 69). The NBD group consisted of 5 females and 5 males with a mean age of 51.7 (range: 20-73). Participants with neurological damage were recruited from a group of stroke patients, undergoing treatment at the Stroke and Physiotherapy Units and the Speech and Language Therapy Center of the Korle Bu Teaching Hospital in Accra (Ghana). They were all right-handed and had no problems with vision, hearing or any psychological disease. They reported to have suffered from a single stroke and some of them had right-side hemiplegia. The time post-stroke onset ranged from 7 to 25 months. All participants were native speakers of Akan, who used Akan as their primary language since birth. All participants signed informed consent forms before testing began.

Ghana has no standardized tests to diagnose aphasia syndromes. Nonetheless, all the brain-damaged participants in this study had been diagnosed by a Speech and Language Therapist as individuals with agrammatic aphasia, based on their language profile and medical records. In the present study, the presence of agrammatic aphasia was diagnosed based on an analysis

of the participants' spontaneous-speech samples. Menn and Obler (1990) gave the criteria for judging the speech samples as agrammatic. Before the spontaneous speech analysis, we decided to use 230 words for the analysis of each speech sample. We were unable to analyze the speech samples of two agrammatic speakers (P6 and P7) because we could not elicit 230 words from them during the semi-structured interview. However, they were still included in the current study because they had already been diagnosed by speech and language therapists as agrammatic speakers. In the spontaneous speech analysis, the agrammatic speakers showed reduced speech rate, reduced mean-length of utterances, fewer correct sentences, and fewer embedded clauses compared to the NBDs (see Table 2.1).

Table 2.1 Spontaneous speech analysis of IWAs and NBDs

| Participants | Speech rate (wpm) | MLU | Embedding (%) | Grammatical errors (%) |
|---|---|---|---|---|
| IWAs | | | | |
| P1 | 95 | 2.5 | 0 | 23.5 |
| P2 | 34 | 4.5 | 24.3 | 19.5 |
| P3 | 86 | 3.8 | 18.9 | 38.4 |
| P4 | 98 | 4.8 | 13.6 | 22.7 |
| P5 | 66 | 3.55 | 14 | 18.6 |
| P6 | - | - | - | - |
| P7 | - | - | - | - |
| Mean | 75.8 | 3.83 | 14.16 | 24.54 |
| | | | | |
| NBDs (n=10) | | | | |
| Scores (Range) | 120 - 153 | 6.7 - 7.7 | 34 - 38.4 | 0 - 9.4 |
| Mean | 134.2 | 6.9 | 38.82 | 3.9 |

The comprehension abilities of the agrammatic speakers were tested using the subtest on auditory word comprehension of the Boston Diagnostic Aphasia Examination (BDAE:

Goodglass & Kaplan, 1972) adapted to Akan. The scores on the BDAE are given in Table 2.2. Only the verbs, objects and numbers subtests were used in the current work because some of the words in this test were not culturally or linguistically appropriate. All brain-damaged participants showed a good performance in single-word comprehension. The Token Test was used to check the severity of the aphasia (De Renzi & Faglioni, 1978). We specifically adopted the Token Test Perspex, the analogous Akan version of the Multilingual Token Test (Bastiaanse et al., 2016). See Table 2.2 for the demographic data of participants and the scores of the agrammatic speakers on the Token Test. The spontaneous speech data, in combination with the relatively preserved comprehension of single words, supports the diagnosis of agrammatic Broca's aphasia made by speech therapists.

Table 2.2 Demographic data of participants and the scores of the agrammatic speakers on the BDAE auditory word comprehension subtest and the token test.

| Participants | Gender | Age | Handedness | Education (Years) | TPO (months) | Native Lang. | BDAE (_ / 46) | Token Test Score (_/36) |
|---|---|---|---|---|---|---|---|---|
| Patients | | | | | | | | |
| P1 | M | 37 | R | 16 | 7 | Akan | 44 | 23.5 |
| P2 | F | 19 | R | 12 | 7 | Akan | 46 | 7 |
| P3 | M | 69 | R | 13 | 24 | Akan | 42 | 10 |
| P4 | M | 49 | R | 10 | 25 | Akan | 46 | 22.5 |
| P5 | F | 49 | R | 11 | 10 | Akan | 42 | 17.5 |
| P6 | F | 67 | R | 9 | 7 | Akan | 44 | 19.5 |
| P7 | F | 56 | R | 11 | 9 | Akan | 46 | 16 |
| Non-Brain-Damaged | | | | | | | | |
| NBD1 | M | 39 | R | 10 | - | Akan | 46 | - |
| NBD2 | M | 46 | R | 10 | - | Akan | 46 | - |
| NBD3 | M | 57 | R | 12 | - | Akan | 46 | - |
| NBD4 | M | 64 | R | 10 | - | Akan | 46 | - |
| NBD5 | M | 67 | R | 12 | - | Akan | 46 | - |
| NBD6 | F | 20 | R | 6 | - | Akan | 46 | - |
| NBD7 | F | 49 | R | 14 | - | Akan | 46 | - |
| NBD8 | F | 73 | R | 10 | - | Akan | 46 | - |
| NBD9 | F | 50 | R | 10 | - | Akan | 46 | - |
| NBD10 | F | 52 | R | 12 | - | Akan | 46 | - |

As part of the diagnosis, we also administered two tone-discrimination tests. The first was a standardized online Tone Screening Test (Kayser, 2011), originally developed by Wexler et al. (1998). Participants heard two tones and had to indicate whether what they heard was the 'same' or 'different'. We also tested tone discrimination using Akan words. Participants heard two Akan words that were similar in phoneme structure, but different in tone and had

to indicate whether the words they heard were the 'same' or 'different'. Intact tone-discrimination was important to ensure participants had no problems comprehending tones. Table 2.3 shows the scores on the tone screening test and the lexical tone-discrimination test. The scores are above chance, thus suggesting that the perception of linguistic and non-linguistic tones is intact.



Table 2.3 Scores on the tone screening test and lexical tone discrimination test

| Patients | Tone Screening Test Score (_/60) | Lexical Tone Discrimination Test Score (_/ 30) |
|---|---|---|
| P1 | 54 | 29 |
| P2 | 55 | 26 |
| P3 | 59 | 28 |
| P4 | 43 | 26 |
| P5 | 50 | 25 |
| P6 | 51 | 27 |
| P7 | 53 | 28 |
| **Mean** | **52.1** | **27** |

*2.2.2 Materials and Procedures*

A total of 86 pictures (presented on a white background) were taken with a digital camera (IXUS 275 HS, Canon) for the experiment. The pictures were cross-checked by 2 native Akan speakers, who did not take part in the main experiment. They were asked to produce the first verb that came to mind in Akan when the pictures were shown to them (name agreement). There was 100 percent accuracy for all pictures except one picture they both named as 'to hit' but was used in the study as 'to hurt'. They admitted it also demonstrates the verb 'to hurt' and so this picture was maintained.

There were 73 experimental sentences for both *who*-questions and focused declaratives, consisting of 60 targets sentences, and 3 examples (not included in the analysis) before testing began. Out of the 70 target sentences, the baseline condition (subject *who*-questions / subject-focused declarative) consisted of 20 sentences; whilst the 4 other target conditions (object *who*-questions / object-focused declaratives) consisted of 10 sentences per condition. The same verbs were used for all the 6 conditions. See Table 2.4 and Table 2.5 for target conditions with examples for *who*-questions and focused declaratives, respectively.

Table 2.4 Target conditions for the *who*-questions with examples

| Conditions | Word order | Sentences |
|---|---|---|
| Subject *who*-question (Baseline; n=20) | Base | Hena na o-pia papa no?<br>Who FOC he/she-PROG-push man the<br>'Who is pushing the man?' |
| Object *who*-question (with wh-word *in situ* a; n=10) | Base | Papa no epia hena?<br>Man the PROG-push who<br>"Who is the man pushing" |
| Object *who*-question (with only a resumptive pronoun; n=10) | Derived | **Hena** na papa no e-pia **nò** ?<br>Who FOC man DET PROG-push **him/her**<br>'Who is the man pushing' |
| Object *who*-question (with only a Clause determiner; n=10) | Derived | **Hena** na papa no e-pia **nó** ?<br>Who FOC man DET PROG-push **CD**<br>'Who is the man pushing?' |
| Object *who*-question (with both RP & CD; n=10) | Derived | **Hena** na papa no e-pia **nò nó** ?<br>Who FOC man DET PROG-push **RP CD**<br>'Who is the man pushing?' |
| Object *who*-question (No Res. Pro./ No Clause Det; n=10.) | Derived | **Hena** na papa no e-pia _ ?<br>Who FOC man DET PROG-push<br>'Who is the man pushing?' |

Table 2.5 Target conditions for the focused declaratives with examples

| Conditions | Word order | Sentences |
|---|---|---|
| Subject-focused declarative (Baseline; n=20) | Base | Papa no na o-pia maame no<br>Man DET FOC he/she-PROG-push woman DET<br>'The man is the one pushing the woman' |
| Object-focused declarative (with only a resumptive pronoun; n=10) | Derived | Papa no na maame no e-pia **nò**<br>Man DET FOC woman DET PROG-push **him/her**<br>'The man is the one the woman is pushing' |
| Object-focused declarative (with only a Clause determiner; n=10) | Derived | Papa no na maame no e-pia **nó**<br>Man DET FOC woman DET PROG-push **CD**<br>'The man is the one the woman is pushing' |
| Object-focused declarative | Derived | Papa no na maame no e-pia **nò nó**<br>Man DET FOC woman DET PROG-push **RP CD** |

| | | |
|---|---|---|
| (with both RP & CD; n=10) | | 'The man is the one the woman is pushing' |
| Object-focused declarative (No Res. Pro./ No Clause Det. ; n=10) | Derived | Papa no na maame no e-pia _<br>Man DET FOC woman DET PROG-push<br>'The man is the one the woman is pushing' |



The order of the experimental sentences was pseudo-randomized to make sure that no more than two pictures depicting the same action follow each other. In the rare instance where two pictures depicting the same action followed each other, the arrangement of the actors in the picture was switched, making the agent and theme different from the preceding picture.

We conducted a person-pointing task (for *who*-questions) and sentence-picture-matching task (for the declaratives). The instructions of the test were read out to the participant and the practice materials administered to make sure the participant understood what was required in the test. The participants were corrected and given feedback during the practice. No further feedback was given during the main test. There was no limit to the number of times a target sentence could be repeated. The experimenter read aloud the target sentence (like in 14 and 15) to the participant and showed a picture (Figure 2.1) for *who*-questions and 2 pictures for focused declaratives (Figure 2.2). For the *who*-questions, participants were expected to point at either the agent or the theme as an answer to the question readout and for the focused declaratives, they were expected to point to the picture (out of 2 pictures) that matched the sentence the experimenter produced. Each test session lasted between 30 and 40 minutes with breaks.

(14) *Who*-question condition:

| | | | | | |
|---|---|---|---|---|---|
| Hena | na | papa | no | e-twe | nò? |
| Who | FOC | man | the | PROG.pull | RP (him/her) |

'Who is the man pulling?'

Figure 2.1 shows an example of a target picture for the *who*-question conditions.

(15) *Focused declarative condition*:

| Papa no | na | maame no | e-pia | nò |
|---|---|---|---|---|
| Man the | FOC | woman the | PROG-push | RP (him/her) |

'It is the man the woman is pushing'

***Pia*** ('push)

Figure 2.2 shows an example of target pictures for the focused declarative conditions.

**2.2.3 Scoring and data analysis**

For the person-pointing task, responses were recorded as correct when the participants pointed at the correct theme or agent as an answer to the question and incorrect if they did otherwise. In the sentence-picture-matching task, responses were recorded as correct when the participant matched (by pointing) the right picture to the sentence the experimenter produced and incorrect if they did otherwise.

*Analysis*

Generalized linear mixed-effects modeling (GLMM) was performed using the *glmer* function of the *lme4* package (Bates et al., 2015) and the *glht* function of the multcomp package (Hothorn, Bretz, Westfall, Heiberger & Schuetzenmeister, 2013) in R (R Core Team, 2013). The dependent variable was log-linked accuracy (1=correct, 0=incorrect), with fixed effect factor 'Condition' (RP, CD, RP&CD, Empty Gap) and random effect factors for 'Participants' and 'Item'. A model was developed to investigate the differences between conditions in the agrammatic speakers. This model controlled for fixed-effects factors, 'Conditions' and 'Task' (persPointing/picMatching). The model was developed by excluding insignificant parameters from a full model-based on the Awake Information Criterion (AIC) and log likelihood-ratio tests (significance defined as $p<0.05$). This exclusion was also to achieve model convergence.

## 2.3 Results

The 10 non-brain-damaged Akan speakers matched in age, gender and education level performed at ceiling. Therefore, we proceed on the assumption that errors made by the Akan agrammatic speaker are a consequence of their brain damage. See Table 2.6 for the raw scores of the agrammatic group.

Table 2.6 Raw test scores of agrammatic individuals

| | **BASELINE (max=20)** | | **RP (max=10)** | | **CD (max=10)** | | **RP and CD (max=10)** | | **Gap (max=10)** | |
|---|---|---|---|---|---|---|---|---|---|---|
| **IWAs** | Subj. Ques. | Subj. Foc. Decl. | Obj. Ques | Obj. Foc. Decl. | Obj. Ques | Obj. Foc. Decl. | Obj. Ques | Obj. Foc. Decl. | Obj. Ques | Obj. Foc. Decl. |
| **P1** | 19 | 17 | 9 | 5 | 10 | 6 | 9 | 5 | 10 | 5 |
| **P2** | 16 | 17 | 4 | 3 | 6 | 4 | 7 | 3 | 8 | 3 |
| **P3** | 16 | 15 | 9 | 5 | 10 | 6 | 9 | 9 | 10 | 6 |
| **P4** | 15 | 18 | 6 | 5 | 5 | 8 | 2 | 8 | 3 | 6 |
| **P5** | 19 | 20 | 5 | 6 | 6 | 4 | 5 | 6 | 8 | 4 |
| **P6** | 17 | 18 | 3 | 4 | 7 | 6 | 4 | 5 | 7 | 6 |
| **P7** | 18 | 19 | 4 | 3 | 5 | 4 | 5 | 4 | 6 | 5 |
| **Mean** | **17.1** | **17.7** | **5.7** | **4.4** | **7** | **5.4** | **5.8** | **5.7** | **7.4** | **5** |

Subj. Ques.-Subject Question; Subj. Foc. Decl.- Subject Focused Declarative; Obj. Ques.- Object Question; Obj. Foc. Decl.- Object Focused Declarative; RP- Resumptive Pronoun; CD- Clause Determiner.

Figure 2.3 shows a comparison in performance between the NBDs and the agrammatic speakers on *who*-questions.

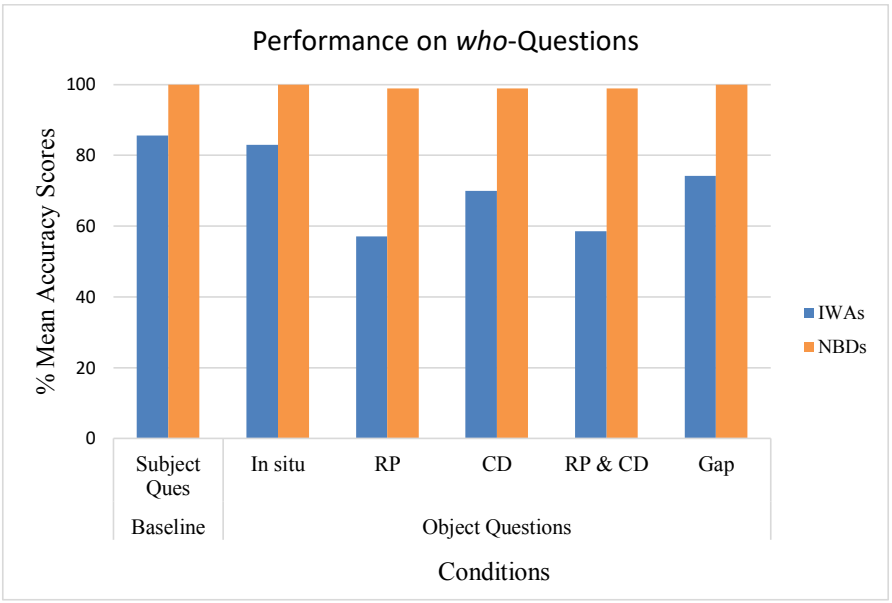



Figure 2.3 shows the percentage mean accuracy score on the baseline (subject *who*-question) and the different resumption variations of the object *who*-questions for the individual with aphasia (IWAs) and the non-brain-damaged participants (NBDs).

A multiple comparison test was conducted to highlight differences between target conditions. The score for the baseline condition (subject *who*-questions) was significantly higher than the object *who*-question with a resumptive pronoun ($Z = 4.28$, SE = 0.36, $p < 0.01$) and the object *who*-question with both the resumptive pronoun and the clause determiner co-occurring ($Z = 4.10$, SE = 0.36, $p < 0.01$). There was no significant difference between the subject *who*-question condition and the object *who*-question with the gap ($Z = 1.95$, SE = 0.38, $p = 0.67$) and the object *who*-question with a clause determiner ($Z = 2.79$, SE = 0.37, $p = 0.15$).

Agrammatic speakers' performance on object-focused declaratives was poor compared to the NBDs. In figure 2.4, we see a graphical presentation of percentage mean-score on focused declaratives for both groups of participants.

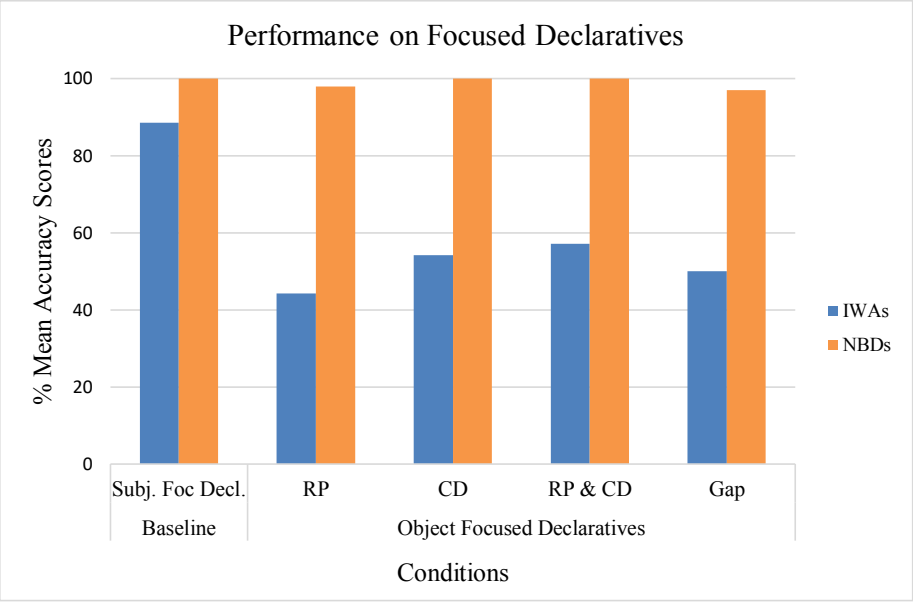



Figure 2.4 shows the percentage mean accuracy score on the baseline (subject-focused declarative) and the different resumption variations of the object-focused declarative conditions for the individuals with aphasia (IWAs) and the non-brain-damaged participants (NBDs).

A multiple comparison test was conducted to reveal differences between the focused declarative conditions. The performance on the baseline condition (subject-focused declarative) was significantly better than on the object-focused declarative with the resumptive pronoun ($Z = 6.29$, SE = 0.38, $p < 0.01$), with a clause determiner ($Z = 5.23$, SE = 038, $p < 0.01$), with both a resumptive pronoun and a clause determiner ($Z = 5.54$, SE = 0.38, $p < 0.01$), and with a gap ($Z = 5.69$, SE = 0.38, $p < 0.01$).

We found no significant difference between the 4 types of object-focused declaratives. There was also no difference in performance between 4 types the object *who*-questions. It is worth noting that for both *who*-question and focused declaratives, there was no effect of task (person-pointing and sentence-picture-matching; $Z = 0.04$, SE = 0.29, $p = 0.96$). Performance on object *who*-questions was not significantly different from object focused declaratives ($Z = 1.71$, SE = 0.46, $p = 0.086$). Overall, base-order structures were significantly easier to comprehend than derived- order structures ($Z = 4.86$, SE = 0.31, $p < 0.001$).

## 2.4 Discussion

The present study aimed to investigate how Akan speakers with agrammatism process the different variations of pronominal resolution and resumption in Akan focus constructions (*who*-questions and focused declaratives). Our goal was also to determine which neurolinguistic theories best explain our observations. We examined the comprehension of four syntactic variations of pronominal resolution and resumption in object-focused declaratives and object *who*-questions. In our target conditions, there were structures with only a resumptive pronoun or only a clause determiner and others with both a resumptive pronoun and a clause determiner at the sentence-final position. We also tested structures with a gap clause-final. These structural variants essentially carried the same meaning. In essence, filling the trace position with an RP did not help the agrammatic individuals to comprehend the sentences in derived order.

### 2.4.1 Comprehension of *who*-questions and focused declaratives and the variants of resumption

In both *who*-questions and focused declaratives, agrammatic speakers' performance on base order structures was significantly better than the derived order structures. There was a deficiency in the comprehension of the object *who*-questions with only a resumptive pronoun in clause-final position and the object *who*-questions with both the resumptive pronoun and the clause determiner co-occurring clause finally, when compared to subject *who*-questions (baseline condition). There was no significant difference in performance between the subject *who*-questions (baseline) and the object *who*-questions with only the clause determiner and the object *who*-question condition with the gap. For the focused declaratives, the agrammatic speakers found comprehension of object-focused declaratives problematic. Just like the object *who*-questions, there was no significant difference in performance among the object focused declaratives. This result is similar to the findings of Friedmann (2008). The agrammatic individuals did not show any difference in performance between the structural variations of resumption for the object *who*-questions and the focused declaratives. In essence, variations in resumption made no difference. However, in the current study, unlike Friedmann's, object *who*-questions with just a clause determiner and those with an empty gap were better comprehended compared to *who*-questions with only a resumptive pronoun and those with both a resumptive pronoun and a clause determiner.

### 2.4.2 The effect of grammatical tone

In Akan, tone is crucial for the distinction between a resumptive pronouns *nò* and a clause determiner *nó* in focus constructions. We observed the influence of tone in the object *who*-questions, but not for the object-focused declaratives. Unlike Gandour and Dardarananda (1983), where agrammatic speakers found the perception of Thai (lexical) tone problematic, the agrammatic speakers we tested did not have (linguistic or non-linguistic) tone-perception problems because this was one of the exclusion criteria. As argued earlier, deficits in the comprehension of object *who*-questions with just a resumptive pronoun required extra processing load to parse. First, the *wh*-word is derived and then because the tone on the morpheme '*no*' is low, the participant has to parse it as a resumptive pronoun to establish a co-reference relationship with the derived *wh*-word. This mechanism also holds when the resumptive pronoun and the clause determiner co-occurs. Agrammatic speakers found this mechanism difficult, hence, the observed deficiency. Performance on the object *who*-question with only a clause determiner was relatively high because once the agrammatic speaker realized the '*no*' had a high tone, there was no need for co-referencing. This depicts the effect of grammatical tone on the processing of pronominal resolution and resumption in Akan object *who*-question among agrammatic speakers.

### 2.4.3 The neurolinguistic theories

Several theories have been propounded to account for comprehension problems in agrammatism, especially problems related to word order. The *Trace Deletion Hypothesis* (Grodzinsky, 2000) predicts an impairment in all object *who*-questions and object-focused declaratives. This prediction is because of a breakdown in the assignment of a correct theta role to the first NP when it is not in its original position. This assertion explains our observations on the object focused declaratives. However, the theory fails to give reasons why some object *who*-questions were spared even though those structures undergo syntactic derivations as described by the TDH. Our results are consistent with Cho-Reyes and Thompson (2012) and Fyndanis et al. (2010).

Frazier and Friederici's (1991) *Complexity Limitation Hypothesis* associate comprehension impairments in agrammatism to the lack of computational resources to perform all operations in time. They further describe complexity as a result of an increased length of chains, that is, the longer the distance between a moved element and its gap the more problematic the sentence becomes and vice versa. In the present study, the distance between a moved element

and its gap in both the *who*-questions and focused declaratives was the same. However, there were variations in performance. Frazier and Friederici's (1991) hypothesis explains the performance of the agrammatic speakers on the object-focused declaratives. The theory falls short once the same logic is applied to our observations on the object *who*-questions because even though the distance between the moved element and its gap remained constant there were variations in performance. This seems to indicate that the length of the chains does not fully account for the difficulties observed, as argued by Friedmann & Gvion, (2003).

According to Hickok and Avrutin's (1996) *Discourse Linking Hypothesis*, difficulty in the comprehension of interrogatives is linked to whether the question structure is discourse linked or not. They argue that *which*-questions are discourse-linked and therefore difficult for agrammatic speakers to comprehend. However, *who*-questions are not discourse-linked and should be relatively spared. The data of the present study do not entirely support this claim because some object *who*-questions were impaired whiles others were spared.

Bastiaanse and Van Zonneveld (2005; 2006) made an overarching proposal to account for comprehension deficits in agrammatism. The *Derived Order Problem Hypothesis* (DOP-H) posits that sentences in derived word order are difficult for agrammatic speakers to comprehend. Just like the TDH, the DOP-H argues that speakers with agrammatism resort to a default strategy, where the first NP is the agent when processing structures with derived word order. However, Bastiaanse and Van Zonneveld (2005; 2006) presuppose that 'derivation' is not restricted to syntactic movement, co-referencing, binding, resumption or any other syntactic phenomenon. Yarbay Duman's (2011) addition to the DOP-H indicates that the more syntactic operations are added to a derived word order structure, the more difficult it becomes for individuals with agrammatism to comprehend. This is what seems to happen in Akan object-questions. We observed that object *who*-questions with only a resumptive pronoun and those with both a resumptive pronoun and a clause determiner in clause-final position were impaired compared to the subject *who*-questions. In the condition with just the resumptive pronoun, not only is the *wh*-word displaced but a resumptive pronoun is inserted in the gap, which co-refers to the derived *wh*-word. The condition with both the resumptive pronoun and clause determiner co-occurring has a similar formation mechanism as the structure with only the resumptive pronoun, but this time a clause determiner is inserted. This addition makes the sentence more complex, which, in essence, means that in object *who*-questions, the deficit was due to the extra complexity entail the additional syntactic operations. In the two other object *who*-question conditions, where the

clause-final position is filled with only a clause determiner in one instance and left empty in the other, we argue that fewer syntactic operations are required. This is because the clause determiner is not processed as a resumptive pronoun and does not add anything semantically to the overall meaning of the sentence. In addition, the clause determiner has no binding relationship with the first NP, unlike the resumptive pronoun. This explanation accounts for the reduced cognitive resources required for processing structures with clause determiners compared to those with the resumptive pronoun. The explanation for the condition with the gap follows the same rationale.

For the object-focused declaratives, there was no difference between the object-focused declaratives. We argue according to the DOP-H that the object-focused declaratives generally involved more syntactic operations than the subject-focused declaratives, hence the deficit observed. Our word order analysis also indicates that base word order structures are easier to comprehend than those in derived order. So far, the DOP-H gives a holistic neurolinguistic explanation to the current study's observations, if the addition made by Yarbay Duman is considered: derived word order is difficult and becomes more difficult when it entails more syntactic transformation processes (such as non-base case in Turkish and resumptive pronoun in Akan that requires establishing a binding relation).

There are still ongoing debates among theoretical linguists about the origin and purpose of the resumptive pronoun (Chung 1994; Pesetsky 1998; Salzmann, 2009, 2011; McCloskey, 2011; van Urk 2018; Klein, 2017). Our data suggest that resumptive pronouns in Akan are not base-generated as argued by some theoretical linguists (Boadi 2005; Korsah 2017). The arguments for base-generation (e.g., Saah 1994) are problematic because they assume that Akan *wh*-words are not derived but the deficits our agrammatic speakers indicate that there were other syntactic mechanisms apart from co-referencing (ie. *wh*-word derivation). This would account for the pattern of deficiencies recorded on the object *who*-questions. Our agrammatic data may be used to shed light on this debate.

The present results open the avenue for future cross-linguistic work on the phenomenon of pronominal resumption in agrammatism. The underlying cause of the deficits we observe is associated with word order processing difficulties. In Akan agrammatic speakers, the presence of a resumptive pronoun worsens performance on *who*-questions. The present work could not extensively assess all aspects of resumption in Akan. The effect of time reference in resumption formation should be investigated in future studies. This will broaden our

understanding of the effect of grammatical tones in the processing of Akan focus constructions.

# CHAPTER 3

# Resumption in the Production of Focused Constructions in Akan Speakers with Agrammatism

# Resumption in the Production of Focused Constructions in Akan Speakers with Agrammatism

**Abstract**

The distribution of pronouns varies cross-linguistically. This distribution has led to conflicting results in studies that investigated pronoun resolution in agrammatic individuals. In the investigation of pronominal resolution, the linguistic phenomenon of 'resumption' is understudied in agrammatism. The construction of pronominal resolution in Akan presents the opportunity to thoroughly examine resumption. To start, the present study examines the production of (pronominal) resumption in Akan focus constructions (*who*-questions and focused declaratives). Second, we explore the effect of grammatical tone on the processing of pronominal resumption since Akan is a tonal language. We administered tone discrimination tests and an elicitation task to five Akan agrammatic individuals, controlling for the structural variations in the realization of resumption: focused *who*-questions and declaratives with (i) only a resumptive pronoun (ii) only a clause determiner (iii) a resumptive pronoun and a clause determiner co-occurring and (iv) neither a resumptive pronoun nor a clause determiner. Tone discrimination, both for pitch and lexical tone were unimpaired. The production task demonstrated that the production of resumptive pronouns and clause determiners was intact. However, the production of declarative sentences in derived word order was impaired; *wh*-object questions were relatively well preserved. We argue that the problems with sentence production are highly selective: linguistic tones and resumption are intact but the word order is impaired in non-canonical declarative sentences.

## 3.1 Introduction

Morphosyntactic deficits generally characterize the impoverished language of individuals with agrammatism (Caramazza & Berndt, 1985; Goodglass, 1968; Menn & Obler, 1990). Agrammatic speakers have problems producing free and bound morphemes (e.g., verb inflection: Friedmann & Grodzinsky, 1997; Bastiaanse & Jonkers, 1998; Friedmann 2000; Bastiaanse 2008), but this is not the only difficulty observed. Verbs with complex argument structure have been found to be difficult to produce both in spontaneous speech (Thompson et al., 1995; Bastiaanse et al., 2002) and in controlled production experiments (Thompson, 2003; Bastiaanse & Van Zonneveld., 2005; Burchert et al., 2008). Studies in agrammatism

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have also identified deficiencies mainly related to structures with non-canonical word order (Thompson et al., 1993; Bastiaanse & Van Zonneveld, 2006; Neuhaus & Penke, 2008; Van der Meulen, et al., 2005, Abuom & Bastiaanse, 2013; Martinez-Ferreiro et al., 2014) and embedding (Bates et al., 1988; Nespoulous et al., 1990; Thompson et al., 1996, 2007). There have been inconsistent results across languages and different language modalities (Hickok & Avrutin, 1996; Thompson et al., 1999; Friedmann, 2002; Neuhaus & Penke, 2008; Cho Reyes & Thompson, 2012; Hanne et al., 2015). For instance, Neuhaus & Penke (2008) found that the production of object *wh*-questions in 9 German agrammatic individuals is relatively spared. However, Friedmann (2002) tested 13 Hebrew and 2 Palestinian Arabic agrammatic speakers and found the production of these questions to be impaired.

The processing of pronouns is also problematic for agrammatic speakers. Cross-linguistic studies have shown that agrammatic speakers produce fewer pronouns in comparison to non-brain-damaged speakers (Greek: Stavrakaki & Kouvava, 2003; French: Nespoulous et al., 1990; Italian: Miceli & Mazzucchi, 1990). Other studies demonstrated that different types of pronouns are unequally affected in agrammatism. For instance, object clitics have been found to be more prone to omission than subject clitics or reflexives (Nerantzini et al., 2010, Martinez-Ferreiro, 2010, Sánchez-Alonso et al., 2011).

However, not all pronoun types have been equally investigated. Resumptive pronouns are understudied in agrammatic speech. Friedmann et al., (2008) assessed Hebrew-speaking children with hearing impairment and found that the presence of resumptive pronouns served as a compensatory strategy in the production of object relative clauses. Friedmann (2008) further investigated the effect of the resumptive pronouns in the comprehension of object relative clauses in Hebrew speakers with agrammatism but noticed that the presence of the resumptive pronoun did not enhance comprehension performance in this population. A similar observation was made in our comprehension study.

Linguistic tone production is a linguistic aspect that has scarcely been investigated in agrammatism. Nonetheless, brain damage in the left hemisphere has been found to cause tone production problems (Naesar & Chan, 1980; Packard, 1986; Ryalls & Reinvang, 1986; Gandour et al., 1988; Gandour et al., 1992; Yiu & Fok, 1995; Liang & Heuven, 2004; Kadyamusuma et al., 2011). It is worth noting that results in tone production across individuals with aphasia are inconsistent. Gandour et al. (1992), examined stroke victims in the acute stage and observed tone production deficits. Prior to this, Gandour et al. (1988) reported tone production deficiencies in six Thai speakers with aphasia tested after the acute

stage. In tone production studies, the focus point has been whether certain tones are more difficult to produce than others. Gandour et al. (1992) reported that dynamic tones (e.g., rising and falling tones) were more easily impaired than static tones (e.g., high, mid and low tones). However, this finding is yet to be replicated. All these studies are on lexical tones, but the production of grammatical tones has not been explored in brain-damaged individuals. This is partly because most of the tone languages like Chinese and Thai studied do not have the grammatical tone feature. In the Akan context, Tsiwah et al (under review) did not find the production of Akan grammatical tones problematic for individuals with agrammatism, when processing different time references.

In the present study, we investigate the production of resumptive pronouns and the phenomenon of resumption in Akan speakers with agrammatism, assessing Akan *who*-questions and focused declaratives. Akan is a tone language and tone plays a crucial role in the execution of resumption. The addition introduces a new variable (tone) to the ongoing discussion on pronominal resolution and resumption. We will first shortly address the neurolinguistic theories related to our study and introduce the relevant characteristics of Akan.

### 3.1.1 Neurolinguistic Accounts of Sentence Production

The use of grammatical tools for the description of agrammatism is important (Grodzinsky, 1990). Syntactic theories within the generative grammar tradition (Chomsky, 1986, 1995; Pollock, 1989) stipulate that sentences be represented as phrasal structures called *syntactic trees*. The complementizer phrase is the highest phrasal node on the tree and hosts complementizers like “that”, and *wh*-morphemes (who, what). The accessibility to the CP node is critical in the construction of embedded sentences and *wh*-questions. Hagiwara (1995) was one of the first to argue that agrammatic speakers had problems accessing the top of the syntactic tree. Friedmann and Grodzinsky (1997) reported that a Hebrew native speaker with agrammatism showed a dissociation between tense, agreement morphology, that is, agreement inflection was intact, and tense inflection was impaired. Following Pollock’s (1989) Split Inflection Hypothesis, Friedmann and Grodzinsky (1997) assumed the two nodes, tense and agreement to be separately represented in the syntactic tree and the agreement node to be located below the tense node. The Tree Pruning Hypothesis (Friedmann & Grodzinsky, 1997) was then to account for the dissociation observed. The hypothesis stated that agrammatic speakers are unable to access functional projections in the syntactic tree from the tense node upwards, including the CP-node, because the tree was

pruned due to brain damage. In effect, agrammatic speakers failed to formulate structures that require higher nodes like *wh*-questions and embedded sentences. However, studies in other languages have challenged the claims of the TPH based on verb inflection (e.g., Wenzlaff & Clahsen, 2004, 2005; Burchert et al., 2005 for German; Stavrakaki & Kouvava, 2003; Nanousi et al., 2006 for Greek). Syntactic transformations low in the tree have also been found to be impaired (Bastiaanse et al., 2003; Burchert et al., 2003)



Bastiaanse and colleagues showed in a number of studies (Bastiaanse & Van Zonneveld, 1998, 2005, 2006; Bastiaanse et al., 2002, 2003) that sentences in which elements were not in a canonical order were difficult to comprehend and to produce for agrammatic individuals. Bastiaanse and Van Zonneveld (2005) proposed the Derived Order Problem Hypothesis, which posits that;

a) Every language has a base word order (e.g., Subject-Verb-Object for English; Subject-Object-Verb for Dutch and German) and that all other word orders are derived.
b) For agrammatic individuals, sentences in the base word order are easier to produce and comprehend than those in the derived word order (e.g., *who*-object questions, as in 1b)

1. a. Who $t_{who}$ pushed the man? Basic word order

   b. Who did the man push $t_{who}$? Derived word order

The DOP-H, meant to describe word-order problems in agrammatic individuals, has been tested cross-linguistically (Dutch, Italian, Turkish, English, see, for example, Bastiaanse et al., 2003; Bastiaanse & Thompson, 2003; Bastiaanse & Van Zonneveld, 2005, 2006; Yarbay Duman et al., 2007, 2008, 2011). The DOP-H is relatively theory-neutral in the sense that its definition of derivation is extensive and not strictly dependent on theories related to movement, binding, co-referencing or any syntactic transformation mechanism. In addition, it is an overarching theory, thus, it covers both production and comprehension.

### 3.1.2 The Akan language and relevant features for the current study

Akan is a language spoken in Ghana and parts of Cote d'Ivoire. Akan is classified as Kwa language of the Niger-Congo phylum. According to the Ghanaian education policy, a native language can be used as a medium of instruction until the 3rd Grade (Mfum-Mensah, 2005). In the south of Ghana, where Akan is predominantly spoken, most children are expected to

read and write Akan before 4th Grade. English then becomes the language of instruction in schools but Akan remains predominantly used in all spheres of life.

*Word order and Tone in Akan*

The base word order in Akan is Subject-Verb-Object (SVO; Saah, 1994). Akan is a tonal language with two main tones, high and low, usually transcribed as [ ´ ] and [ ` ] respectively (Dolphyne 1988). These tones are used to make both grammatical and lexical distinctions. In the next section, the formation of focus constructions and the use of grammatical tones in pronominal resolution and resumption in Akan are described.

*Focused Construction Formation in Akan*

Any lexical element in a sentence structure can be focused. There are two focus markers in Akan, *na* and *deɛ*. Every focused constituent must be realized before a focus particle, otherwise, the structure is ungrammatical (2). This is required in the formation of both questions[3] and declaratives.

2. a. Declarative base order

| | | | | |
|---|---|---|---|---|
| Me | wosoo | **akonwa no** | | |
| I | shake.PST | chair | the | Grammatical |

'I shook the chair'

b. Focused declarative

| | | | | |
|---|---|---|---|---|
| **akonwa no na** | me | woso-e | | |
| Chair the FOC | I | shake.PST | | Grammatical |

'It is the chair that I shook'

c. *na akonwa no me woso-e

| | | | | | |
|---|---|---|---|---|---|
| FOC | chair | the | I | shake.PST | Ungrammatical |

'It is the chair that I shook'

The two structures (2a and 2b) essentially convey the same message, that is, the speaker shook a chair. However, in (2b), the speaker asserts that "*the chair and only the chair was*

[3] In the formation of wh-questions in Akan, the question word can also be found *in situ* (Saah,1994). The *wh*-word in object questions is in base position.. See example below:

| | | | |
|---|---|---|---|
| *Papa* | *no*$^{subject}$ | *wosoo*$^{verb}$ | *dɛn* $^{object}$*?* |
| Man | the | shake.PST | what |

'What did the man shake?'

*what I shook*". The whole sentence can be paraphrased as an object cleft in English and is similar in contrastive nature. Henceforth, structures like 2b will be named in the current study as 'focused declaratives'.

*Resumptive pronouns and clause determiners in Akan*

In the formation of Akan focus structures, a resumptive pronoun may be used at the clause-final position. Syntactically, pronominal resumption shows the syntactic transformation of a derived nominal constituent to construct focus, topic, relative, and question structures. Resumptive pronouns are not used in English (3a-c).



3. a. [Who$_1$ did [ the woman hug $t_1$]]?
   b. [Who$_1$ [ $t_1$ hugged the woman]]?
   c.* [Who$_1$ did [ the woman hug $t_{\textbf{/him/her}}$]]?

In example (3) the original position of the *wh*-word is marked *t*. A phonetically null element indicates the base-generation position of a displaced element. In English, the derived element cannot be replaced with a pronominal form (3c). However, in Akan, Hausa and Hebrew resumptive pronouns can fill in the original position of the derived element with a resumptive pronoun (RP), which matches the morpho-syntactic features of the moved constituent (Saah 1994; McCracken 2013: see 4).

| | | | | | | |
|---|---|---|---|---|---|---|
| 4. a. | Hena | na | maame | no | twe-e | **no**? |
| | Who | FOC | woman | the | pull.PST | him/her (RP) |

'Who did the woman pull?'

In example (4), the resumptive pronoun is represented as '*no*' but the morpheme '*no*' in Akan can have three different functions in a sentence. It can be a definite article (the), a clause determiner[4] (CD) and a resumptive pronoun (RP). The distinction between the three can only be made based on the context and the tone they carry. When used as a resumptive pronoun, the tone on the vowel is low, but when used as a definite article or clause determiner, the tone on the vowel is high (5). The resumptive pronoun *nò* can be replaced by a clause determiner *nó*; a combination of both is also possible. Notice that neither the resumptive pronoun nor the clause determiner is obligatory. The meaning of the sentence is left intact with these structural variations.

[4] In Akan a clause determiner is a morpheme used to mark the end of a clause. Semantically, it does not add any extra information to the sentence. It acts as a clause boundary.

5. Hena na maame **nó** etwe **(nò)** **(nó)**?
   Who FOC woman the PROG.pull RP CD
   'Who is the woman pulling?'

From the above examples, it is clear that resumptive pronouns in Akan (but not clause determiners) are bound within the sentence. The production of intrasentential binding in agrammatic production has been understudied. There are some studies on comprehension of reflexives versus pronouns that show the comprehension of sentence-bound reflexives is relatively spared (Grodzinsky et al., 1993; Avrutin, 2006). According to Avrutin (2006) this is because reflexives can be processed within the sentence, as opposed to pronouns that have to be linked to the extra-sentential discourse. Resumptive pronouns and clause determiners can also be processed by clausal syntax and should, thus, be relatively spared.

### *3.1.3 The current study*

Given that this study focuses on virtually unexplored constructions in an underrepresented language, a series of questions need to be addressed. In what follows, we present the questions of interest in the present work.

*Grammatical tone and Resumption in Akan who-questions and declaratives*

Few studies have investigated the processing of resumptive pronouns and the concept of resumption in agrammatism. Friedmann (2008) tested Hebrew speakers with agrammatic aphasia and found that comprehension of object relative clauses was impaired regardless of the presence or absence of a resumptive pronoun. The main question of the current study is how agrammatic individuals will perform in a production experiment investigating pronominal resumption and the concept of resumption in general. In addition, we assessed how Akan agrammatic speakers produce the structural variations in the realization of resumption in Akan *who*-questions and focused declaratives.

In the previous sections, the role of grammatical tones in relation to resumption in Akan focus constructions was introduced, where tone is used to make a distinction between a resumptive pronoun and a clause determiner. So far, it is unknown whether grammatical tone is affected in individuals with agrammatism. Since the only difference between Akan resumptive pronoun and clause determiner is grammatical tone, varying conditions with and without the tone elements is an excellent way to test the production of grammatical tone.

*Focus marking in Akan*

In Akan, focus marking is essential in the construction of questions and declaratives. For content questions like *who*-questions, we have seen that focusing is not always required because the question word can be realized in situ. The current work explores the effect of focused elements on production in Akan *who*-questions and focused declaratives. The assessment of *who*-question formation in Akan agrammatic speakers is interesting because object *who*-questions are constructed by either focusing the *wh*-word or with the *wh*-word *in situ*. The question then is, are agrammatic individuals able to produce both structures?



*Neurolinguistic approaches to the effect of Word Order*

In the present study, sentence structure is key to our investigations and analysis. Akan *who*-questions and declaratives are assessed in base and derived order. Two neurolinguistic theories, the Derived Order Problem Hypothesis (DOP-H: Bastiaanse and Van Zonneveld, 2005) and the Tree Pruning Hypothesis (TPH: Friedmann and Grodzinsky, 1997) have been highlighted to help us understand our observations. Bastiaanse and Van Zonneveld's DOP-H (2005) predicts sentences in the base word order to be easier to produce than those in the derived order. Following the DOP-H's assertions, we hypothesize Akan *who*-questions and declaratives in the derived word order to be relatively difficult to produce compared to the *who*-questions and declaratives in base word order. Friedmann and Grodzinsky's TPH (1997) predicts that the CP-node of sentences in a syntactic tree is inaccessible, so all focus constructions should be impaired.

Currently, there are no neurolinguistic theories on the production of resumptive pronouns and clause determiners in agrammatic speech. In addition, the effect of agrammatism on grammatical tone-production is unknown. Based on syntactic theories, it is predicted that the production of Akan resumptive pronouns and clause determiners is left relatively intact since they are bound within the sentence or with other bound elements, such as reflexives, have been found to be left relatively intact in aphasic speakers (Avrutin, 2006).

## 3.2 Methods

### 3.2.1 Participants

The present study included 2 groups of participants, 5 with left hemisphere brain-damage and 10 non-brain-damaged (NBD) speakers. The individuals in the brain-damaged group all suffered from agrammatic aphasia (4 males; mean age of 52.8, rang: 37-69). The NBD group consisted of 5 females and 5 males with a mean age of 51.7 (range: 20-73). Recruitment of the agrammatic group was done in the Korle Bu Teaching Hospital (KBTH, Accra/Ghana). All participants were right-handed and had no problems with vision, hearing or any psychological defects. Paralysis on the right side was manifest in all agrammatic speakers, who were reported to have suffered a single stroke. The time post-onset ranged from 7 to 25 months. All participants in the NBD and agrammatic group were Akan native speakers and confirmed Akan to be their principal language of communication since birth. All participants signed an informed consent form before testing commenced.

In Ghana, there are no standardized test materials to diagnose aphasia. Nonetheless, all recruited individuals with aphasia had been diagnosed by a speech and language therapist as being aphasic. This classification was not suitable for the present study, so we judged the presence of agrammatism based on spontaneous speech analysis[5]. We found that agrammatic speakers in the current study showed reduced speech-rate, reduced mean-length of utterances, fewer correct sentences, and fewer embedded clauses (see Table 3.1). This finding is in line with the observations of Bastiaanse and Jonkers (1998) in their group of Dutch agrammatic speakers.

[5] We employed Menn and Obler (1990) as a guide in the process. Factors such as grammaticality of utterances produced, speech rate, diversity in the use of lexical verbs and nouns

Table 3.1 Spontaneous speech analysis of IWAs and NBDs

| Participants | Speech rate (wpm) | MLU | Embedding (%) | Grammatical errors (%) |
|---|---|---|---|---|
| IWAs | | | | |
| P1 | 95 | 2.5 | 0 | 23.5 |
| P2 | 34 | 4.5 | 24.3 | 19.5 |
| P3 | 86 | 3.8 | 18.9 | 38.4 |
| P4 | 98 | 4.8 | 13.6 | 22.7 |
| P5 | 66 | 3.55 | 14 | 18.6 |
| Mean | 75.8 | 3.83 | 14.16 | 24.54 |
| | | | | |
| NBDs (n=10) | | | | |
| Scores (Range) | 120 – 153 | 6.7 - 7.7 | 34 - 38.4 | 0 - 9.4 |
| Mean | 134.2 | 6.9 | 38.82 | 3.9 |

Additionally, we adapted the subtest on auditory word comprehension of the Boston Diagnostic Aphasia Examination (BDAE: Goodglass and Kaplan, 1972) to Akan to assess agrammatic speakers' word comprehension. In the adapted BDAE, we concentrated on the verb, object and number subsets. See the scores on the BDAE in Table 3.2. The agrammatic speakers were not deficient in single-word comprehension. The severity of the aphasia suffered by the brain-damaged participants was checked by administering the Token Test (De Renzi and Faglioni, 1978). Specifically, we administered the Token Test Perspex, the analogous version of the Multilingual Token Test (Bastiaanse et al., 2016). The scores on the Token Test showed different levels of severity amongst the brain-damaged group. Table 3.2 shows the demographic data of all participants and the performance of agrammatic individuals on the BDAE and the Token Test.

Table 3.2 Demographic data of all participants and scores of the agrammatic speakers on BDAE and Token Test

| Participants | Gender | Age | Handedness | Education (Years) | Time Post Onset (months) | Native Language | BDAE (_ / 46) | Token Test Score (_/36) |
|---|---|---|---|---|---|---|---|---|
| **Patients** | | | | | | | | |
| P1 | M | 37 | R | 16 | 7 | Akan | 44 | 23.5 |
| P2 | F | 49 | R | 12 | 7 | Akan | 42 | 7 |
| P3 | M | 69 | R | 13 | 24 | Akan | 42 | 10 |
| P4 | M | 60 | R | 10 | 18 | Akan | 46 | 15 |
| P5 | M | 49 | R | 10 | 25 | Akan | 46 | 22.5 |
| **Non-Brain Damaged** | | | | | | | | |
| NBD1 | M | 39 | R | 10 | - | Akan | 46 | - |
| NBD2 | M | 46 | R | 10 | - | Akan | 46 | - |
| NBD3 | M | 57 | R | 12 | - | Akan | 46 | - |
| NBD4 | M | 64 | R | 10 | - | Akan | 46 | - |
| NBD5 | M | 67 | R | 12 | - | Akan | 46 | - |
| NBD6 | F | 20 | R | 6 | - | Akan | 46 | - |
| NBD7 | F | 49 | R | 14 | - | Akan | 46 | - |
| NBD8 | F | 73 | R | 10 | - | Akan | 46 | - |
| NBD9 | F | 50 | R | 10 | - | Akan | 46 | - |
| NBD10 | F | 52 | R | 12 | - | Akan | 46 | - |

Since one of the variables we examined in the sentence production test is grammatical tone, two tone-discrimination tests were administered. First, in the online Tone Screening Test (Kayser, 2011; Wexler et al., 1998), we played two non-linguistic tones for the participant who had to indicate whether the tones s/he heard were the 'same' or 'different'. Second, we tested lexical tone discrimination using Akan words, for which the agrammatic speakers heard two words that were identical or only differed in tone: they had to indicate whether the words they heard were the 'same' or 'different'. The agrammatic participants had problems neither with non-linguistic nor with linguistic tone perception. Table 3.3 shows the scores on the tone discrimination tests.

Table 3.3 Tone discrimination test scores

| Individuals with agrammatism | | |
|---|---|---|
| | Tone Screening Test Score (_/60) | Lexical Tone Discrimination Test Score (_/ 30) |
| P1 | 54 | 29 |
| P2 | 55 | 26 |
| P3 | 59 | 28 |
| P4 | 58 | 28 |
| P5 | 43 | 26 |
| **Mean** | **53.8** | **27.4** |
| **SD** | **6.38** | **1.34** |
| Non-Brain-Damaged Participants | | |
| NBD1 | 56 | 30 |
| NBD2 | 58 | 30 |
| NBD3 | 59 | 30 |
| NBD4 | 57 | 30 |
| NBD5 | 60 | 30 |
| NBD6 | 60 | 29 |
| NBD7 | 58 | 30 |
| NBD8 | 57 | 30 |
| NBD9 | 56 | 29 |
| NBD10 | 59 | 30 |
| **Mean** | **58** | **29.8** |
| **SD** | **1.49** | **0.42** |



### 3.2.2 Materials and Design

We conducted two elicitation tasks, one with *who*-questions and the second one with declaratives. A total of 20 pictures (presented on a white background) were taken with a digital camera (IXUS 275 HS, Canon). Two native Akan speakers, who did not take part in the main experiment, crosschecked the pictures. A name agreement test was conducted, where the informants were asked to produce the first verb that came to mind in Akan when the pictures were shown to them. There was 100 percent accuracy for all pictures except one picture they both named as 'to hit' but was used in the study as 'to hurt'. Nonetheless, the informants admitted it also demonstrates the verb 'to hurt' and so this picture was maintained.

We created two separate tasks for the focused declaratives and the object questions. Each task had 5 conditions of 10 items, adding up to 50 items per task. These items were preceded by 3 examples. In each task, the order of the items was pseudo-randomized to make sure that items from one condition did not occur sequentially. The same verbs were used for all the 5

conditions. See Table 3.4 and Table 3.5 for particulars about experimental conditions with examples.

Table 3.4 Experimental conditions for the *who*-questions with examples

| **Word Order** | **Conditions** | **Sentences** |
|---|---|---|
| Base | Object *who*-question (*in situ*) Baseline | Papa no e- pia hena?<br>man DET PROG-push who?<br>'Who is the man pushing?' |
| Derived | Object-focused *who*-question (with a resumptive pronoun) | Hena na papa no e-pia **nò** ?<br>Who FOC man DET PROG-push **him/her**<br>'Who is the man pushing?' |
| Derived | Object-focused *who*-question (with Clause determiner) | Hena na papa no e-pia **nó** ?<br>Who FOC man DET PROG-push **CD**<br>'Who is the man pushing?' |
| Derived | Object-focused *who*-question (with both RP & CD) | Hena na papa no e-pia **nò nó** ?<br>Who FOC man DET PROG-push **RP CD**<br>'Who is the man pushing?' |
| Derived | Object-focused *who*-question (Empty Gap) | Hena na papa no e-pia _ ?<br>Who FOC man DET PROG-push<br>'Who is the man pushing?' |

Table 3.5 Experimental conditions for declaratives with examples

| **Word Order** | **Conditions** | **Sentences** |
|---|---|---|
| Base | Subject-focused declarative (baseline) | Papa no na o-pia maame no<br>Man DET FOC he/she-PROG-push woman DET<br>'The man is the one pushing the woman' |
| Derived | Object-focused declarative (with a resumptive pronoun) | Papa no na maame no e-pia **nò**<br>Man DET FOC woman DET PROG-push **him/her**<br>'The man is the one the woman is pushing' |
| Derived | Object-focused declarative (with Clause determiner) | Papa no na maame no e-pia **nó**<br>Man DET FOC woman DET PROG-push **CD**<br>'The man is the one the woman is pushing' |
| Derived | Object-focused declarative (with both RP & CD) | Papa no na maame no e-pia **nò nó**<br>Man DET FOC woman DET PROG-push **RP CD**<br>'The man is the one the woman is pushing' |
| Derived | Object-focused declarative (Empty Gap) | Papa no na maame no e-pia _<br>Man DET FOC woman DET PROG-push<br>'The man is the one the woman is pushing' |

### 3.2.3 Procedure

Elicitation tasks were conducted for both *who*-questions and focused declaratives. In both cases, the instructions of the test were read aloud to the participant and the practice materials were administered to make sure the participant understood what was required for the test. The participants were corrected and given feedback during the practice items. No further feedback was given during the test. The experimenter showed two pictures to the participant and produced the prime sentence corresponding to the picture displayed at the left-hand side (see Figure 2.2 repeated below as Figure 3.1 for illustrative purposes). The structure produced by the experimenter was supposed to prime participants to produce a similar structure for the picture on the right. The only difference in the target response was the change of thematic roles in comparison to the one the experimenter produced. This procedure has been successfully administered in other studies (Burchert et al. 2008; Yarbay Duman et al., 2008). The same procedure was used to elicit both the *who*-questions and declaratives. Each test session lasted between 30- and 50- minutes including breaks.

***Pia* (push)**

A B

Figure 3.1 An example of items used for the experiment

Experimenter: *wohwɛ nfoni mienu wei mu a, nea ɛkɔ so yɛ 'pia'. Obi pia obi, nti sɛ mehwɛ nfoni wei mu a metumi ebisa sɛ,' Hena na maame no epia* ***nò****?'. Wonso wohwɛ nfoni wei mu a wobebisa sɛ...*

'When you look at these pictures, the ongoing action is "to push". Looking at this picture (Experimenter points to picture A), I can ask the question, 'Who is pushing the man?' If you (the participant) look at this picture (picture B) you can ask the question…'

Participant: *Hena na papa no epia* ***nò****?*

'Who is the man pushing?' (Target response)

*3.2.4 Scoring and statistical analysis*

The sessions were audio-recorded and the sentences produced by the participants were transcribed orthographically. The tone of the resumptive pronoun/clause determiner was clearly indicated. Responses were scored as correct when the participant produced the required target sentence. Two types of analyses were performed, qualitative (correct-incorrect) and quantitative.

For the qualitative analysis, there were 3 main error types determined post hoc. These error types directly addressed the research questions of the current study. They were; word order errors, resumption errors and focus marking errors. The 3 main error types had 6 different error classifications that were also determined post hoc, based on the errors made during testing. The following errors were distinguished:

A: thematic roles, agent and theme, were reversed but word order structure was left intact

B: incorrect word order (the use of SVO instead of OSV without thematic role reversal)

C: omission of the clause determiner when it occurs with the RP

D: inserting the wrong '*no*' morpheme clause finally (substituting RP for CD and vice versa)

E: inserting a morpheme when not primed to do so

F: focus marker '*na*' is omitted.

A and B are word order errors; C, D, and E represent resumption errors; F is for focus marking errors.

For the quantitative analysis, statistical mechanisms were applied to both correct and incorrect responses. A generalized linear mixed-effects modeling (GLMM) was performed, using the *glmer* function of the *lme4* package (Bates, et al., 2015) and the *glht* function of the multcomp package (Hothorn, Bretz, Westfall, Heiberger & Schuetzenmeister, 2013) in R (R Core Team, 2013). The GLMM was adopted because it robustly processes random effects. The GLMM also helped us account for variations across participants and items because of the

relatively small sample size recorded. The dependent variable (score) was log-linked accuracy (1=correct, 0=incorrect) with fixed effect factor 'Condition' (RP, CD, RP&CD, Empty Gap) and random effect factors for 'Participants' and 'Item'. A model was developed to investigate the differences between conditions for the agrammatic speakers. We developed **a** model by excluding insignificant parameters from a full model (with interactions) based on the Awake Information Criterion (AIC) and log likelihood-ratio tests (significance defined as $p < 0.05$). This exclusion was also to achieve model convergence. To better understand the effect of word order, we substituted the fixed factor (conditions) in the previous model with word order (base vs derived).



## 3.3 RESULTS

### 3.3.1 Quantitative analysis

The non-brain damaged participants performed at ceiling on both *who*-questions and declaratives. This result shows that the test is appropriate and that errors made by the agrammatic group most likely due to their aphasia rather than weaknesses in the test design. The accuracy scores of the participants with agrammatic aphasia are shown in Table 3.6.

Table 3.6 Mean accuracy score of speakers with agrammatism and NBDs on *who*-questions and declaratives

| | Base word order | | Derived word order | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Wh*-In situ | Subj. Focus Decl. | Resumptive Pronoun (RP) | | Clause Determiner (CD) | | RP & CD | | Gap | |
| | Baseline Conditions | | *wh*-Q (%) | Decl. (%) | *wh*-Q (%) | Decl. (%) | *wh*-Q (%) | Decl. (%) | *wh*-Q (%) | Decl. (%) |
| IWAs | | | | | | | | | | |
| P1 | 80 | 100 | 100 | 10 | 100 | 20 | 100 | 30 | 100 | 10 |
| P2 | 90 | 100 | 50 | 40 | 40 | 30 | 60 | 40 | 70 | 40 |
| P3 | 80 | 80 | 100 | 40 | 100 | 20 | 90 | 10 | 100 | 10 |
| P4 | 90 | 60 | 50 | 70 | 60 | 80 | 60 | 70 | 70 | 70 |
| P5 | 70 | 70 | 60 | 60 | 50 | 60 | 40 | 50 | 60 | 60 |
| Mean | 82 | 82 | 72 | 44 | 70 | 42 | 70 | 40 | 80 | 38 |
| SD | 8.37 | 17.89 | 25.88 | 23.02 | 28.28 | 26.83 | 24.49 | 22.36 | 18.71 | 27.75 |
| NBDs (Group) | | | | | | | | | | |
| Mean | 99 | 99 | 100 | 99 | 99 | 98 | 99 | 99 | 100 | 98 |
| SD | 3.16 | 3.16 | - | 3.16 | 3.16 | 4.22 | 3.16 | 3.16 | - | 4.22 |

*wh*-Q= *who*-question; Subj. FOC Decl.= subject focused declarative; Decl.= declarative

A multiple comparison test was conducted to highlight differences between conditions for both *who*-questions and declaratives. Performance on the subject-focused declarative condition (baseline) was significantly higher than on the object-focused declarative conditions (with Resumptive Pronoun: $Z = 3.35$, SE = 1.13, $p = 0.02$; with Clause Determiner: $Z = 3.95$, SE = 0.46, $p < 0.01$; with both ResPro and ClauseDet: $Z = 4.11$, SE = 0.46, $p < 0.01$; with Empty Gap: $Z = 4.7$, SE = 0.42, $p < 0.01$). There was no significant difference between the *who*-question *in situ* condition (baseline) and the object-focused *who*-questions (with Resumptive Pronoun: $Z = -1.18$, SE = 0.48, $p = 0.98$; with Clause Determiner: $Z = 1.39$, SE = 0.48, $p = 0.94$; with both ResPro and ClauseDet: $Z = -1.39$, SE = 0.48, $p = 0.94$; with Empty Gap: $Z = 0.25$, SE = 0.51, $p = 1$). There was a significant difference between the production of base order structures and derived order structures ($Z = 3.24$, SE = 0.39, $p < 0.01$). Statistically, performance did not differ between the resumption variations for both object-focused *who*-questions and object-focused declaratives. See results of the comparisons between the different resumption types in Table 3.7.

Table 3.7 Output of comparison between the different resumption types

| *Between Object who-questions* | Statistical Values | | |
|---|---|---|---|
| | Z score | SE | P-value |
| RP - CD | 0.44 | 0.221 | 1 |
| RP - RP&CD | 0.44 | 0.221 | 1 |
| RP - Empty Gap | 0.47 | -0.935 | 0.9973 |
| CD - RP&CD | 0.43 | 0 | 1 |
| Empty Gap - CD | 0.47 | 1.151 | 0.9859 |
| Empty Gap - RP&CD | 0.47 | -1.151 | 0.9859 |
| | | | |
| *Between object-focused declaratives* | | | |
| RP - CD | 0.43 | 1.04 | 0.9936 |
| RP - RP&CD | 0.43 | 1.228 | 0.9771 |
| RP - Empty Gap | 0.43 | 1.417 | 0.9392 |
| CD - RP&CD | 0.4 | -0.204 | 1 |
| Empty Gap - CD | 0.41 | -0.409 | 1 |
| Empty Gap - RP&CD | 0.41 | 0.205 | 1 |

### 3.3.2 Qualitative analysis

We determined likely errors that could be made post hoc and categorized them into 6 groups after our observations of the agrammatic individuals during testing. See the categorizations below. Figure 3.2 shows the distribution of the different error types on the object-focused *who*-questions and declaratives.

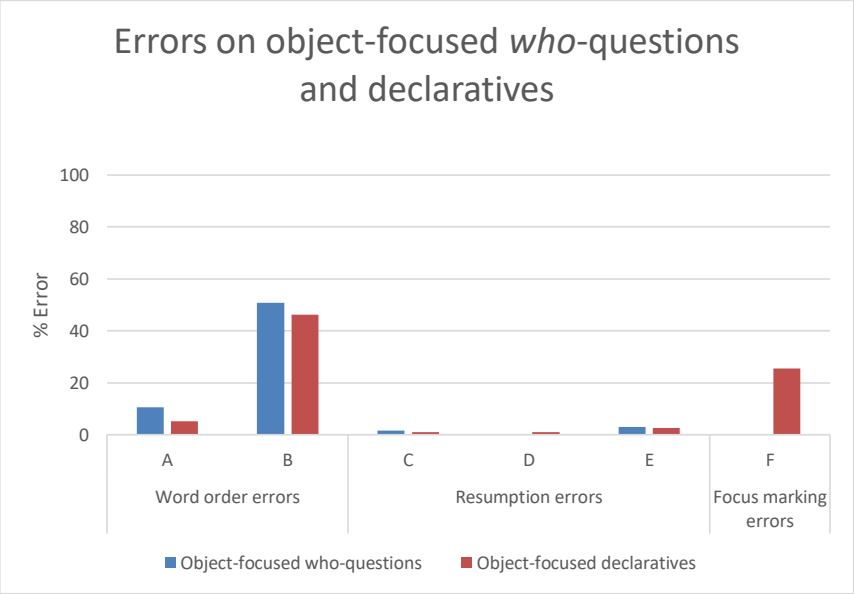


Figure 3.2 shows the three main error classifications sub-categorized into 6 different error types; A: thematic roles of agent and theme were reversed but word order structure is left intact; B: incorrect word order (use SVO instead of OSV without thematic role reversal); C: omission of the clause determiner when it occurs with the RP; D: inserting the wrong '*no*' morpheme clause finally (substituting RP for CD and vice versa); E: inserting a morpheme when not primed to do so; F: focus marker '*na*' is omitted.

The most frequent error type in object-focused *who*-questions and object-focused declaratives was word order related. Word order errors were classified into two groups, A and B. In A, the agrammatic speakers interchanged the thematic roles (agent and theme) in the sentence without changing the word order. For instance, an agrammatic speaker produced '*papa nó na maame nó epia nò'* 'The man is the one the woman is pushing' when the target sentence is '*maame nó na papa nó epia nò'* The woman is the one the man is pushing'. For B, the agrammatic individual did not interchange the thematic role but rather reverted to the baseline word order structure. For example, the experimenter primes the agrammatic speaker with '*papa nó na maame nó epia'* 'The man is the one the woman is pushing' (object-verb-subject) but the individual with agrammatism produces '*maame no epia papa nò*' 'The woman is pushing the man' (subject-verb-object). This error type accounted for almost 50 percent of the errors in both object-focused *who*-questions and declaratives. We also see that the agrammatic speakers produced an insignificant amount of errors in relation to resumption (See C, D, and E in figure 3.2).

Figure 3.2 shows that some agrammatic speakers produced structures without the focus marker '*na*'(n=25.6%). This makes such sentences ungrammatical. It is worth noting that when the agrammatic speakers used the focus marker, it always was in the correct position.

## 3.4 DISCUSSION

In the present study, we explored three main issues. First, we investigated the production of resumption (pronoun/clause determiner) in Akan *who*-questions and declaratives, testing Akan speakers with agrammatism. The different grammatical configuration of pronominal resolution and resumption in Akan were analyzed. These structural differences were to help us understand the effect of the presence and absence of resumptive pronouns and clause determiners in the production of questions and declaratives in Akan agrammatic speakers. According to Avrutin (2006), the production of the resumptive pronoun and the clause determiner is expected to be relatively spared since they are bound within a sentence Secondly, we explored how Akan agrammatic individuals produce focused constructions in Akan *who*-questions and declaratives. According to the DOP-H, the production of these focused constructions is impaired. Finally, neurolinguistics theories were assessed to help us understand the deficits observed in the current study.

### 3.4.1 Production of resumption in Akan who-questions and declaratives

Quantitatively, the data show that the production of object-focused *who*-questions in the speakers with agrammatism was relatively spared. The resumptive pronoun and/or clause determiner neither enhanced nor worsened performance. This finding is in line with a comprehension study by Friedmann (2008) where the presence or absence of a resumptive pronoun did not affect performance in Hebrew agrammatic speakers. For the declaratives, there were significant differences in performance between the subject-focused declaratives (baseline) and object- focused declaratives. However, within the object-focused constructions, we did not find an effect for the resumptive pronoun and clause determiner. Our quantitative analysis showed that focused object *who*-questions were better produced than object-focused declarative constructions.

In the error analysis, two main observations were made. First, most of the errors recorded for both *who*-questions and declaratives were linked to agrammatic speakers' inability to use the correct word order when the agrammatic speaker was primed to produce a structure with derived word order. Difficulties in the production of structures with derived word order

explain our second observation. We found that the substitutions were mainly a *wh*-in situ question for the *who*-questions and a subject-focused declarative for the focused declaratives. Notice that both structures are grammatically correct but are not the target structure.

The production of the distinct tones on the resumptive pronoun and the clause determiner was observed to be spared. This result adds a new dimension to the ongoing discussion in the literature on tone production difficulties in left hemisphere brain-damaged individuals (Naesar & Chan, 1980; Packard, 1986; Ryalls & Reinvang, 1986; Gandour et al., 1988; Gandour et al., 1992, Yiu & Fok, 1995; Liang & Heuven, 2004; Kadyamusuma, 2011). All the tone-production studies in agrammatism investigated lexical tones and showed that individuals with left hemisphere brain-damage were deficient in lexical tone production. However, the current study assessed grammatical tones and the data show that Akan left hemisphere brain-damaged agrammatic speakers do not have problems producing the correct grammatical tones on resumptive pronouns and clause determiners.



Interestingly, another production study on Akan grammatical tones showed similar results (Tsiwah et al., under review). However, in our comprehension study, Akan agrammatic speakers do show deficiency in the comprehension of RP structures, showing that grammatical tone is vulnerable. An explanation for the finding that the production of grammatical tone is not impaired in the current study may be that errors with grammatical tone would result in ungrammatical structures. It has been argued that such structures are not produced by agrammatic speakers (Grodzinsky, 1990; Bastiaanse & Thompson, 2003). Instead of producing these ungrammatical structures, the Akan agrammatic speakers seem to resort to base order sentences when too much grammatical complexity is required.

### 3.4.2 Focus marking

In languages like English, focused elements in sentences are not morphologically marked. Akan marks its focused constituents with the free morpheme '*na*'. The present study sought to find out if Akan agrammatic individuals could produce focused structures. We indicated that the *who*-question conditions presented the opportunity for such analysis because, in that structure, a question can be formed with a focused question word or with the question-word in situ; the meaning of both sentences is similar. Our data showed that the agrammatic speakers hardly ever omitted the focus marker in *who*-questions. Focus-marker omissions were observed primarily on the object-focused declaratives. We argue that focus marking is largely spared in *who*-question production because linguistically, object questions are

inherently considered focused. This makes the phenomenon of focusing relatively easy to produce. Thus, even though the use of focus marking in Akan *who*-questions is optional, the inherently focused nature of *wh*-questions makes it less problematic to produce. In addition, errors in focus formation were not observed in isolation but also combined with thematic role reversals.

### 3.4.3 The results interpreted in a neurolinguistics framework

Although an effect of word order was found, the focused *wh*-object questions were not more difficult than the *wh*-object questions *in situ*. This is because two agrammatic speakers (P1 and P3) performed at ceiling in both conditions, whereas the other three participants were impaired. The good performance of P1 and P3 cannot be attributed to severity: they were the most impaired participants on declarative sentences in derived order. According to the TPH (Friedmann & Grodzinsky, 1997), the focused *wh*-object questions should be problematic to produce, because individuals with agrammatism cannot project to the CP node in the syntactic tree. The current results are not in line with this hypothesis: two agrammatic speakers can produce the focused object *wh*-questions correctly, and the other agrammatic speakers make word order errors, but they do produce the *wh*-word in sentence-initial position. Neuhaus and Penke (2008) also found that object *wh*-question production in their German agrammatic speakers was spared, with the *wh*-word in topicalized position. Our results are in the middle: some agrammatic speakers can produce this question type perfectly, others cannot. This pattern is in line with comprehension data of *wh*-object questions reported by Thompson et al (1999).

The data showed that subject-focused declaratives were less problematic than object focused declaratives. This is predicted by the DOP-H. Bastiaanse and Van Zonneveld (2005) assume that all languages have a base word order and all other word orders are derived. The latter is expected to be difficult for speakers with agrammatism. The DOP-H correctly explains our findings on the focused declaratives because they were significantly more impaired than the subject-focused constructions and there was no difference between the object-focused declaratives with all the structural variations (resumptive pronoun and/or clause determiner). This is in line with the findings of Abuom and Bastiaanse (2013) for Swahili and English agrammatic bilinguals. The DOP-H also predicts that focused *wh*-questions will be problematic because constituents appear in derived order. This deficit was earlier reported for French (Van der Meulen et al., 2005). However, accuracy on base order structures was not different from those in derived order. Neuhaus and Penke (2008) made similar observations

in nine German agrammatic speakers. Hickok and Avrutin's (1996) Discourse Linking Hypothesis, if extended to production explain our observation on the *who*-questions. Hickok and Avrutin (1996) argue that *who*-questions are non-discourse-linked, hence, they are relatively easy to comprehend. Our results show that object *who*-question production is indeed relatively spared. Even though the discourse-linking hypothesis is originally proposed to explain comprehension deficits, it is in line with our production data on the *who*-questions.

The outcome of the error analysis supports the DOP-H. The data indicate that the most frequent error type is associated with word order. Agrammatic speakers usually opted for base word order structures even when primed with derived order structures. In addition, most of the substitution errors were base word-order instead of derived word order structures. The DOP-H explains why such errors were made; structures in the base word order are less difficult to produce.



*Conclusion*

Our data and analysis (quantitative and qualitative) show an extensive word-order deficiency in the Akan speaking agrammatic individuals. A neurolinguistic approach to the effect of word order on performance suggests that the data of the current study can best be explained by the DOP-H. However, the DOP-H does not predict the high accuracy scores on *who*-questions. Word-order deficiencies reflected in the omission of focus markers mainly occur in declaratives even though focus marking was largely preserved. The current study has shown that the production of resumptive pronouns is relatively spared in agrammatic aphasia parallel to what Friedmann (2008) found for comprehension. In clinical terms, the current work provides evidence to Akan speech therapists to develop and include diagnostic tests on word order and resumption processing in Akan agrammatic speakers. The novel finding of this study is that Akan agrammatic speakers, who have problems with the production of sentences in derived word order, made no errors with grammatical tone. The reason for this may be that errors with grammatical tone would have resulted in ungrammatical structures that are usually not produced by agrammatic speakers.

# CHAPTER 4

## The role of grammatical tone and animacy in Akan sentence processing: An ERP study

# The role of grammatical tone and animacy in Akan sentence processing: An ERP study

**Abstract**

In sentence comprehension, the knowledge of linguistic components such as phonology and syntax is crucial for a correct interpretation. Over the years, ERP components have helped us better understand language processing in a wide variety of languages. The current study explored antecedent-trace dependencies in Akan (a tonal African language), testing native speakers' sensitivity to the distribution of resumptive pronouns and clause determiners. We also examined the interaction between phonology (grammatical tone) and syntax when processing pronominal resolution and resumption in Akan antecedent-trace structures. Auditory sentences were presented to 23 native speakers of Akan with two violation types; word-order violation and animacy agreement mismatch. In the word order violation condition, the LAN and a short-lasting early positive effect were simultaneously recorded 300-500 ms post-stimulus onset. The animacy violation elicited the LAN (300-500 ms) and an early P600 (300-800 ms). This finding shows that the LAN is elicited by both morphosyntactic and phonosyntactic incongruences. Furthermore, the elicited early P600 in the animacy-agreement mismatch context broadens our understanding and adds a phonological dimension to the repair and reanalysis of animacy-agreement violations. [6]

## 4.1 Introduction

Language comprehension goes beyond the retrieval of lexical items from long-term memory and the combination of these items based on written or spoken input. Higher-order phonological, morphosyntactic and semantic constraints are required for coherent sentence interpretation. The implementation manner of these constraints during the formulation and interpretation of sentences is still unresolved. Some researchers have argued that during language comprehension, morphosyntactic, semantics and phonology are processed serially (Friederici, 2002) whilst others suggest that these levels are processed in parallel (Marslen-Wilson & Tyler, 1980; MacDonald et al., 1994). These differences affect the assessment of linguistic computations like affixation and co-referencing.

The current ERP study focuses on Akan, an understudied African language, which is also suitable to address issues on phonotactics and morphosyntax. We assess the effect of tone and

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animacy as licensing features for pronominal resumption. To achieve this, we rely on language-related ERP components to help us understand how native Akan speakers process antecedent-trace relationships.

### 4.1.1 Relevant features of Akan to the current study

Akan is the dominant language for about 60 % of Ghanaians. The base word order of Akan is subject-verb-object (SVO). Akan is a tonal language with two main tones, that is, high and low, transcribed as [ ´ ] and [ ` ] respectively (Dolphyne 1988). Akan tones can be lexical, like in Mandarin Chinese: they distinguish between word meanings (e.g., ***pàpà*** 'fan' versus ***pàpá*** 'man'). Unlike Mandarin Chinese, tones in Akan are also used for making grammatical distinctions. For example, tones are used to mark differences between verb tenses (high tone denotes present habitual, whereas low tone marks the past). The current project uses the term *grammatical tone* for linguistic tones with grammatical functions (for a detailed discussion on Akan tones, see Dolphyne, 1988).



*Akan focus constructions and resumptive pronouns*

In discourse comprehension, the ability to resolve co-reference relationships is important for coherence. Such a relationship entails two (pro)nominal elements, that is, a pronoun and its antecedent. The antecedent usually introduces the referent for the first time in its full form (e.g., a full NP). Subsequently, a pronoun is used later in the discourse, which refers to the antecedent's entity. The distribution and use of pronouns mainly depend on semantic-pragmatic factors. However, there are instances in which pronoun use can be syntactically determined. For example, languages such as Akan and Hebrew exhibit a phenomenon called *Pronominal Resumption*.

This pronominal-resumption phenomenon can be studied in relative clauses in which an argument from the relative clause moves to the matrix clause. In the generative framework (Chomsky, 1986), such arguments leave a trace in its original position and this trace is co-indexed with the moved argument. In Standard English, the trace is not phonologically realized (1a). However, in languages such as Akan and Hebrew, the position of the trace is occupied by a phonologically overt pronoun (1b). This pronoun is referred to as a *Resumptive Pronoun (RP).*[7] In Akan, the RP is present in a number of contexts described later in this

[7] We acknowledge the long-standing debate in the theoretical linguistics literature on whether the resumptive pronoun is base-generated or is just a phonological representation of a trace spellout.

section. Since the Akan resumptive pronoun is a phonetically overt realization of the trace, we refer to the resumptive pronoun as a syntactic phenomenon.

(1a) English

I saw the duck$_i$ that John drew $t_i$

(1b) Hebrew

| Ra'itit | et | ha-barvaz$_i$ | she-John | ciyer | **oto$_i$** |
|---|---|---|---|---|---|
| I-saw | ACC | the-duck | that-John | drew | **RP (him)** |

'I saw the duck that John drew'

(Examples taken from Friedmann, 2008: p 141)

Another feature of Akan is that there are several ways of emphasizing elements in a sentence. One of these is focus marking. Here, the information to be emphasized is placed in clause-initial position and marked with a postposition focus marker *na* (Boadi, 2009), as demonstrated in (2a) and (2b).

| 2. a. Papa | nó | edi | akutuo |
|---|---|---|---|
| man | the | PROG.eat | orange |

'The man is eating an orange'

| 2. b. **Akutuo** | nó | **na** | papa | nó | edi |
|---|---|---|---|---|---|
| orange | the | FOC | man | the | PROG.eat |

'It is the orange that the man is eating'.

Such constructions can be used to place focus on either the subject or the object. In English, object relative clauses, object clefts, and object *wh*-questions are strategies for focusing the object. All these different ways of placing emphasis on the object employ antecedent-trace structures. This means that an element (antecedent or object) is base-generated in one position, but moves to another position, leaving a trace, as illustrated in (3).

However, this issue has no bearing on the present study so we have decided to gloss over it (for detailed discussions see Saah 1994; Pesetsky 1998; Van Urk 2018; Korsah 2017).

3. It is the child$_i$ that the man is picking up $t_i$ from school.

Object-focused declaratives in Akan undergo a similar process. However, in Akan, the gap left after the derivation of the NP can be filled with a 'resumptive pronoun' *nò* (Saah 1990), like in example (4). The Akan RP *nò* is produced with a low tone (indicated by ` ). This pronominal-resumption phenomenon is also observed in languages such as Hebrew (Sharvit, 1999) and Arabic (Alotaibi & Borsley, 2013). In addition, the RP in Akan must agree with its antecedent in number. Thus, in (4), the RP *nò* 'him/her' must be singular since *abofra nó* 'the child' is in the singular form. However, when *abofra nó* becomes *mmofra nó* 'the children' (plural), then the RP *nò* must change to *wɔn* 'them' (plural) for number agreement with the antecedent.



4. [Abofra nó]$_i$ na maame nó ɛfa **nò**$t_i$ efri sukuu.

Child the FOC woman the PROG.pick up RP from school

'It is the child that the woman is picking up from school'.

More importantly, for an RP to be a licensed feature, the antecedent must be animate. Thus, a resumptive pronoun can only co-refer to an animate entity (human and animals). For example, if the antecedent *abofra nó* 'the child' in (4) is changed to *kyɛnsen nó* 'the plate', then the presence of a resumptive pronoun makes the sentence ungrammatical, as shown in (5).

5. Kyɛnsen nó na papa nó ɛfa * **nò** efri sukuu

Plate the FOC man the PROG.pick up RP from school

'It is the plate that the man is picking up from school'

*Clause determiner*

The clause determiner (CD) *nó* is an Akan morpheme used in relative and embedded clauses to mark the end of a clause. In (6), the CD *nó* marks the end of the clause *Papa no bae* 'The man came'. Semantically, the CD does not add to the overall meaning of the structure within which it occurs. The CD is produced with a high tone, indicated by [ˊ] (Arkoh and Matthewson, 2013). The realization of the CD is not obligatory (Ofori, 2011). For a detailed

discussion on the Akan CD, see Carla et al. (2019). The CD is homophonous with the definite article in Akan *nó* meaning 'the' and can only be positioned clause finally, see (6).

6. Papa nó bae **nó**, yɛtenaa hɔ

   Man the come.PST CD we.sit.PST there

   'When the man came, we sat there'

*The co-occurrence of the RP and CD*

As shown above, the two morphemes RP and CD differ only in the vowel tone. They can occur in adjacent positions, such as in (7). However, the RP must be realized before the CD, otherwise, the sentence is ungrammatical.

7. Kwantuni nó na papa nó ɛfa **nò nó** wɔ kwan neho.

   traveller the FOC man the PROG.pick up RP CD at road beside

   'It is the traveller that the man is picking up by the roadside'.

From the discussion of the RP and CD, the question that arises is whether native Akan speakers are sensitive to the morphosyntactic requirements of pronominal resumption realization[8]. Since the RP and CD differ only in tone height (Arkoh & Mathewson, 2013), proper phonosyntactic sensitivity needs to complement such morphosyntactic sensitivity. In other words, Akan presents the opportunity to investigate pronominal-resumption processing with an interaction between phonology, morphology, and syntax. This interaction can be measured using an ERP paradigm. In the next section, an overview of relevant Event-Related Potential (ERP) components is given.

### 4.1.2 ERP components

In 1980, Kutas and Hillyard made a major discovery of a semantic-processing component called the 'N400'. This component is a negative deflection that peaks around 400ms after the onset of the semantically anomalous word. Subsequently, other language-related ERP components have been described, such as the left anterior negativity (LAN) and the P600 (Osterhout & Holcomb, 1992; Hagoort, et al., 1993). Traditionally, the LAN and the P600 are

[8] It is worth noting that the presence of the RP and/or the CD is not always obligatory in the resumption position. The trace is sometimes covert; like in English object relative clause.

associated with morphosyntactic processing (Friederici, et al., 1993; Brown & Osterhout, 1999; Friederici, et al., 2002; Molinaro et al., 2011).

Different aspects of syntactic processing have been linked to an early or late left anterior negativity (LAN). The early left anterior negativity (ELAN) is elicited when there is a phrase structure violation (Neville et al., 1991; Friederici & Mecklinger, 1996). This violation demonstrates a mismatch between a predicted word category and an incoming word, violating the phrase structure. The latency of the ELAN is typically observed from 150 ms post-stimulus onset (Friederici et al., 2004; Rossi et al., 2005). Some authors argue that the ELAN demonstrates independent word-category processing, different from other syntactic information types, and is used for local phrase structure formation (Frazier 1987; Friederici 2002). In addition, the ELAN is noted to represent automaticity in response, unaffected by variations in violation probability or task demands (Hahne & Friederici, 1999, 2002). Other studies reported the ELAN as a preceding effect of semantic and morphosyntactic processes (Hahne & Friederici, 2002; Frisch et al., 2004; Friederici et al., 2004; Rossi et al., 2005).



The LAN peaks between 300-500 ms post-stimulus onset (Hahne & Friederici, 1999; Gunter et al., 2000). Just like the ELAN, the distribution of the LAN is left-lateralized and anterior. However, less focalized distribution of the LAN has been reported in a number of studies (Hahne & Jescheniak, 2001; Hahne & Friederici, 2002). Its function is often understood as that of an automatic morphosyntactic error detector as we see in agreement violations (Friederici, 2002; Molinaro et al., 2011). Furthermore, the LAN has been reported in studies on phrase structure violations in which the ELAN was expected (Münte et al., 1993; Hagoort et al., 2003). Therefore, phrase structure violations have been shown to elicit both the ELAN and the LAN, the difference between the two is the early onset of the ELAN. The issue may be due to methodological differences between studies (for a comprehensive discussion on ELAN, see Steinhauer & Drury, 2012).

In most studies, the LAN is followed by the P600 component, a positive deflection most often associated with structural repair and reanalysis (Friederici, et al., 2002; Gouvea, et al., 2010). This positive effect usually starts from 500 ms post-stimulus onset (Molinaro et al., 2011, Popov & Bastiaanse, 2018), with a predominantly centro-parietal scalp distribution (Hagoort & Brown, 2000). However, the onset of the P600 differs between studies, with a number of studies reporting an *early P600*, from as early as 300 ms (Demestre et al., 1999; Friederici & Mecklinger, 1996). Such an early onset can be explained by two factors; in Demestre et al. (1999), the *early P600* was attributed to the short duration of the target one-

phoneme syllable, which was the point of discrimination between grammatical and ungrammatical sentences tested. Therefore, the stimulus length may affect the onset of the P600, particularly in auditory studies (Popov, 2017). A functional explanation is attributed to the *early P600* to the effect that it represents simple structural reanalysis (Friederici & Mecklinger, 1996).

The one-to-one mapping of ERP components to linguistic violations has been claimed to be an oversimplification. For instance, the N400 and P600 are elicited during semantic and morphosyntactic violations, respectively. Brouwer et al. (2012) suggest that the N400 is not strictly related to semantic anomaly but also to unexpected events. For the P600, some researchers argue that it is sensitive to the discrepancy between what is expected and what is actually perceived (Kolk & Chwilla, 2007; Vissers, et al., 2008). According to such accounts, the N400 is elicited when there is a difference between what is perceived and expected. However, if the level of disparity is exceptionally high, the P600 is expected. This is because the P600 is assumed to initiate a structural reanalysis to assess the possible errors perceived (Vissers, et al., 2008).

ERP components are adopted to help us understand how language is processed in real-time. In the next sections, we explore ERP studies on antecedent-trace dependencies and pronoun resolution, the function of animacy in sentence comprehension, as well as tone (pitch) processing.

### *4.1.3 ERP studies on antecedent-trace dependencies and pronoun resolution*

A number of ERP studies have explored antecedent-trace dependencies in English and German *wh*-questions (Kluender & Kutas, 1993a, b; McKinnon & Osterhout, 1996; Müller et al., 1997; Kluender & Münte, 1998; Kaan et al., 2000; Fiebach et al., 2001, 2002; Felser et al., 2003; Phillips et al., 2005). Processing of antecedent-trace dependencies is often associated with the LAN (Müller et al., 1997; Kluender and Münte, 1998). For instance, King and Kutas (1995) noticed a negative slow wave in English relative clauses between the antecedent and the trace. In addition, they reported a phasic LAN effect after the gap. In Fiebach et al. (2001), a sustained LAN was registered for object questions with long filler-gap distance. This sustained negativity was interpreted as a reflection of memory processes required to maintain the displaced object in memory. The LAN is not the only ERP component associated with antecedent-trace dependencies. Kaan et al. (2000) studied *wh*-questions and found the P600 component at the pre-gap position. The positive effect in Kaan

et al. (2000) was described as a mechanism for complex syntactic-integration in filler-gap constructions.

Most studies on pronoun resolution have focused on the agreement between the antecedent and the pronoun. During sentence processing, the features of a pronoun (e.g., number, gender, and case) are expected to match those of its antecedent. A pronoun and an antecedent mismatch result in the elicitation of the P600 (Harris et al., 2000; Schmitt et al., 2002; Hammer et al., 2005, 2008). The pronoun-antecedent mismatch leads to a morphosyntactic repair and a structural reanalysis of the sentence.

Antecedent-trace relationship and pronoun resolution are both linked to agreement processing. Most agreement studies have investigated number and gender agreement in sentence processing (e.gs, Molinaro et al., 2008; O'Rourke & Van Petten, 2011; Caffarra & Barber, 2015; Caffarra et al., 2015, Popov & Bastiaanse, 2018). The LAN and P600 are the ERP components elicited in agreement studies. Usually, a biphasic response on morphosyntactic violation is reported, where the P600 follows the LAN (Gunter et al., 2000; Barber & Carreras, 2005; Molinaro et al., 2008). However, the most consistent agreement marker found in agreement studies is the P600, unlike the LAN, which is not always elicited. For instance, in two Spanish determiner-noun gender agreement studies, Barber and Carreiras (2005) found that the P600 preceded the LAN whilst Wicha et al. (2004) reported only the P600. There is still no clear explanation for the LAN's random distribution across studies.



### 4.1.4 ERP studies on tone (pitch) processing

The correlation between pitch processing and language encoding has been studied using ERP components (Hruska, et al., 2001; Johnson, et al., 2003; Magne, et al., 2005). Hruska et al. in 2001 examined the correlation between information processing and intonational phrase boundaries in German by presenting spoken sentences to participants. Participants were asked focus questions about a noun or a verb in the target sentences. Hruska et al. (2001) reported a negative peak within 200-400 ms after the onset of focused words in the target sentences with no intonation focus. However, the distinction between linguistic pitch processing and lexical tone processing (with both lexical and grammatical functions) should be made.

Linguistic tones in languages like Chinese and Thai use pitch contours to make lexical distinctions. ERP studies investigating lexical tone violations (e.g., in Mandarin and Cantonese) have reported an N400 effect (Brown-Schimdt & Canseco-Gonzalez, 2004; Li et

al., 2008) and a P600 effect (Kung et al., 2014). There are still no clear explanations why both an N400 and a P600 are elicited in lexical tone violations. However, in both Li et al. (2008) and Kung et al. (2014), the underlying mechanism responsible for the elicitations is a processing difficulty arising from a mismatch between lexical tone and intonational information during spoken discourse comprehension.

Apart from lexical tones, Akan uses linguistic tone to distinguish grammatical categories. The issue of grammatical tone processing has been rarely addressed in the literature. The immediate question grammatical tone processing poses is whether it mirrors the processing mechanism of morphologically realized affixes. Two ERP studies have looked into the role of pitch accent in Swedish and its role in the grammatical context (Söderström et al., 2016; 2017). Swedish marks lexical words with either falling or rising tone, with a limited number of minimal pairs. Moreover, the lexical tone on the stem is sensitive to inflectional morphology, with certain suffixes requiring either a low or a high tone on the stem. Two Swedish ERP studies investigated how listeners use morphologically relevant tonal cues in words to predict word endings (Söderström et al., 2016; 2017). In the Swedish studies, Pre-Activation Negativity (PrAN) was reported between 100 and 200 milliseconds. This finding suggested that tones in Swedish word stems have a pre-activation effect on word endings like suffixes.

Further cross-linguistic investigations will help us better understand tone processing, especially grammatical tone processing. The current project explores the role of grammatical tone in the processing of Akan pronominal resolution and resumption. Unlike in Swedish, grammatical tone in Akan is completely independent of inflectional morphology, thus creating an instance of a language with a pure grammatical tone.

### 4.1.5 ERPs on animacy processing

ERP experiments studying animacy-processing mainly examined the connection between the predicate and its arguments. This connection shows how stored semantic information of verbs restricts potential argument selection during lexical-semantic processing. For example, in the sentence *the accountant promoted the *table* …, the noun phrase *table* is semantically anomalous because *promoted* selects for an animate rather than an inanimate entity as a direct object. In ERP studies, animacy violations elicit the N400 in a sentence in which the incongruity occurs on the predicate, such as in *the window was *flattered* (Rösler, et al., 1993; Hahne & Friederici, 2002; Bornkessel-Schlesewsky, et al., 2011). Other studies found

the N400 effect on one of the predicate's arguments, for example, *the contractor knew whether the plumber called the *pipe on site* (Ainsworth-Darnell, et al., 1998; Friederici & Frisch, 2000; Paczynski & Kuperberg, 2011). The P600 component has also been reported in relation to animacy violations (Hoeks et al., 2004; Kuperberg et al., 2007; Stroud 2008) in sentences like *every evening at dinner, the cake would *climb.* The P600 elicited in these sentences has been described as a 'semantic P600'. There have been several accounts explaining the difference between the semantic P600 and the N400. However, the issue is outside the current study's scope (for a detailed discussion, see Paczynski & Kuperberg, 2011).



Animacy processing in pronoun resolution is understudied and this is partly because most languages that have been investigated do not have a distinctive animacy feature on pronouns for pronominal processing (Schmitt et al., 2002; Callahan, 2008; Hammer et al., 2008). The common pronominal features examined in pronoun resolution studies are case, gender and number (Harris et al., 2000; Schmitt et al., 2002; Hammer et al., 2005; 2008; Molinaro, et al., 2008). However, in languages like Akan, animacy is essential in pronoun resolution, that is, the [+animacy] feature of the antecedent licenses the RP. Of particular interest is the fact that in Akan, tone identification is crucial in animacy agreement. The question that arises is whether the Akan speaker processes an animacy-feature mismatch as has been observed in previous studies that investigated gender and number violations. The present study also examines the processing of grammatical tone as an animacy-feature marker in the processing of Akan pronoun resolution.

### 4.1.6 Current study

The focus of the present work is on the effect of grammatical tone, word order and animacy violations in Akan pronominal resolution and resumption. In the current study, a phonological aspect of pronominal resolution is introduced to the ongoing discourse. We highlighted two fundamental conditions in the formation of Akan focus constructions. First, there must be a grammatical tone, number and animacy agreement between the displaced NP and the resumptive pronoun. Secondly, the resumptive pronoun must always precede the clause determiner when they co-occur. These unique features enable us to examine the interaction between phonology, syntax, and semantics in Akan pronoun resolution. Thus, the questions we seek to answer are:

1) Are native Akan speakers sensitive to the violations of the resumptive pronoun in a context in which the resumptive pronoun *nò* and the clause determiner *nó* co-occur with positions interchanged? If so, at which level, phonological or syntactic, do they perceive this violation?
2) What is the role of animacy in the construction of pronominal resolution and resumption in Akan?

Regarding the first research question, the violation can be recognized under two conditions: 1) the participant is aware of the distributional properties of the RP and CD; 2) the participant can correctly process the grammatical tone which differentiates the RP from the CD. Since we tested only native speakers, our participants should fulfill both criteria. Therefore, the detection of the word order violation is highly probable since the RP cannot follow the CD. We expect the word order violation, triggered by grammatical tone identification, to elicit the (E)LAN. In the scenario where the parser's strategy is to repair the violated tonal pattern on the RP and CD, we expect the (E)LAN to be followed by the P600. However, since the RP is not obligatory, the most economical approach would be to simply ignore it. This approach implies a less complex repair process and a less pronounced P600 effect (if any).

Animacy mismatch is expected to pattern with the most commonly reported biphasic LAN-P600 pattern in agreement studies. The N400 is not expected because the animacy violation tested here is mainly phonosyntactic and not semantic like in previous studies (Hahne & Friederici, 2002; Bornkessel-Schlesewsky, et al., 2011). Again, in order for the violation to be registered, participants need to: 1) be aware that only animate antecedents license the RP; 2) be sensitive to the grammatical tone – if they perceive or reanalyze the RP as CD, there will be no violation. Once the violation is detected, we expect the LAN as an automatic response to a morphosyntactic violation. However, since the LAN is not consistently registered in agreement studies (e.g., Wicha et al., 2014), the LAN may be absent despite an obvious morphosyntactic error. We expect an ensuing structural repair to be marked by the P600 when there is an animacy mismatch between the pronoun and its antecedent. This expectation also implies that we proceed with the assumption that Akan speakers are sensitive to a mismatch in animacy in relation to the use of grammatical tone as the distinguishing factor. The table below summarizes our predictions based on the research questions.

Table 4.1 Summary of predictions for the current study.

| Research Questions | Predictions (ERP components) | |
|---|---|---|
| 1. Expectations when the syntactic order of the RP *nò* and the CD *nó* is switched | (E)LAN | P600? |
| 2. Expectations when there is animacy mismatch between the RP and its antecedent | LAN? | P600 |

## 4.2 Materials and methods

### 4.2.1 Participants



In the present study, 23 native Akan speakers were recruited (4 females; mean age = 25.8, age range= 23 – 40) in Amsterdam, The Netherlands. All participants were right-handed, as confirmed by the Edinburgh Handedness Questionnaire (Oldfield, 1971), and had no reported history of neurological diseases. They all had normal to corrected-to-normal vision. Participants were enrolled at a university or had a degree from Ghana or The Netherlands. None of them had studied psychology or linguistics. They were all unfamiliar with grammaticality judgment tests and ERPs. We will come back to this in the discussion. The study was approved by the Research Ethics Committee (CETO), University of Groningen. Participants signed informed consent before the experiment began. Each participant received 15 euros for participation.

### 4.2.2 Materials

Stimuli consisted of 240 experimental items and 120 filler items. The items were recorded in a soundproof studio booth with the Adobe Audition software, at the University of Groningen. There were 4 target conditions indicated as: 1) Word-order grammatical 2) Word-order ungrammatical 3) Animacy grammatical 4) Animacy ungrammatical. Stimuli were divided into two lists according to the Latin square design, with each participant being exposed to only one list of 180 stimuli. Prior to the experiment, all items underwent an acceptability rating by 10 native speakers of Akan (mean age= 26.6), who had at least a university degree. The raters neither had a degree in linguistics nor in psychology. Sentence rating was done online. The raters listened to sentences and indicated '1' or '0' for acceptable and unacceptable sentences respectively. The instruction was for raters to attentively listen to each sentence and give their response based on their first intuition. Raters could listen to each sentence more than once; whether they had the sentence repeated was not registered. Each

item was judged as correct by at least 80 % of the participants. None of the raters took part in the ERP experiment. This result also confirms the previous assumption that Akan speakers are sensitive to tone as a distinguishing factor in the conditions being tested.

For the word-order conditions (8), the critical region was the resumptive pronoun and the clause determiner. To form the violated word order condition, the order of the RP and CD was switched (8a and 8b). Each sentence was made of two noun phrases (agent and theme), a verb, the RP and CD, and a prepositional phrase. The position of the critical word was constant across conditions. The mean length of sentences for the word-order conditions was 2.99 seconds. In the experimental items tested, the mean intensity levels of RP and CD were 63.69dB and 72.95dB respectively. The mean pitch levels were, 108.22Hz for the RP and 144.04Hz for the CD. In Figures 4.1 and 4.2, the spectrograms illustrate the difference between the RP and CD in 8a and 8b.

(8) Examples of word-order condition

a. *Grammatical*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $\text{Akua}_{\text{theme}}$ | na | $\text{Mansa}_{\text{agent}}$ | epia | nò | nó | ɛwɔ | fie | hɔ |
| Akua | FOC | Mansa | PROG.push | RP | CD | at | house | there |

'It is Akua who Mansa is pushing in the house'

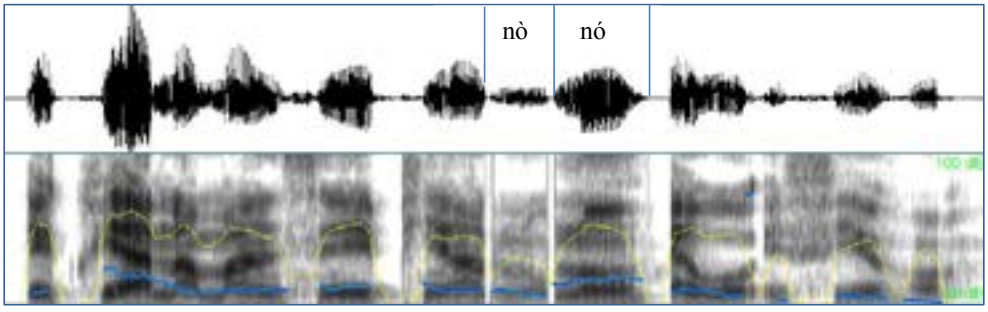


Figure 4.1 shows the spectrogram of (8a) and illustrates the correct positioning of the resumptive pronoun when it co-occurs with the clause determiner. The blue and yellow lines depict pitch and intensity patterns respectively.

b. *Ungrammatical*

| Akua | na | Mansa | epia | nó | *nò | ɛwɔ | fie | hɔ |
|---|---|---|---|---|---|---|---|---|
| Akua | FOC | Mansa | PROG.push | CD | RP | at | house | there |

'It is Akua who Mansa is pushing in the house'

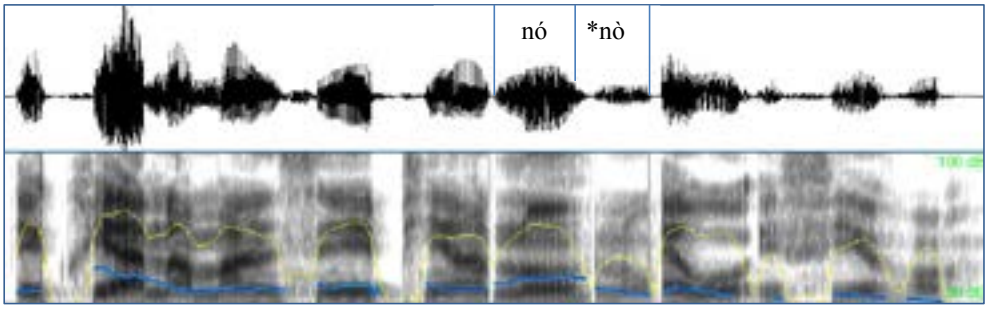


Figure 4.2 shows the spectrogram of (8b) and illustrates the wrong positioning of the resumptive pronoun when it co-occurs with the clause determiner. The blue and yellow lines depict pitch and intensity patterns respectively.

For experimental items in the animacy conditions, the first NP and the verbs for both the correct and violated conditions were controlled for plausibility. Thus, we made sure selected predicates legally applied to both animate and inanimate entities. So in (9), the verb *twɛn* 'wait for' can be used with both animate (John) and inanimate (*nsuo*: 'water') objects. However, the presence of the RP *nò* in (9b) renders the sentence ungrammatical because it cannot refer to the inanimate NP *nsuo* 'water'.

(9) Examples of animacy condition

a. *Grammatical*

| John | na | Mary | ɛtwɛn | $_{\text{trigger}}$\|nò | wɔ | dan | nim |
|---|---|---|---|---|---|---|---|
| John | FOC | Mary | PROG.wait for | RP | at | room | inside |

'It is John who Mary is waiting for in the room'

b. *Ungrammatical*

| Nsuo | na | Mansa | ɛtwɛn | $_{\text{trigger}}$\|*nò | wɔ | dan | nim |
|---|---|---|---|---|---|---|---|
| water | FOC | Mansa | PROG.wait for | RP | at | room | inside |

'It is water that Mansa is waiting for in the room'

We used filler sentences, presented once as either grammatical or ungrammatical (10a and 10b). For the ungrammatical filler sentences (like 10b), the bound pronoun morpheme *ɔ* 'he' of the structure *ɔgye:* 'he takes' was omitted.

(10) Examples of fillers

a. *Grammatical*

| Kwabena | na | ɔgye | book | no | wɔ | nensam |
|---|---|---|---|---|---|---|
| Kwabena | FOC | he.take | book | the | at | POSS.hand |

'It is Kwabena who is taking the book from him'.

b. *Ungrammatical*

| Kwabena | na | *_gye | book | no | wɔ | nensam |
|---|---|---|---|---|---|---|
| Kwabena | FOC | take | book | the | at | POSS.hand |

'It is Kwabena who is taking the book from him/her'.

### 4.2.3 Procedure

Participants sat comfortably facing a screen from a distance of about 80cm. The task was to listen to Akan sentences attentively and make a grammaticality judgment after each sentence. E-prime 2.0 (Psychology software tools, Inc.) was used as the presentation software. The details of the tasks were clearly explained to the participant with examples. In addition, instructions were presented on the screen with 5 practice items. The experimenter asked several times whether participants required further clarification before the actual experiment started. The presentation of the 180 experimental stimuli was done in 4 blocks. Participants had the opportunity to take a break after each block and continued with the experiment when they were ready. An experimental session lasted for 25-30 minutes.

Sentences were auditorily presented through headphones. Each stimulus was preceded by a fixation cross (500ms) on a black background. After each stimulus presentation, a white question mark appeared. Participants were then required to make a grammaticality judgment with a gamepad in hand. The gamepad had a red and green button, representing grammatical and ungrammatical sentences respectively.

### 4.2.4 EEG recording and data analysis

The electroencephalogram recording was done from a 32 Ag/AgCI scalp electrodes (WaveGuard), employing the EEGO (ANT Neuro Inc. Enschede, The Netherlands). Data were recorded at a sampling rate of 500 Hz, using the online common average reference. Impedances were kept below 10 KΩ.



After data acquisition, offline processing was done with the Brain Vision Analyzer 2.0.4 software (Brain Products, GmbH, Munich, Germany). First, data were re-referenced to the average of the mastoids. This was followed by offline filtering, using a band-pass filter (0.1 – 30 Hz) and an ICA-based eye-blink correction. Data segmentation was done in epochs from 200 ms before the onset of the critical word (the resumptive pronoun in all conditions), until 1000 ms post-word onset. An automatic artifact rejection was then applied, and all epochs containing activities exceeding +/- 75 μV were excluded. Baseline correction was applied starting from -200 ms until 0 ms pre-stimulus onset. Finally, an averaging was done for each participant and each condition. At this stage, all participants who fulfilled the 60 percent threshold of averaged trials in all conditions were included in the grand average.

*Analysis*

The scalp electrodes were divided over 8 regions of interest (ROIs): left anterior (F3, F7, FC5), right anterior (F4, F8, FC6), left central (C3, CP5), right central (C4, CP6), left posterior (O1, P3, P7), right posterior (O2, P4, P8), midline central (CP1, CP2, Cz) and midline posterior (O2, POz, Pz). After a detailed visual inspection of the grand averages, statistical analysis was performed on 2 time windows: 300-500 ms and 500-800 ms. The first time window was meant to test the LAN and the later time window was for the P600.

For statistical analysis, a repeated measure ANOVA was conducted on the following within-subject factors: conditions (2 levels: word order and animacy); grammaticality (2 levels: grammatical and ungrammatical); hemisphere (2 levels: left and right); anteriority (3 levels: anterior, central and posterior). We employed two separate omnibus ANOVAs for each time

window. In the first ANOVA, only lateral regions were analyzed with all four factors. The factor hemisphere was excluded in the second midline ANOVA, and there were two levels of anteriority only and the analysis was run on the other factors. The significance level was set to $p < .05$, when there were marginally significant interactions ($p < .1$) that included factor grammaticality. For posthoc pairwise comparisons, the Bonferroni adjustment was applied.

## 4.3 Results

### 4.3.1 Behavioral results

Table 4.2 shows the individual performance of the grammaticality judgment task on each experimental condition.

Table 4.2 Individual scores (in percentages) on grammaticality judgment tasks during testing.

| **Conditions** | **12 Participants for List 1 (180 items)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P1 | P2 | P3 | P4 | P5 | P6 | P7 | P8 | P9 | P10 | P11 | P12 | ***Mean*** |
| Word order Gr. | 86.6 | 63.3 | 53.3 | 86.6 | 60 | 66.6 | 90 | 86.6 | 60 | 63.3 | 93.3 | 86.6 | *74.7* |
| Word order Ungr. | 33 | 30 | 43.3 | 3.3 | 40 | 40 | 16.6 | 36.6 | 53.3 | 36.6 | 10 | 100 | *36.9* |
| Animacy Gr. | 68.9 | 65.5 | 58.6 | 89.6 | 48.2 | 72.4 | 93 | 51.7 | 100 | 55.1 | 100 | 96.5 | *75* |
| Animacy Ungr. | 46.6 | 80 | 80 | 40 | 90 | 36.6 | 56.6 | 73.3 | 16.6 | 70 | 23 | 10 | *51.9* |
| Filler Gr. | 90 | 80 | 73.3 | 100 | 70 | 76.6 | 100 | 63.3 | 96.6 | 93.3 | 93.3 | 100 | *86.4* |
| Filler Ungr. | 13.3 | 10 | 53.3 | 6.6 | 36.6 | 20 | 73.3 | 40 | 3.3 | 6.6 | 6.6 | 10 | *23.3* |
| ***Mean*** | *56.4* | *54.8* | *60.3* | *54.4* | *57.5* | *52* | *71.6* | *58.6* | *55* | *54.2* | *54.4* | *67.2* | *58* |
| **11 Participants for List 2 (180 items)** | | | | | | | | | | | | | |
| | P13 | P14 | P15 | P16 | P17 | P18 | P19 | P20 | P21 | P22 | P23 | | ***Mean*** |
| Word order Gr. | 93.3 | 66.6 | 96.6 | 43.3 | 76.6 | 80 | 96.6 | 73.3 | 60 | 96.6 | 96.6 | | *80* |
| Word order Ungr. | 73.3 | 46.6 | 6.6 | 76.6 | 33.3 | 16.6 | 10 | 30 | 36.6 | 6.6 | 10 | | *31.5* |
| Animacy Gr. | 70 | 70 | 90 | 80 | 70 | 73.3 | 96.6 | 56.6 | 66.6 | 56.6 | 90 | | *74.5* |
| Animacy Ungr. | 66.6 | 66.6 | 26.6 | 63.3 | 70 | 86.6 | 13.3 | 60 | 76.6 | 40 | 40 | | *55.4* |
| Filler Gr. | 93.3 | 93.3 | 93.3 | 96.6 | 83.3 | 93.3 | 93.3 | 90 | 83.3 | 96.6 | 100 | | *92.4* |
| Filler Ungr. | 63.3 | 20 | 0 | 36.6 | 23.3 | 36.6 | 20 | 10 | 70 | 6.6 | 3.3 | | *26.3* |
| ***Mean*** | *76.6* | *60.5* | *52.2* | *66.1* | *59.4* | *64.4* | *55* | *53.3* | *65.5* | *50.5* | *56.7* | | *60.02* |

Gr. - 'Grammatical'; Ungr. - 'Ungrammatical'

On average, the participants performed at chance level (59%), but they performed significantly better on the grammatical than on the ungrammatical sentences ($t(5)=5.31$, $p=0.0032$). This means that there is a *yes*-bias: the participants tend to say 'yes' when they perform the task. As can be seen in Table 4.2, participants generally perform better on grammatical sentences than on ungrammatical sentences in all conditions, including fillers that did not have tone violations. This means that neither the tone nor inflectional violations were perceived as ungrammatical. However, none of the participants were excluded from the ERP analysis. We will come back to this in the *Discussion*.

### 4.3.2 ERP results

*Topographic maps*

From approximately 300-500 ms post-stimulus onset, a visual inspection of waveforms and topographic maps showed a left-lateralized, mainly anterior negativity in the word-order condition (Figure 4.3). The ungrammatical word order sentences elicited a more negative waveform compared to the grammatical sentences.

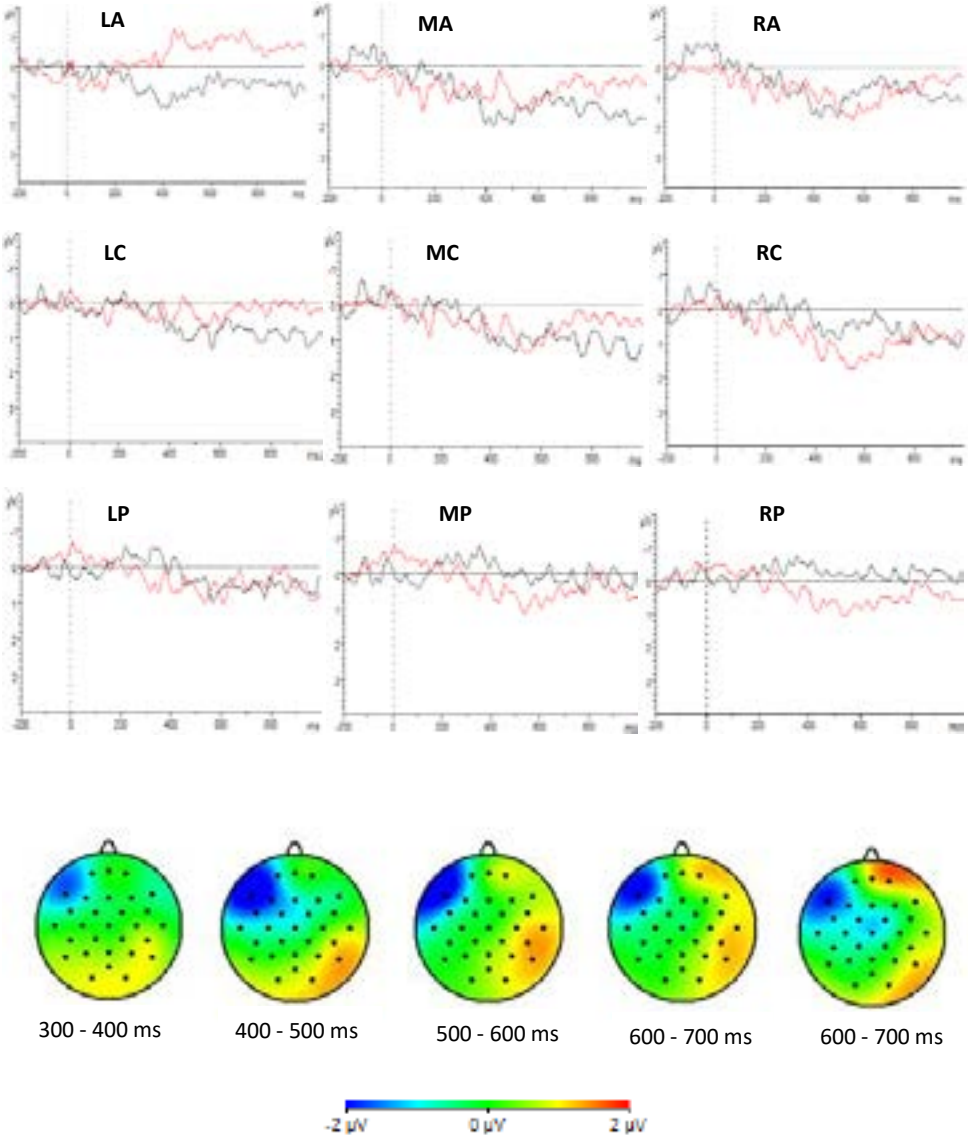

Figure 4.3 shows the Grand Average ERPs across the regions of interest for the tone condition. The black and red waveforms represent grammatical and ungrammatical sentences respectively. The topographical maps depict the difference between a grammatical and ungrammatical sentence.

The animacy-condition visuals indicate a centro-parietal positivity from 300 ms (Figure 4.4). Like the word-order condition, this positivity was caused by the ungrammatical animacy condition.

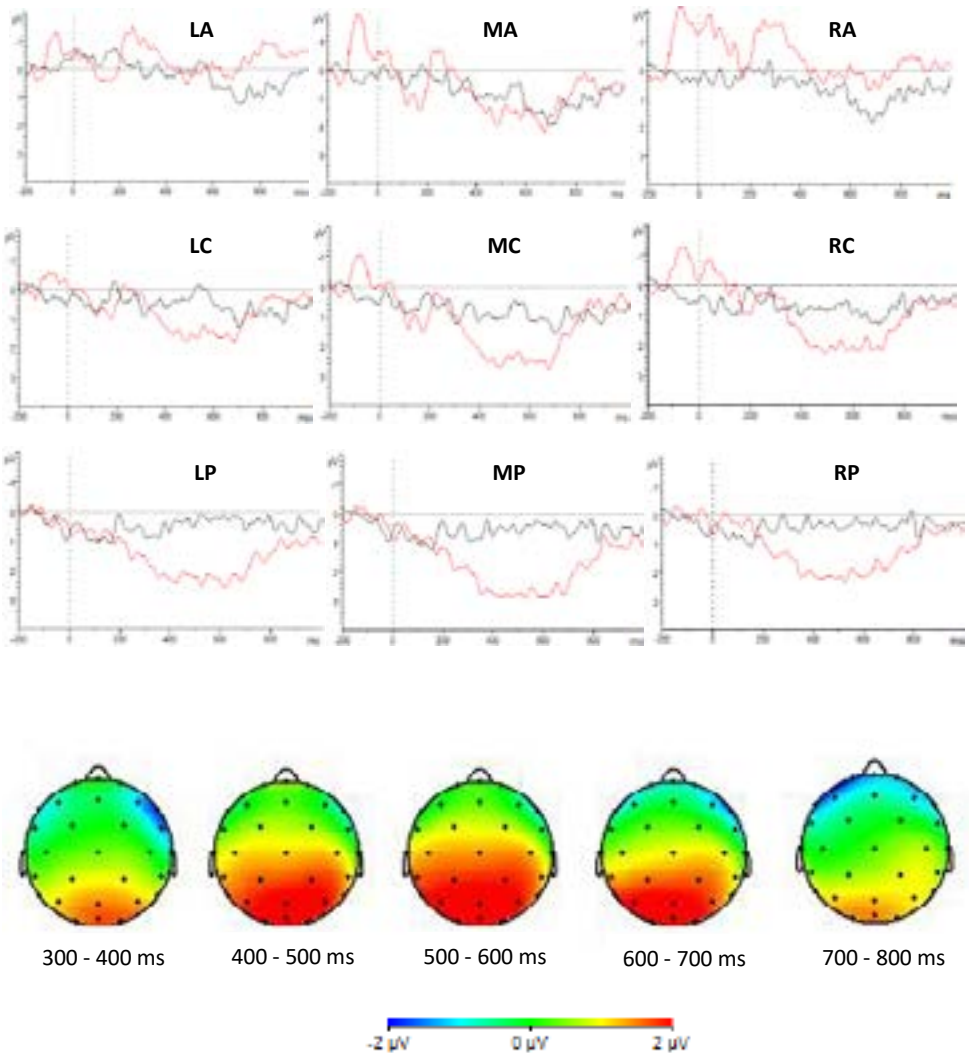


Figure 4.4 shows the Grand Average ERPs across the regions of interest for the animacy condition. The black and red waveforms represent grammatical and ungrammatical sentences respectively. The topographical maps depict the difference between a grammatical and ungrammatical sentence.

Analysis of time windows

*300 – 500 ms*

The omnibus ANOVA on the lateral regions (300-500 ms) yielded a significant interaction between grammaticality and anteriority ($F(2, 44 = 19.36, p < .001$). Follow-up tests showed that ungrammatical sentences elicited a more negative response than grammatical sentences in the anterior regions ($t(22) = 2.64$, $p < .05$), and a more positive response in the posterior regions ($t(22) = -3.65$, $p < .01$).

In the midline analysis, the main effect of grammaticality was significant ($F(1, 22) = 6.03$, $p < .05$), as well as the grammaticality*anteriority interaction ($F(1, 22) = 16.18$, $p < 0.01$). The post-hoc analysis revealed that ungrammatical sentences elicited a more positive waveform than grammatical sentences in the posterior region only ($t(22) = -3.86$, $p < .001$).

*500 – 800 ms*

In the 500-800 ms, a significant interaction between grammaticality and anteriority was recorded ($F(2, 44) = 15.09$, $p < .001$), as well as two marginally significant three-way interactions: condition*grammaticality*hemisphere ($F(1, 22) = 3.06$, $p < .1$) and condition*grammaticality*anteriority ($F(2, 44) = 3.53$, $p < .1$). The three-way interaction with the factor hemisphere did not yield any significant results in the post-hoc analysis. The follow-up on the interaction with the factor anteriority showed that ungrammatical sentences in the animacy condition elicited a more positive waveform than grammatical sentences in the posterior regions ($t(22) = -3.24$, $p < .01$).

The midline analysis showed an overall effect of grammaticality ($F(1, 22) = 6.49$, $p < .05$), as well as an interaction between grammaticality and anteriority ($F(1, 22) = 10.84$, $p < .01$) and grammaticality and condition ($F(1, 22) = 5.24$, $p < .05$). The follow-up on the latter interaction revealed that ungrammatical sentences elicited a marginally more positive effect only in the animacy condition ($t(22) = -2.4$, $p < . 1$).

*Results summary*

The statistical analysis established the presence of two ERP components, the LAN and the P600. The LAN was evident in both the word order and animacy conditions. This negative effect was significant 300 – 500 ms post-stimulus onset.

The P600 showed a relatively early onset (300-500 ms) and was statistically attested in both conditions. However, the P600 was present only in the animacy condition in the later time window (500 – 800 ms).

## 4.4 Discussion

The current study investigated the effect of grammatical tone and animacy in the processing of Akan pronominal resolution and resumption. We explored the processing of resumptive pronouns and clause determiners involved in Akan focused structures formation and the rules that govern their use.



Interestingly, the participants of the ERP-experiment performed poorly on the grammaticality-judgment task. Even though they were better on the grammatical sentences, as a group, participants were mostly either at or below chance in ungrammatical conditions. These results are interesting in two respects. First, all sentences had been tested via the internet with native speakers of Akan. In all conditions, the accuracy score for each item was or above 80%, indicating that Akan speakers do notice the target violations. However, the behavioral data show that the participants of the ERP-experiment were not sensitive to the target violations when they had to judge the sentences. It may also be that the background of our participants is different from that of participants in most of the ERP-experiments on language. These are usually students of Linguistics or Psychology, who are familiar with EEG and ERP and with judging the grammaticality of written sentences. Our participants were neither familiar with the ERP-methodology nor with grammaticality judgment. Moreover, the experimental sentences were presented auditorily. The main difference between the pre-test (acceptability-rating test) and the behavioral test in the ERP experiment was, participants could listen to each sentence more than once, which was not the case in the ERP-experiment. Since we did not anticipate this discrepancy, we did not keep track of the number of times sentences were repeated in the acceptability-rating test. The subtleness of the linguistic violations tested in the present study could have caused participants to miss violations during the ERP-experiment. Further discussions with participants after testing ended indicated that they understood all instructions and also confirmed they were aware of the violations.

Regardless of the behavioral results, ERP-experiment participants' scalp recordings indicate violation detection. The ERP-results are clear: in all violation conditions, we find the effects that we more or less expected. The elicitation of the LAN and the P600 components in the

present study suggests that Akan speakers are sensitive to the violations of pronominal resolution and resumption rules, even though they do not indicate correctly whether a sentence is grammatical or not.

### 4.4.1 Grammatical tone and word-order violation

Phrase structure violations, which include word-order violations, have been reported to elicit the early left anterior negativity (ELAN), approximately 150-300 ms post-stimulus onset (Friederici et al., 2004; Rossi et al., 2005). However, the detection of morphosyntactic violations has mainly been associated with left-lateralized negativity, usually 300-500 ms post-stimulus onset (Osterhout & Holcomb, 1992; Hagoort, et al., 1993; Hahne & Friederici, 1999; Gunter et al., 2000). It should be noted that both the localization and the time window of the LAN have been inconsistently reported across studies. For instance, Hagoort et al. (2003) reported bilateral anterior negativity starting at 300 ms from the onset of a word-category violation in an auditory experiment. This observation is important to our study because it shows that word-category violations can elicit anterior negativity in a broad time-window, approximately between 150 and 500 ms post-stimulus onset.

Our results show the LAN in the word-order condition, where the positions of the resumptive pronoun *nò* and the clause determiner *nó* are interchanged. For example in *John na papa nó epia nó*$_{CD}$ **nò*$_{RP}$ 'John is the one the man is pushing', the sentence remains grammatical until the resumptive pronoun is encountered. A negative peak was observed between 300 – 500 ms in the left anterior regions post-stimulus onset. The LAN effect in the word-order condition suggests the sensitivity of Akan native speakers to the tonal differences between the resumptive pronoun and the clause determiner in antecedent-trace dependencies. Listeners first have to be sensitive to the tonal differences for the violation to be detected because the RP and CD are phonemically the same. Listeners' sensitivity to the tonal differences assisted the recognition of the word-order violation (…*nó*$_{CD.}$ **nò*$_{RP}$). We assume the LAN here represents the detection of the word-order violation since an RP cannot follow a CD. This negative effect is also in line with results from studies on phrase structure violations (e.g., Münte et al., 1993; Hagoort et al., 2003).

In studies where the LAN is registered, a positive effect in the form of the P600 is usually reported (Osterhout & Holcomb, 1992; Gouvea et al., 2010). Statistical analysis shows that in the word-order condition, a positive effect was registered in the same time window as the LAN, 300 – 500 ms. We would like to point out that, despite the statistical significance of the

positive effect in the 300 – 500 ms time window, the P600 effect was almost completely absent from the waveforms (Figure 4.3). However, this co-occurring positive and negative effect highlights the detection of the tonal violation of the resumptive pronoun and the clause determiner and also demonstrates a structural integration that happens parallel to the violation detection. The question that arises is why the positive effect is not sustained in the 500 – 800 ms time window for the word-order condition. This result could be because the syntactic repair happens locally between the resumptive pronoun and the clause determiner. Here, we see an interaction between phonology and syntax, where the detected tonal violation is corrected by a syntactic repositioning of the resumptive pronoun. In essence, listeners could solely have been engaged in exchanging just the tones, thereby syntactically rearranging the two morphemes for the repair. There is no need to re(establish) a relationship between the antecedent and the resumptive pronoun. This leads to another repair strategy the parser could adapt. A minimalist strategy for the repair of the word order is for the parser to simply omit the resumptive pronoun. The use of the resumptive pronoun is optional in this environment and its omission results in a grammatical sentence. Consequently, the simplest strategy is to reanalyze the clause in the way that the clause determiner marks the end of the clause by deleting the resumptive pronoun. This strategy may be the most economical approach to resolving the syntactic violation, and since it requires only one simple operation (i.e., deletion of RP), it is likely to elicit only a weak positive effect.



### 4.4.2 Tone triggered animacy effect

The current project also explored tone and animacy in Akan antecedent-trace dependencies when processing pronominal resumption. Pronoun resolution in antecedent-trace dependencies has been extensively studied using ERPs (e.gs., Harris et al., 2000; Schmitt et al., 2002). These studies have shown the elicitation of both positive (P600) and negative (LAN, N400) language-related ERP components in antecedent-trace violations (Müller et al., 1997; Kluender & Münte, 1998; Harris et al., 2000; Schmitt et al., 2002). These findings are in line with the results of the present study, which also elicited the LAN and the P600 when the resumptive pronoun and its antecedent did not agree in animacy.

Previous studies on animacy have mainly reported a P600 when the animacy condition was violated (Hoeks et al., 2004; Kuperberg et al., 2007; Stroud 2008). However, animacy violation in pronominal resolution and resumption, as well as in agreement studies in general, has been understudied. In Akan, the resumptive pronoun can occur only with an animate antecedent, making the relationship between the resumptive pronoun and its antecedent akin

to animacy agreement. In the present study, a violation of this rule elicited a LAN and a P600, which is in line with what has been found in most agreement studies (e.g., Molinaro et al., 2011).

In Akan, the animacy violation is identified after the recognition of the low tone on the morpheme *nò*, which is a resumptive pronoun. Processing the resumptive pronoun is impossible because the listener is unable to make the coreference between the resumptive pronoun and an inanimate antecedent. This violation detection is reflected in the elicited LAN (Friederici, 2002; Molinaro et al., 2011).

The tone identification in the animacy condition is important because a high tone on the morpheme *no* would render the sentence grammatical. The morpheme would then be understood as a clause determiner *nó* in this case. So this is how we expect the repair of the violation to unravel – the parser changes the tone on *no* from low to high if the antecedent is inanimate. In doing so, the parser changes/repairs the resumptive pronoun *nò* to a clause determiner *nó* which makes the sentence grammatical regardless of the antecedent's animacy status. Unlike in the word-order condition, this violation cannot be repaired locally by simply omitting one word without establishing the relationship with the antecedent. Here, the antecedent's animacy value has to be reactivated and a link established between the *nò* and the antecedent to check whether a co-reference can be established. In case it cannot, the tone on the *nò* is changed, which repairs the whole structure. This complex repair mechanism results in a large P600 effect lasting well until 800 ms post-stimulus onset.

The last issue that has to be addressed is the early onset of the P600, approximately 300 ms post-stimulus onset. The early realization of this positive effect can be attributed to the mode of stimulus presentation (auditory) and a relatively short duration of the target word (app. 130 ms). Such an *early P600* is in line with previous studies that used auditory presentation (Domestre et al., 1993; Friederici & Mecklinger, 1996).

In a number of studies, a positivity has been elicited on tone processing (Scabini, 1998; Escera et al., 2000; Friedman et al., 2001). We assume that the early positivity in our study depicts an *early P600* (300 – 800 ms). We argue that this early positivity is unique to the animacy condition. The statistically significant positive effect for the 300 – 500 ms time window analysis was in the posterior regions. The topographic maps and the ROI waveforms corroborate this assertion. Our results show that phonologically triggered animacy violations in relation to antecedent-trace referencing in Akan undergoes a structural repair and

reanalysis. The negative and positive effects are also evidence for an interaction between phonology and syntax in agreement formation.

## *Conclusion*

The current study contributes to a large body of literature on morphosyntactic agreement violations. We tested the role of grammatical tone processing in pronoun resolution and resumption. The experimental manipulation of the word-order condition (switched RP and CD positions) elicited the LAN concurrently with an early positive effect (300 – 500 ms). For the animacy condition, the same results were found, but the P600 was relatively sustained. We associate the early elicitation (from 300 ms) of the P600 to the mode of stimuli presentation and the target word's length. This shows that ERP components such as the LAN and P600 are sensitive not just to morphosyntactic violations but also to phonosyntactic incongruences.

# CHAPTER 5

## General discussion and conclusions

## General discussion and conclusions

This dissertation focused on processing pronominal resolution and resumption in Akan speakers. The exploration of this subject was motivated by the unique characteristics of Akan in the formation of pronominal resolution and resumption. In chapter 1, we highlighted these unique features: the variant distribution of two morphemes, the resumptive pronoun *nò* (RP) and the clause determiner *nó* (CD) in Akan focused constructions. In addition, we identified the role of grammatical tone and animacy in the formation of pronominal resolution and resumption. The current project which included two behavioral studies and an ERP study helps us better understand Akan pronominal resolution and resumption. Our research questions were;

1. How do Akan speakers with agrammatism comprehend and produce Akan focus constructions;
   a) With only a resumptive pronoun
   b) With only a clause determiner
   c) With both a resumptive pronoun and a clause determiner
   d) With the gap left empty
2. Which neurolinguistic account(s) explain(s) the processing of focus constructions in Akan best?
3. Are native Akan speakers sensitive to the tonal differences between RPs and CDs in focus constructions?
4. How can ERPs help us better understand the effect of tone and animacy on resumption in Akan?

This discussion provides an overarching outlook on the issues presented in chapter 1 in relation to the major findings of the experimental chapters.

### 5.1 Resumptive pronoun and clause determiner processing in agrammatism

Akan is a tonal language and tone is used to make both lexical and grammatical distinctions. In chapter 1, it was demonstrated that the Akan morpheme *no*, can be identified both as a resumptive pronoun *nò* and a clause determiner *nó*. Even though the two morphemes are phonemically the same, they play different roles in a sentence. Whilst the resumptive pronoun coreferences a moved nominal element in Akan focus constructions, the clause determiner marks the end of a clause and also places an emphasis on the clause or proposition preceding it.

The distribution of pronouns varies across languages. For instance, languages such as Hebrew, Hausa, and Akan, have a phenomenon called *pronominal resumption,* which is not seen in most Indo-European Languages.

Pronominal resumption is understudied in aphasia research, even though studies have reported pronoun processing deficiencies in agrammatic speakers (Grodzinsky et al., 1993; Love et al., 1998; Edwards & Varlokosta, 2007). Friedmann (2008) tested Hebrew speaking agrammatic individuals on the role of resumptive pronouns in the comprehension of object relative clauses. The presence/absence of the resumptive pronoun did not affect the participants' comprehension. In the current project, Akan resumptive pronouns were extensively examined. Our comprehension study showed that resumptive pronouns were problematic for Akan agrammatic speakers. The questions are of course, whether the resumptive pronouns as such were problematic or whether the problems were caused by the fact that sentences with resumptive pronouns involve, by definition, displaced NPs. The answer to this question is linked to ongoing debates in theoretical linguistics as to whether a resumptive pronoun is base-generated or not. These issues will be addressed in subsequent sections. In our sentence production test, the resumptive pronoun was spared. Thus, agrammatic speakers correctly used the resumptive pronoun when required, even though they generally showed production preference for structures without the resumptive pronoun.



We also investigated the comprehension and production of clause determiners in Akan agrammatic speakers. Clause determiners are seen in other Kwa languages (Ga: Renans 2016; Gungbe: Larson 2003). There is no study in which clause determiners were of interest except the current work because they have phonemic resemblance to the resumptive pronoun *nò*; the only difference is the tone, which is rising in the CD and falling in the RP. One of the goals of the current study was to examine the presence or absence of the RP on agrammatic speakers' performance. Data from the production and comprehension studies suggest that the clause determiner neither improves nor hinders performance in Akan individuals with agrammatism. However, in the comprehension study, we observed deficiencies in the conditions where the resumptive pronoun and the clause determiner co-occurred. We argue that this deficiency is because of the resumptive pronoun and not because of the clause determiner. In fact, comprehension of structures with only the clause determiner was relatively spared in the agrammatic individuals. This performance corroborates the earlier assertion that the clause determiner did not enhance or hinder agrammatic speakers' performance.

### 5.2 Grammatical tone processing in agrammatism

Gandour (2006) and Moen (2009) have encouraged the need for an elaborate approach to the study of other tone languages than those in East Asian languages, Norwegian and Swedish. Most studies on tone processing in language-impaired populations focused on lexical tone perception and production (Packard, 1985; Gandour et al., 1992; Yiu & Fok, 1995; Casserly & Pisoni, 2010, Kadyamusuma et al., 2011). Processing of grammatical tone is understudied, especially in aphasia. In Akan, tonal variations on predicates distinguish present, past and future time references. Tsiwah et al. (in press) investigated grammatical tone and time reference processing in Akan agrammatic speakers. Their findings suggest that grammatical tone was not the critical factor for the difficulties observed in past time reference processing. The current project investigated grammatical tone processing in Akan pronominal resolution and resumption. Comprehension and production tests were administered on Akan agrammatic speakers. In the production study, the deficiencies observed were not associated with grammatical tone processing difficulties but with word-order processing constraints: derived word order constructions (OSV) were more difficult to produce than base order constructions (SVO). For the comprehension study, a word order effect was observed in addition to processing difficulties in sentences with only a resumptive pronoun or a resumptive pronoun and clause determiner co-occurring. In essence, the identification and processing of grammatical tone on the resumptive pronoun and clause determiner affected patients' comprehension. The question then is why a similar pattern is not observed in production. It is important to note that the use of a resumptive pronoun and clause determiner in Akan is not obligatory. This presents agrammatic speakers with the opportunity to omit them.

### 5.3 Akan speakers' sensitivity to grammatical tone: an ERP approach

ERP components have been used to broaden our understanding of how tone is processed by the brain. ERP studies on tone processing focused almost exclusively on lexical tones (e.g., Hrueska et al., 2001; Johnson, et al., 2003; Magne, et al., 2005). In relation to the grammatical tone, there has been some work done on Swedish (Söderström et al., 2016; 2017). A number of ERP studies investigated violations in antecedent-trace dependencies (King & Kutas, 1995a; Müller et al., 1998). These dependencies include pronoun violations. Most studies on pronouns assessed case, gender and number violations (Harris et al., 2000; Molinaro et al., 2008). The current project introduced grammatical tone and animacy as crucial elements for pronoun resolution and resumption. In Akan, a pronoun matches its antecedent in number, tone, and animacy.

The investigation of the resumptive pronoun and the clause determiner was also relevant to test the sensitivity of Akan speakers to grammatical tones. In our ERP study, native speakers of Akan showed sensitivity to the difference between the tonal pattern of the resumptive pronoun *nò* and the clause determiner *nó*. When the positions of the resumptive pronoun and clause determiner were switched (… $nó_{CD}$ $*nò_{RP}$ …), which results in an ungrammatical string, a left anterior negativity (LAN) was elicited. More importantly, the ungrammatical string was detected because parsers could distinguish between the tone on the resumptive pronoun and clause determiner. This finding also confirms that the expected position of the clause determiner in Akan is clause-final. Our study also showed a LAN and an early P600 (300 - 800 ms) when there was a phonologically triggered animacy mismatch between a pronoun and its antecedent (*Adua* $no_{\text{the wood}}$ … $*nò_{RP}$ …). This reaction to the animacy violation suggests that the tone on the resumptive pronoun in Akan is indeed low (Arkoh & Mattewson 2013) and identifiable. The recorded LAN and early P600 effects mark violation detection and morphosyntactic reanalysis, once the tone-triggered animacy incongruence is encountered.



### 5.4 Theoretical frameworks and their implications

In terms of theories, the present project covered issues of both theoretical linguists and neurolinguists. Here, a detailed theoretical linguistics approach will be taken to explore the theoretical frameworks highlighted in chapter 1 relative to the experimental findings. However, since the aphasiological theories of interest to our project are discussed at length in the experimental chapters, there will only be a brief review with concluding remarks. These remarks address the broader issues of interest to this project.

#### 5.4.1 Aphasiological studies

This dissertation examined agrammatic comprehension and production of pronoun resolution and resumption. Generally, agrammatic speakers are reported to perform poorly on the comprehension of passive compared to active sentences (Caplan & Futter, 1986; Sherman & Schweikert, 1989; Grodzinsky, 1995). Individuals with agrammatism also have difficulties comprehending object clefts and object relative clauses (Caplan & Futter, 1986; Sherman & Schweikert, 1989; Hickok & Avrutin, 1995; Burchert, et al., 2003). Parallel to comprehension deficits, agrammatic speakers have production difficulties at the word order level (Bastiaanse, et al., 2002; Bastiaanse & Thompson, 2003; Bastiaanse, et al., 2003; Burchert, et al., 2008). Different accounts have been proposed for comprehension and

production deficits. In chapter 1, two production accounts were highlighted, the Tree Pruning Hypothesis (TPH: Friedmann & Grodzinsky, 1997) and the Argument Structure Complexity Hypothesis (ASCH: Thompson 2003). For comprehension, we explored the Trace Deletion Hypothesis (TDH: Grodzinsky, 1986), the Discourse-Linking Hypothesis (Hickok and Avrutin, 1996), and the Complexity Limitation Hypothesis (Frazier and Friederici, 1991). The Derived Order Problem Hypothesis (DOP-H: Bastiaanse and Van Zonneveld, 2005, 2006) presented the opportunity to holistically assess both production and comprehension deficits.

*Production accounts*

The TPH claims that individuals with agrammatic aphasia are unable to access elements in the syntactic tree from the tense node upwards because of their brain damage. This implies that *wh*-questions and embedded sentences are expected to be problematic for agrammatic speakers. The current study investigated *wh*-question production in Akan speakers with agrammatism and observed no deficiency in production, which implies that the TPH cannot account for the production data.

Thompson (2003) demonstrated that agrammatic production deficits should be attributed to the argument structure of a predicate. This attribution is linked to both the number of arguments attached to a verb and syntactic movement in the sentence. In our production study, the number of arguments in the structures tested could not explain the deficiencies observed. However, syntactic derivation accounted for the production difficulties recorded. This means that the argument structure complexity hypothesis and its tenets do not fully explain observations in the production experiment.

*Comprehension accounts*

According to the TDH (Grodzinsky 1986, 1995), comprehension deficiencies in agrammatism are caused by a breakdown in the construction of trace links after derivation. This leads to difficulties in theta role assignments. Agrammatic speakers resort to a guessing strategy, assigning the agent role to the first NP in a sentence. This claim was evident in the comprehension of object-focused declaratives. However, the TDH does not explain why the comprehension of object *wh*-questions with an empty gap was relatively spared but *wh*-questions with a resumptive pronoun impaired. In the broader context, the TDH accounts only for comprehension of focused-declaratives but not on derived *wh*-questions.

The Discourse-Linking Hypothesis (Hickok and Avrutin, 1996) argues that discourse-linked questions (e.g., *whichNP*-questions) are more difficult for agrammatic speakers than non-discourse-linked questions (e.g., *who*-questions). Even though the present work only tested *who*-questions, we expected comprehension to be relatively spared based on the predictions of Hickok and Avrutin (1996). However, Akan agrammatic speakers found the comprehension of *who*-questions with a resumptive pronoun problematic.

The accounts discussed so far exclusively explained either production or comprehension deficits. Overall, their propositions selectively explain the observations of the current project. In addition, most of the neurolinguistic theories do not directly address pronominal resumption in their assertions. The DOP-H (Bastiaanse & Van Zonneveld, 2005) takes an overarching approach to explain production and comprehension deficits, including pronominal resumption.

*Derived Order Problem Hypothesis*



Van der Meulen et al. (2005) proposed the Movement Hypothesis to explain deficiencies observed in French agrammatic speakers on derived *wh*-object questions, whereas those with the *wh*-word *in situ* were understood relatively well. This hypothesis evolved into the DOP-H. The DOP-H states that sentences with derived word order are difficult to comprehend and produce in agrammatism. Here, the underlying assumption is that all languages have a base word order and that any other word order is derived. Again, the definition of derivation according to the DOP-H is not limited to movement but includes other syntactic processes such as resumption. In essence, the DOP-H suggests that the more syntactic processes a sentence undergoes, the more difficult it is for agrammatic speakers to comprehend and produce. The DOP-H is based on cross-linguistic data (Dutch, Italian, Turkish, English, for example, Bastiaanse, et al., 2003; Bastiaanse and Thompson, 2003; Bastiaanse & Van Zonneveld, 2005, 2006; Yarbay Duman, et al., 2007; 2008; 2011).

The DOP-H presented the opportunity to test Akan resumption. We argued that Akan focused constructions undergo both syntactic movement and in some cases the insertion of a resumptive pronoun and/or a clause determiner. In both behavioral studies, derivation as described by DOP-H generally accounted for deficiencies observed. However, the DOP-H failed to explain why the production of object *who*-questions was relatively spared. Nonetheless, our error analysis on the production data showed a preference for object *who*-question in base word order (SVO: *in situ*) over those in derived order (OSV: object *who*-

questions). An extension of the discourse-linking hypothesis (Hickock & Avrutin, 1996) could explain why *who*-questions in the production study were relatively spared.

In conclusion, we observed a selective impairment in the production and comprehension of sentences with pronoun resolution and resumption in Akan agrammatic speakers. Also, the current project highlights the preservation of grammatical tone sensitivity in native Akan speakers.

### 5.4.2 Theoretical linguistics approach

*Focusing in Akan questions and declaratives*

In general, focusing in Akan means that, lexical items in a sentence such as nouns, verbs, and adjectives can be topicalized by marking them with the morpheme *na*. It does not matter whether this lexical element is the subject or the object. Thus, there are both subject and object focused sentences. In chapter 1, we examined Akan focus constructions, exploring their formation in questions and declaratives. This examination brought a long-standing debate to the fore. This debate is usually in two-fold. First, linguists disagree on the underlying syntactic processes in focus construction formation (Saah 1994; Boadi 2005; Korsah 2017). Secondly, the origin of the resumptive pronoun is still unclear (Saah 1994; Pesetsky 1998; Salzmann 2011; McCloskey, 2011; Van Urk 2018).

There are various theoretical frameworks on whether to assume that focused elements are syntactically derived or base generated. In the Akan context, the debate was mainly on the formation of Akan *wh*-questions and whether the *wh*-word undergoes syntactic displacement. This debate also had a broader implication on the formation of focused declaratives and pronominal resumption. Even though pronominal resumption was the main topic of investigation in the current project, a stand had to be made first on whether Akan question words in *wh*-object questions are derived. This is interesting because Akan has two systems for *wh*-object question formation; the question word can either occur *in situ* or can be in focus position. This question formation system is also observed in French. We conducted a pilot study, investigating how Akan agrammatic speakers comprehend *in situ* and focused *wh*-object questions. The predictions of the Derived Order Problem Hypothesis (DOP-H: Bastiaanse & Van Zonneveld, 2005) helped us to ascertain the mechanism involved in the processing of *in situ* and focused Akan *wh*-object question. As predicted by the DOP-H, focused questions were more problematic for agrammatic speakers to comprehend than those *in situ*. For example, ***hena na***$_{\text{focused}}$ *papa nó epia nó*? 'Who is the man pushing?' was more

difficult to comprehend than *Papa nó epia* ***hena***$_{\text{in situ}}$? 'Who is the man pushing?'. According to our findings and the predictions of the DOP-H, we concluded that Akan focused question words in *wh*-object questions undergo syntactic displacement.

This conclusion leads to the second point of disagreement among theoretical linguists and it is linked to pronominal resumption. In the construction of Akan focus constructions, resumptive pronouns are realized. Whilst some linguists argue that resumptive pronouns are base-generated, others assert that they are just phonological representations of trace spellouts. Our pilot study did not address this part of the debate but our subsequent studies did. This part of the debate was crucial because of its potential implications for Akan agrammatic speakers' sentence comprehension and production. It also presented the opportunity to thoroughly examine the concept of resumption. In the next section, we will look at the different accounts on resumptive pronouns relative to the findings of the present project. For clarity, the discussion of these theories in the next sections will be divided into two parts*, arguments against movement* and *arguments for movement*.



*Arguments against movement*

Saah (1994) argues that resumptive pronouns in Akan are base-generated and for that matter focused *wh*-words cannot possibly be derived. Saah (1994) adopts the *Barriers theory* (Chomsky 1986) to assert that the *gap* is illicit because it is filled with a resumptive pronoun, which makes L-marking unnecessary. Furthermore, Saah (1994) posits that resumption in Akan is obligatory and suggests that even when the resumptive pronoun is not overt, it is still covertly represented.

Based on our findings on resumption in Akan agrammatism, it is clear that focused elements in focus constructions are syntactically derived and not base generated. We argue that the phonological representation of the *trace* as a resumptive pronoun is not obligatory. Indeed, Saah (1994) alludes to that effect, indicating that the resumptive pronoun can be covert. This is also a position the current project takes but our point of departure is when a claim is made to suggest that a resumptive pronoun is still overtly represented even when covert. For example, in a sentence such as *Papa no na maame no piaa*$_{\text{past}}$ *nò*$_{\text{RP}}$ 'the man is the one the woman pushed', Saah (1994) is right to argue that the RP is obligatory because the sentence makes reference to the past. However in *Papa no na maame no epia*$_{\text{prog}}$ (*nò*$_{\text{RP}}$) 'the man is the one the woman is pushing', the predicate is in the present tense and this does not make the presence of the RP obligatory. This is when Saah (1994) assumes the RP is covertly present

but we take a contrary stand to this assumption. In the present work, we investigated focus constructions in the present progressive tense, with and without the resumptive pronoun. Behavioral tests were administered in both Akan agrammatic speakers and non-brain-damaged individuals. It is important to note that none of the non-brain-damaged participants indicated that structures without the resumptive were ungrammatical or sounded weird. This observation supports the claim that resumptive pronouns are not always obligatory as argued by Saah (1994). Even if we assume that resumption in Akan is always obligatory, it does not rule out the derivation of the focused element in a sentence. Data from our production study also show word order deficiency as the underlying cause of the deficits in agrammatic individuals. If focused elements in Akan focus constructions were base-generated, how do we explain the discrepancy in performance between *in situ* and focused *wh*-questions. Our comprehension data also tell a similar story. In relation to Chomsky's (1986) *Barriers theory*, all sentence types tested in the current work did not break any of the syntactic movement rules.

*Arguments for movement*

Other scholars have proposed that the resumptive pronoun is evidence of syntactic derivation of a nominal element in a sentence. In fact, Pesetsky (1998) and Van Urk (2016) claim that the resumptive pronoun is a phonetic representation of the trace left behind by the moved element. In the Akan context, there are suggestions that focused constructions involve syntactic derivation (Korah and Murphy, 2016). Hence, the resumptive pronoun is not base generated but fills the gap of the derived element. Klein (2017) presents the *Big DP* approach to demonstrate that the resumptive pronoun and its antecedent are part of the same structure. Klein (2017) further argues that A-bar movement in structures with resumption causes the head NP/DP to be stranded causing the addition of the resumptive pronoun. This claim also explains the anaphoric relationship observed between the resumptive pronoun and its antecedent. Klein's (2017) claim can be seen in an Akan sentence like *Mehuu* ***papa nó*** $_{NP}$ *a Kwame piaa* ***nò***$_{RP}$ 'I saw the man who Kwame pushed'. The NP *papa no* 'the man' undergoes A-bar movement and is stranded as described by Klein (2017). In Akan, this situation is solved with the insertion of the resumptive pronoun *nò* to make the sentence complete and grammatical.

In Korsah and Murphy (2016), a phonological approach is taken to explain the movement account. In this approach, they suggest that tonal features of the moved element affect other elements on its path. They argue that in sentences such as *John* ***fàà krátáá nó*** 'John took the

book' and ***krátáá nó na*** *John* ***fáá*** *yɛ* 'It is the book that John took', the tone on the verb in the latter sentence ***fáá*** was non-high in the first sentence. This change in tonal pattern is because the tone on focused element ***krátáá nó na*** was transferred to the verb when it moved to the sentence-initial position. According to Korsah and Murphy (2016), this demonstrates that the focused element was extracted from an *ex situ* position. The present project is unable to support this claim. There is still no psycholinguistic evidence supporting Korsah and Murphy's (2016) claim but from a native speaker's perspective, I can appreciate the argument made.

From the two schools, it appears there is a disagreement on the syntactic derivation of the moved NP (antecedent). Our findings provide more insight into the ongoing debate. First, the pilot study helped us proceed on the basis that Akan focused constructions undergo syntactic derivation, contrary to claims by Saah (1994). Further studies also suggested that resumption is not obligatory in Akan focus constructions. In addition, focused elements in structures like *wh*-questions undergo syntactic derivation. This implies that our results are in line with proponents for movement, which in effect means resumptive pronouns are not base-generated.



### 5.5 Research and clinical implications in the Ghanaian context

In research terms, the present project creates awareness in the Ghanaian academic space about the essence of adopting a neurolinguistic approach to investigating language. This approach would not only strengthen the theoretical discussions but also equip speech and language therapists with the necessary tools for the assessment and treatment of aphasia. In relation to the findings of the present work, we are unable to concretely establish the effect of pronominal resumption in sentence processing because of selective impairments and the small sample size. However, word order deficiencies were an underlying factor in the impairments observed. Therefore, it would be prudent for speech therapists to identify word order difficulties in Akan agrammatic speakers as part of their diagnoses.

### 5.6 Limitations of current project and scope for future studies

The current project has two main limitations. The first is in relation to the aphasia studies. We are unable to make extensive claims on the production and comprehension of pronominal resumption with the current data because of the limited sample size. Therefore, follow-up studies must recruit more agrammatic speakers. Additionally, it would be interesting to investigate pronominal resumption in other sentence types in Akan, like *which*-questions,

clefts, and relative clauses. Furthermore, pronoun resolution and resumption could also be explored in different aphasia groups, such as Wernicke's aphasia and anomia. A cross-linguistic approach to the effects of the clause determiner on agrammatism will help us better understand its distribution and role in language processing.

Second, our observations on the grammaticality-judgment task during the ERP experiment cannot be clearly explained. This is partly because we did not keep track of the number of times each item was heard during the acceptability-rating test. This oversight should be taken into account in future works.

# Summary

Speech and language processing has been studied in various academic fields such as (neuro)linguistics, philosophy, and (neuro)psychology. In the current thesis, a neurolinguistic approach was taken to study a linguistic phenomenon called *pronominal resumption* in Akan, an understudied West African Language. Akan is a tonal language and so we explored the roled of grammatical tone in pronominal resumption processing. The examination of this linguistic phenomenon adds to the large body of research in sentence processing. Our investigations involved native Akan speakers with agrammatism and non-brain-damaged individuals. Apart from behavioural testing, we did an event-related potentials (ERPs) experiment to assess how Akan speakers process pronominal resumption. The current project also addressed theoretical issues in linguistics, agrammatism and ERP research.

**In chapter 1**, *the General Introduction*, the Akan language was first and foremost introduced and its relevant features highlighted. Here, linguistic terms such as resumptive pronoun, clause determiner, and grammatical tone were explained, with Akan examples. Also, we explored the rules governing the different variations of Akan resumption. In structures such as object-focused *wh*-questions and declaratives, the resumptive pronoun *nò* could occur alone or together with a clause determiner *nó*. It is possible, however, not to have either the resumptive or the clause determiner in object-focused constructions. The two linguistic phenomena, resumptive pronoun and clause determiner, were interesting for the current study. Although the resumptive pronoun and the clause determiner are orthographically identical, they are phonologically different and fulfill different functions in a sentence. Note that the resumptive pronoun *nò* and the clause determiner *nó* bear a low and high tone, respectively. The resumptive pronoun corefers to a focused noun phrases in Akan focus constructions whilst the clause determiner marks the end of a clause and emphasizes the proposition that precedes it. The general introduction also explored theoretical linguistic frameworks, where arguments concerning the structural occurrence of resumptive pronouns are discussed. In the linguistic debate on Akan, the claims have been made about whether the presence of the resumptive pronoun can be used as evidence for syntactic derivation in focused structures. Beyond the theoretical linguistic controversies, the present project explored pronominal resumption effects in agrammatism. Sentence comprehension and production in agrammatic speakers were examined including current neurolinguistic theories for observed deficits. The theories examined for sentence comprehension deficits in

agrammatic speakers were; *Trace Deletion Hypothesis, Discourse-Linking Hypothesis,* and *Complexity Limitation Hypothesis*. For production, the theories were *Tree Pruning Hypothesis* and *Argument Structure Complexity Hypothesis*. Amongst the neurolinguistics theories examined, claims of the *Derived Order Problem Hypothesis* accounted for both comprehension and production deficits.

The controversies on Akan pronominal resumption led to a pilot study and subsequently our main research questions. In the pilot study, a small group of three Akan agrammatic speakers were tested. Performance on the sentences with the resumptive pronoun was worst compared to those without. The results can be explained by assuming that focused elements in Akan undergo syntactic derivation. This outcome justified us to further study the resumption phenomenon because we could proceed with the assumption that focused *wh*-words in object questions undergo syntactic derivation. To better understand pronominal resolution and resumption in Akan agrammatic speakers, examination of other Akan resumption variations were required. Therefore, two research questions were formulated; 1) How do Akan agrammatic speakers comprehend and produce the variations of resumption? 2) Which neurolinguistic account(s) best describe(s) the observed deficits adequately?

The aphasiological studies were complemented with an ERP study that addresses the questions: 1) Are Akan speakers sensitive to the grammatical tone difference between the resumptive pronoun and the clause determiner? 2) What is the role of grammatical tone as an animacy licensing feature in Akan pronominal resumption?

**Chapter 2** presents the first aphasia study that investigated how Akan speakers with agrammatism comprehend the variations of pronominal resumption in focus constructions. We also wanted to know which neurolinguistics theory best described observed deficiencies if any. Here, the neurolinguistics theories of interest were the *Trace Deletion Hypothesis, the Derived Order Problem Hypothesis, the Discourse-linking hypothesis*, and the *Complexity Limitation Hypothesis*. Focused *who*-questions and declaratives were tested. We administered a person-pointing task (for *who*-questions) and sentence-to-picture-matching task (for the focused declaratives). In both *who*-questions and focused declaratives, the variations of pronominal resumption were tested. The results showed that variations of pronominal resumption made no difference in the focused declaratives. However, in the *wh*-question conditions, performance on focused *who*-questions with the resumptive pronoun was more difficult to comprehend than subject *who*-questions. The *Trace Deletion Hypothesis,* the *Discourse Linking Hypothesis*, and the *Complexity Limitation Hypothesis* did not provide a

holistic explanation for the observed deficits. For instance, the *Trace Deletion Hypothesis* and the *Discourse Linking Hypothesis* can not explain the deficiency pattern where object *who*-questions with only a clause determiner were relatively spared. However, the predictions of *Derived Order Problem Hypothesis* captured deficits in both *who*-questions and focused declaratives. According to the *Derived Order Problem Hypothesis*, the selective deficits on the object *who*-questions with the resumptive pronoun suggest that those sentences were relatively more complex and required extra cognitive resources for processing. With this revelation, the next step was to investigate whether a similar observation could be made in a production study.

In **chapter 3**, the production of the resumption variations and focus marking were examined in five native speakers of Akan with agrammatic aphasia. We assessed two neurolinguistic theories, the *Tree Pruning Hypothesis* and the *Derived Order Problem Hypothesis*. Fundamentally, both theories expect impairments on focused *who*-questions and declaratives. In an elicitation task, participants produced *who*-questions and object-focused declaratives. The object *who*-questions were relatively spared but object-focused declaratives were impaired. There was no difference between the variations of resumption in questions and declaratives. This is not in line with the predictions of the *Tree Pruning Hypothesis* and the *Derived Order Problem Hypothesis*. However, the *Discourse Linking Hypothesis* helped us explain this outcome. This hypothesis stipulates that *who*-questions are not discourse-linked and are, hence, relatively easy to comprehend. An extension of the *Discourse Linking Hypothesis* to our production data suggests that Akan agrammatic speakers found *who*-question production relatively easy because no discourse-linking is needed. An error analysis showed that the most frequent error was word-order related. The word-order errors came in two forms: agrammatic speakers either interchanged thematic roles of the noun phrases (NPs) in the sentence or produced Subject-Verb-Object structures instead of Object-Verb-Subject. These observations are in-line with the assumptions of the *Derived Order Problem Hypothesis*. Focus-marking omission was also recorded in focused declaratives but not in focused *who*-questions. Focusing in the *who*-questions was relatively spared because *wh*-questions are inherently focused and consequently relatively easy to produce.

**Chapter 4** describes an ERP study that explores the role of grammatical tone and animacy in Akan pronominal resumption. The use of the ERP methodology can offer us a deeper insight into the processing of pronominal resumption. Essentially, the experiment in chapter 4 addresses two issues. First, the study investigated how native speakers respond to the

incorrect position of the resumptive pronoun when it co-occurs with the clause determiner, that is, …*nó*$_{CD}$ **nò*$_{RP}$ instead of ...*nò*$_{RP}$ *nó*$_{CD}$. This investigation can also give empirical evidence to native speakers' sensitivity to the phonological difference between the resumptive pronoun and the clause determiner, that differ only in tone. Secondly, we examined grammatical tone as an animacy licensing feature in Akan pronominal resumption. An auditory experiment was conducted with 23 native Akan speakers. In the condition where the position of the resumptive pronoun and clause determiner was interchanged, the Left Anterior Negativity (LAN: 300-500 ms) and a short positivity from 300 to 500 ms were elicited simultaneously. We also reported the LAN and an early P600 (300 – 800 ms) in violations of grammatical tone as an animacy licensing feature in pronominal resumption. This study is the first one that demonstrates listeners' sensitivity to morphosyntactic violations created by grammatical tone differences. The study showed the role of grammatical tone in the realization of Akan pronominal resumption.

In conclusion, the three studies investigated the role of grammatical tone in the processing of Akan pronominal resumption. We see that grammatical tone does not make a difference in the production of resumption variations. However, in the study of agrammatic comprehension, the identification of the grammatical tone on the resumptive pronoun causes the activation co-referencing. The co-referencing activation requires extra processing resources, which causes the observed deficits in agrammatic speakers. The ERP study provides empirical evidence of the sensitivity of native speakers to grammatical tone in resumptive-pronoun formulation. Most importantly, the current project provides a novel and deeper insight into the role of grammatical tone in resumptive pronoun formulation in sentence processing.

# Samenvatting

Spraak- en taalverwerking wordt door vele academische vakgebieden onderzocht, zoals de (neuro)linguïstiek, filosofie en (neuro)psychologie. In dit proefschrift is de verwerking van resumptieve voornaamwoorden in het Akan (een weinig bestudeerde West-Afrikaanse taal) neurolinguïstisch onderzocht. Het Akan is een toontaal en wij hebben de rol van grammaticale toon in de verwerking van resumptieve voornaamwoorden bestudeerd. Het onderzoeken van dit linguïstische verschijnsel draagt bij aan kennis op het gebied van zinsverwerking. Aan ons onderzoek namen moedertaalsprekers van het Akan deel. Onder hen waren agrammatische sprekers en taalgebruikers zonder hersenschade. Naast gedragsonderzoek, hebben wij een elektro-encefalografisch (EEG) experiment uitgevoerd om de verwerking van resumptieve voornaamwoorden door sprekers van het Akan te bestuderen. Op dezer manier hopen wij meer inzicht te verkrijgen op het gebied van zowel de theoretische taalkunde als de neurolinguïstiek.

**In hoofdstuk 1,** the *General Introduction*, wordt het Akan geïntroduceerd, en worden relevante eigenschappen van deze taal belicht. Verder worden in dit hoofdstuk door middel van voorbeelden uit het Akan definities gegeven van resumptieve voornaamwoorden, *clause determiners* en grammaticale toon. Daarnaast bestudeerden wij de taalkundige regels in verschillende varianten van resumptie in het Akan. In structuren als object-gefocuste *wh*-vragen en declaratieve zinnen kan het resumptieve voornaamwoord *nò* alleen voorkomen in combinatie met de *clause determiner nó.* In object-gefocuste constructies is het ontbreken van ofwel het resumptieve voornaamwoord, ofwel de *clause determiner* wel mogelijk. Deze twee linguistische begrippen, resumptieve voornaamwoord en *clause determiner,* worden onder de loep genomen in de onderhavige studie. Hoewel het resumptieve voornaamwoord en de *clause determiner* orthografisch identiek zijn, zijn ze fonologisch verschillend. Het resumptieve voornaamwoord *nò* draagt een lage, en de *clause determiner nó* een hoge toon. Het resumptieve voornaamwoord in het Akan verwijst naar een gefocuste *noun phrase*, terwijl de *clause determiner* het einde van een *clause* markeert en de propositie die hieraan voorafgaat benadrukt. In de inleiding worden ook de linguïstisch kaders besproken en wordt de argumentatie aangaande het structurele voorkomen van resumptieve voornaamwoorden besproken. Het onderhavige project richt zich op de effecten van pronominale resumptie bij mensen met een grammaticale stoornis ten gevolge van hersenletsel, zogenaamde 'agrammatische sprekers'. Bij hen is het begrijpen en produceren van zinnen met resumptieve voornaamwoorden en clause determiner onderzocht, waarbij relevantie theorieën getoetst

werden: de *Trace Deletion Hypothesis,* de *Discourse-Linking Hypothesis,* en de *Complexity Limitation Hypothesis*. Theorieën op het gebied van productie waren de *Tree Pruning Hypothesis* en de *Argument Structure Complexity Hypothesis*. De *Derived Order Problems Hypothesis* was de theorie voor zowel begrips- als productie.

Uit een pilot studie bij een kleine groep van drie agrammatische sprekers bleek dat de prestatie bij zinnen met een resumptieve voornaamwoord minder goed was dan op zinnen zonder een resumptieve voornaamwoord. Een mogelijk verklaring is dat gefocuste elementen in het Akan syntactische afleiding ondergaan. Om pronominale resolutie en resumptie in agrammatische sprekers beter te kunnen begrijpen zijn daarna ook, andere vormen van resumptie in het Akan onderzocht. Hiervoor werden de volgende twee onderzoeksvragen geformuleerd:

1) Hoe begrijpen en produceren agrammatische Akan sprekers de verschillende variaties van resumptie?

2) Welke neurolinguïstische theorie(ën) beschrijft (beschrijven) de geobserveerde stoornissen het beste?

De afasiologische studies werden aangevulg met een ERP-onderzoek, welke de volgende vragen trachte te beantwoorden:

1) Zijn Akan sprekers gevoelig voor grammaticale-toonverschillen in grammaticale toon tussen het resumptieve voornaamwoord en de *clause determiner*?

2) Wat is de rol van grammaticale toon in de vorm van een *animacy licensing feature* binnen pronominale resumptie in het Akan?

In **Hoofdstuk 2** wordt de eerste afasie studie beschreven waarin onderzocht werd hoe agrammatische sprekers van het Akan de variaties van pronominale resumptie in focus constructies begrijpen. Tevens wilden wij weten welke neurolinguïstische theorie de geobserveerde stoornis het beste beschrijft. De theorien die hiervoor in aanmerking kwamen waren de *Trace Deletion Hypothesis, de Derived Order Problem Hypothesis, de Discourse-linking hypothesis*, en de *Complexity Limitation Hypothesis.* Gefocuste *wie*-vragen en declaratieve zinnen werden getoetst. Er is een *person-pointing* taak gebruikt (voor *wie*-vragen) en een *sentence-to-picture-matching* taak (voor gefocuste declaratieve zinnen). In zowel de *wie*-vragen als de gefocuste declaratieven werden enkele variaties van pronominale resumptie getoetst. De resultaten laten zien dat variaties van pronominale resumptie geen

verschil maken in gefocuste declaratieven. Bij de *wie*-vraag conditie werd er slechter gepresteerd op focus *wie*-vragen met een resumptieve voornaamwoord dan *wie*-vragen waarbij het subject bevraagd werd. De *Trace Deletion Hypothesis,* de *Discourse Linking Hypothesis*, en de *Complexity Limitation Hypothesis* waren niet in staat om een holistische verklaring te bieden voor deze observaties. De *Trace Deletion Hypothesis* en de *Discourse Linking Hypothesis* bijvoorbeeld, kunnen niet verklaren waarom object *wie*-vragen met enkel een *clause determiner* relatief gespaard bleven. De voorspellingen van de *Derived Order Problem Hypothesis* verklaarden echter de problemen in zowel het gevonden patroon in de *wie*-vragen als in de gefocuste declaratieven. Volgens deze hypothese geven de selectieve problemen met de object *wie*-vragen met een resumptieve voornaamwoord aan dat deze zinnen complexer zijn en extra cognitieve verwerkingskracht vereisen. Met deze bevinding was de volgende stap om te onderzoeken of een dergelijk patroon ook te vinden is in zinproductie van agrammatische sprekers.

In **hoofdstuk 3,** wordt productie van resumptie variaties en focus markering onderzocht in vijf agrammatische sprekers van het Akan. Er zijn twee theorieën getoetst: *Tree Pruning Hypothesis* en de *Derived Order Problem Hypothesis*. In essentie voorspellen beide theorieën moeilijkheden met het produceren van gefocuste *wie*-vragen en declaratieve zinnen. Productie van object *wie*-vragen was relatief gespaard, maar productie van *object*-gefocuste declaratieven was gestoord. Er was geen verschil tussen de resumptievariaties in vragen en declaratieve zinnen. Dit komt niet overeen met de voorspellingen van de *Tree Pruning Hypothesis* en de *Derived Order Problem Hypothesis*. De *Discourse Linking Hypothesis* helpt ons echter om dit resultaat te verklaren. Deze hypothese stelt dat *wie*-vragen niet *discourse-linked* zijn en daarom relatief eenvoudig zijn te begrijpen. Een uitbreiding van de *Discourse Linking Hypothesis* op basis van onze productiedata suggereert dat agrammatische Akan sprekers de productie van *wie*-vragen relatief eenvoudig vonden aangezien hier geen *discourse-linking* vereist was. Een fouten-analyse liet zien dat de meest frequente fout de woordvolgorde betrof. Er waren twee soorten volgordefouten: agrammatische sprekers verwisselden soms de thematische rollen van de *noun phrase* (NPs) in de zin en daarnaast produceerden zij soms Subject-Verb-Object-structuren in plaats van Object-Verb-Subject-structuren. Deze observaties komen overeen met de aannames van de *Derived Order Problem Hypothesis*. Soms werd de focusmarkeerder weggelaten bij de declaratieve zinnen, maar niet bij gefocuste *wie*-vragen.

In **hoofdstuk 4** wordt een ERP-studie beschreven gericht op de rol van grammaticale toon en *animacy* in pronominale resumptie in het Akan. Het gebruik van elektro-encefalografie geeft ons diepere inzichten in de verwerking van pronominale resumptie. In essentie worden in hoofdstuk 4 twee zaken besproken. Ten eerste is onderzocht hoe moedertaalsprekers reageren op de incorrecte positie van resumptieve pronomina, wanneer deze vergezeld worden door *clause determiner,* oftewel …*nó*$_{CD}$ **nò*$_{RP}$ in plaats van ...*nò*$_{RP}$ *nó*$_{CD}$. Dit onderzoek biedt tevens empirisch inzicht in de gevoeligheid van moedertaalsprekers voor fonologische verschillen tussen het resumptieve pronomen en de *clause determiner,* welke slechts verschillen in toon. Ten tweede werd schending van grammaticale toon onderzocht als *animacy licensing* in combinatie met pronominale resumptie in het Akan. 23 moedertaalsprekers van het Akan namen deel aan een auditief ERP-experiment. In de conditie waarin de positie van het resumptieve voornaamwoord en de *clause determiner* waren verwisseld werd een *Left Anterior Negativity* (LAN: 300-500 ms) en een korte positiviteit van 300 tot 500ms gevonden. We vonden ook een LAN en een vroege P600 (300-800 ms) in de conditie met een schending van grammaticale toon als een *animacy licensing feature* bij pronominale resumptie. De onderhavige studie is de eerste die gevoeligheid van luisteraars voor morfosyntactische schendingen op het gebied van grammaticale toon demonstreert. De studie illustreert de rol van grammaticale toon in de realisatie van pronominale resumptie in het Akan.

De drie experimenten onderzochten de rol van grammaticale toon in de verwerking van pronominale resumptie in het Akan. Het blijkt dat grammaticale toon voor agrammatische sprekers geen rol speelt bij de productie van variaties van resumptie. In de studie naar agrammatisch begrip veroorzaakte de herkenning van grammaticale toon bij het resumptieve voornaamwoord activatie van co-referentie. De activatie van co-referentie vereist blijkbaar aanvullende verwerkingscapaciteit, iets dat de agrammatische sprekers lijken te ontberen. De ERP-studie biedt empirisch bewijs voor de gevoeligheid van grammaticale toon bij moedertaalsprekers van het Akan. Dit onderzoek geeft nieuwe inzichten op het gebied van grammaticale toon bij gebruik van resumptieve voornaamwoorden in zinsverwerking.

# Appendices

**Appendix to Chapters 2 and 3**

**Materials used for the aphasia studies**

*Subject who-questions (baseline condition)*

1. Hena na o-pia papa no / maame no?
   'who is pushing the (wo)man?'
2. Hena na ɔ-twe papa no / maame no?
   'who is pulling the (wo)man?'
3. Hena na o-mia papa no / maame no?
   'who is holding the (wo)man firmly?'
4. Hena na o-tin papa no / maame no?
   'who is pinching the (wo)man?'
5. Hena na o-tia papa no / maame no?
   'who is stepping on the (wo)man?'
6. Hena na ɔ-bɔ papa no / maame no?
   'who is hitting the (wo)man?'
7. Hena na ɔ-ka papa no / maame no?
   'who is biting the (wo)man?'
8. Hena na ɔ-kyekyere papa no / maame no?
   'who is tying the (wo)man?'
9. Hena na o-twa papa no / maame no?
   'who is photographing the man?'
10. Hena na o-wia papa no / maame no?
    'who is pickpocketing the (wo)man up?'

*Object who-question with wh-word in situ*

1. Papa no e-pia hena?
   'The man is pushing who/ Who is the man pushing?'
2. Papa no ɛ-twe hena?
   'The man is pulling who/ who is pulling the man?'
3. Papa no e-mia hena?
   'The man is pressing who/ who is the man pressing?'

4. Maame no e-tin hena?
   'The man is pinching who/ who is the man pinching?'

5. Papa no e-tia hena?
   'The man is stepping on who/who is the man stepping on?'

6. Maame no ɛ-bɔ hena?
   'The woman is hitting who/who is the man hitting?'

7. Maame no ɛka hena?
   'The woman is biting who/ who is the man biting?'

8. Maame no ɛ-kyekyere hena?
   'The woman is tying who/ who is the man tying?'

9. Maame no e-twa hena?
   'The woman is photographing who/ who is the man photographing?'

10. Maame no e-wia hena?
    'The woman is pickpocketing who/ who is the woman pickpocketing?'

*Object who-questions (with resumption variations)*

1. Hena na maame / papa no e-pia (nò nó)?
   'Who is the (wo)man pushing?'

2. Hena na maame / papa no ɛ-twe (nò nó)?
   'who is the (wo)man pulling?'

3. Hena na maame / papa no e-mia (nò nó)?
   'who is the (wo)man pressing?'

4. Hena na maame / papa no e-tin (nò nó)?
   'who is the (wo)man pinching?'

5. Hena na maame / papa no e-tia (nò nó)?
   'who is the (wo)man stepping on?'

6. Hena na maame / papa no ɛ-bɔ (nò nó)?
   'Who is the (wo)man hitting?'

7. Hena na maame / papa no ɛ-ka (nò nó)?
   'who is the (wo)man biting?'

8. Hena na maame / papa no ɛ-kyekyere (nò nó)?
   'who is the(wo)man tying?'

9. Hena na maame / papa no e-twa (nò nó)?
   'who is the (wo)man photographing?'

10. Hena na maame / papa no e-wia (nò nó)?

'who is the (wo)man pickpocketing?'

*Fillers*

Semantically irreversible declaratives

1. Maame no ɛ-kyekyere ɛmo no
   'The woman is tying the bag/sack of rice.'
2. Papa no ɛ-hyɛ ataadeɛ no
   'The man is putting on shirt'
3. Maame no ɛ-kae sika no
   'The woman is counting the money.'
4. Papa no ɛ-hyɛ mpaboa no
   'The man is putting on the shoe.'
5. Papa no ɛ-bɔ twene no
   'The man is playing the money.'
6. Papa no e-pia table no
   'The man is pushing the table.'
7. Maame no e-di kwadu no
   'The woman is eating the banana.'
8. Papa no e-twa brodo no
   'The woman is slicing the bread.'
9. Maame no ɛ-twe akonwa no
   'The woman is pulling the chair.'
10. Maame no ɛ-bobɔ ataadeɛ no
    'The woman is folding the dress.'
11. Papa no e-mia bage no
    'The man is pressing the bag.'
12. Maame no ɛ-to ataadeɛ no
    'The woman is ironing the dress.'
13. Papa no ɛ-so bage no
    'The man is carrying the bag.'
14. Papa no ɛ-nom nsuo no
    'The man is drinking the water.'
15. Papa no e-si ataadeɛ no

'The man is washing the dress.'

16. Papa no ɛ-pra dirt no
'The man is sweeping the dirt.'

17. Maame no e-kyim ntomaa no
'The woman is hand squeezing the cloth.'

18. Maame no ɛ-kae buuku no
'The woman is reading the book.'

19. Papa no ɛ-te ataadeɛ no
'The man is tearing the dress.'

20. Maame no ɛ-bɔ duku no
'The woman is putting on a headscarf.'

# Appendix to chapter 4

## Materials used in the ERP experiment

**Sentences for the word-order conditions**

| | NP1 | FOC | NP2 | verb | Gram. Cond. | Ungram. Cond. | Prepositional Phrase |
|---|---|---|---|---|---|---|---|
| 1 | Akua | na | Mansa | epia | nò nó | (nó *nò) | ɛwɔ efie hɔ |
| | Akua is the one that Mansa is pushing in the house' | | | | | | |
| 2 | Kofi | na | Kwame | ɛtwe | nò nó | (nó *nò) | ɛwɔ anim hɔ |
| | Kofi is the one that Kwame is pulling over there' | | | | | | |
| 3 | Mansa | na | Kofi | ɛkyekyere | nò nó | (nó *nò) | ɛwɔ nwura nim |
| | Mansa is the one that Kofi is tying in the bush' | | | | | | |
| 4 | Kwame | na | Paapa | etwa | nò nó | (nó *nò) | ɛwɔ asɔre neho |
| | Kwame is the one that Paapa is photographing at church' | | | | | | |
| 5 | Akua | na | Akosua | emia | nò nó | (nó *nò) | ɛwɔ dwa nim |
| | Akua is the one that Akosua is holding firm in the market' | | | | | | |
| 6 | Kwesi | na | Kwajo | ɛka | nò nó | (nó *nò) | ɛwɔ anim hɔ |
| | Kwesi is the one that Kwajo is biting over there' | | | | | | |
| 7 | Akua | na | Afia | etia | nò nó | (nó *nò) | ɛwɔ kwan ne so |
| | Akua is the one that Afia is stepping on by the roadside' | | | | | | |
| 8 | Kofi | na | Maame | etin | nò nó | (nó *nò) | ɛwɔ dan nim |
| | Kofi is the one that Maame is pinching in the room' | | | | | | |
| 9 | Wofa | na | Paapa | ɛbɔ | nò nó | (nó *nò) | ɛwɔ anim hɔ |
| | Wofa is the one that Paapa is hitting over there' | | | | | | |
| 10 | Abena | na | Akua | epra | nò nó | (nó *nò) | ɛwɔ mantem hɔ |
| | Abena is the one that Akua is hurting in the neighborhood' | | | | | | |
| 11 | Yaa | na | Akosua | ɛdandan | nò nó | (nó *nò) | ɛwɔ kwan neso |
| | Yaa is the one that Akosua is turning round on the way' | | | | | | |
| 12 | Mansa | na | Maame | apagya | nò nó | (nó *nò) | ɛwɔ asɔre hɔ |
| | Mansa is the one that Maame is lifting up' | | | | | | |
| 13 | Kwaku | na | Abena | ɛsane | nò nó | (nó *nò) | ɛwɔ nwura nim |
| | Kwaku is the one that Abena is untying in the bush' | | | | | | |
| 14 | Nyame | na | Maame | ɛsɔre | nò nó | (nó *nò) | ɛwɔ asɔre hɔ |
| | God is the one that Maame is worshipping at church' | | | | | | |
| 15 | Paapa | na | Maame | ɛprɛ | nò nó | (nó *nò) | ɛwɔ akonwa nim |
| | Maame is the one that Paapa is hitting lightly in the chair' | | | | | | |
| 16 | Kwajo | na | Wofa | ɛfrɛ | nò nó | (nó *nò) | ɛwɔ kwan neho |
| | Kwajo is the one that Wofa is calling by the road' | | | | | | |
| 17 | Kwame | na | Paapa | ɛpoma | nò nó | (nó *nò) | ɛwɔ dwa nim |
| | Kwame is the one that Paapa is hitting in the market' | | | | | | |
| 18 | Mansa | na | Maame | ɛposa | nò nó | (nó *nò) | ɛwɔ dwa nim |
| | Mansa is the one that Maame is dealing with in the market' | | | | | | |
| 19 | Kwabena | na | Paapa | ehu | nò nó | (nó *nò) | ɛwɔ asɔre hɔ |
| | Kwabena is the one that Paapa is seeing at church' | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 20 | Akua | na | Kwame | ɛorda | nò | nó | (nó *nò) | ɛwɔ dan nim |
| | Akua is the one that Kwame is dictating to in the room' | | | | | | | |
| 21 | Maame | na | Wofa | akyim | nò | nó | (nó *nò) | ɛwɔ asa neso |
| | Maame is the one that Wofa is turning in the living room' | | | | | | | |
| 22 | Kwajo | na | Maame | ɛboa | nò | nó | (nó *nò) | ɛwɔ anim hɔ |
| | Maame is the one that Kwajo is helping over there' | | | | | | | |
| 23 | Paapa | na | Kofi | esuasua | nò | nó | (nó *nò) | ɛwɔ sukuu nim |
| | Paapa is the one that Kofi is emulating in the school' | | | | | | | |
| 24 | Kwesi | na | Naana | ɛyɛ | nò | nó | (nó *nò) | ɛwɔ mantem hɔ |
| | Kwesi is the one that Naana is insulting in the neighborhood' | | | | | | | |
| 25 | Akua | na | Kwabena | etie | nò | nó | (nó *nò) | ɛwɔ asɔre hɔ |
| | Akua is the one that Kwabena is listening to at church' | | | | | | | |
| 26 | Abofra no | na | Paapa | ɛkura | nò | nó | (nó *nò) | ɛwɔ kwan neho |
| | The child is the one that Paapa is holding by the roadside' | | | | | | | |
| 27 | Wofa | na | Maame | ahyia | nò | nó | (nó *nò) | ɛwɔ krom hɔ |
| | Wofa is the one that Maame is meeting in the village' | | | | | | | |
| 28 | Kwame | na | Kwaku | ɛhwɛ | nò | nó | (nó *nò) | ɛwɔ sukuu nim |
| | Kwame is the one that Kwaku is seeing in the school' | | | | | | | |
| 29 | Ama | na | Kwaku | ɛhwe | nò | nó | (nó *nò) | ɛwɔ sukuu nim |
| | Ama is the one that Kwaku is beating up in the school' | | | | | | | |
| 30 | Abena | na | Mansa | agyina | nò | nó | (nó *nò) | ɛwɔ kwan neho |
| | Abena is the one that Mansa is stopping by the road' | | | | | | | |
| 31 | Kwesi | na | Yaa | ɛtwɛn | nò | nó | (nó *nò) | ɛwɔ sukuu nim |
| | Kwesi is the one that Yaa is waiting for in the school' | | | | | | | |
| 32 | Yaa | na | Paapa | ɛsoma | nò | nó | (nó *nò) | ɛwɔ akyere hɔ |
| | Yaa is the one that Paapa is sending on an errand over there' | | | | | | | |
| 33 | Mansa | na | Maame | ɛtɔn | nò | nó | (nó *nò) | ɛwɔ dwa nim |
| | Mansa is the one that Mansa is talking about in the market' | | | | | | | |
| 34 | Maame | na | Paapa | ɛmoa | nò | nó | (nó *nò) | ɛwɔ asɔre nim |
| | Maame is the one that Paapa is hugging tightly in the church' | | | | | | | |
| 35 | Akosua | na | Kwabena | ɛdaada | nò | nó | (nó *nò) | ɛwɔ dan nim |
| | Akosua is the one that Kwabena is deceiving in the room' | | | | | | | |
| 36 | Abofra no | na | Maame | ɛsra | nò | nó | (nó *nò) | ɛwɔ dan nim |
| | The child is the one that Maame is pomading in the room' | | | | | | | |
| 37 | Kwaku | na | Paapa | ɛsra | nò | nó | (nó *nò) | ɛwɔ sukuu nim |
| | Kwaku is the one that Paapa is visiting in the school' | | | | | | | |
| 38 | Kofi | na | Wofa | esiesie | nò | nó | (nó *nò) | ɛwɔ anim hɔ |
| | Kofi is the one that Wofa is dressingup over there' | | | | | | | |
| 39 | Kwabena | na | Yaa | ebue | nò | nó | (nó *nò) | ɛwɔ fie hɔ |
| | Kwabena is the one that Yaa is opening the door for in the house' | | | | | | | |
| 40 | Abena | na | Kwame | ɛsesan | nò | nó | (nó *nò) | ɛwɔ awareɛ n'ase |
| | Abena is the one that Kwame is chaning in the marriage' | | | | | | | |
| 41 | Kwame | na | Kwaku | ɛhwehwɛ | nò | nó | (nó *nò) | ɛwɔ anim hɔ |
| | Kwame is the one that Kwaku is looking for over there' | | | | | | | |

42 Paapa na Kofi etwi nò nó (nó *nò) ɛwɔ kuro nim
Paapa is the one that Kofi is driving in the village'
43 Kwesi na Maame eyi nò nó (nó *nò) efri nsuo nim
Kwesi is the one that Maame is helping out from the water'
44 Kwabena na Ama agyae nò nó (nó *nò) ɛwɔ dan nim
Kwabena is the one that Ama is breaking up wit h in the room'
45 Maame na Wofa ɛgye nò nó (nó *nò) efri akronfoɔ nensam
Maame is the one that Wofa is rescuing from the thieves'
46 Afia na Yaw awia nò nó (nó *nò) ɛwɔ fie hɔ
Afia is the one that Yaw is stealing from in the house'
47 Kwabena na Policini ɛkye nò nó (nó *nò) ɛwɔ fie hɔ
Kwabena is the one that the Police is arresting in the house'
48 Kwajo na Ohene ɛsɛn nò nó (nó *nò) ɛwɔ kuro nim
Kwajo is the one that a chief is hanging in the village'
49 Afia na Yaw ɛsere nò nó (nó *nò) ɛwɔ ekyere hɔ
Afia is the one that Yaw is mocking over there'
50 Adjoa na Akua ɛsɛe nò nó (nó *nò) ɛwɔ kuro nim
Adjoa is the one that Akua is influencing negatively in the village'
51 Kofi na Kwabena awia nò nó (nó *nò) ɛwɔ akansie nim
Kofi is the one that Kwabena is cheating in the competition'
52 Mansa na Abena ahuro nò nó (nó *nò) ɛwɔ akyere hɔ
Mansa is the one that Abena is teasing over there'
53 Paapa na Kwame ɛpempem nò nó (nó *nò) ɛwɔ akyere hɔ
Paapa is the one that Kwame is hitting over there'
54 Akosua na Paapa abirim nò nó (nó *nò) ɛwɔ dan nim
Akosua is the one that Paapa is beating up in the room'
55 Yaw na Kwasi ɛnom nò nó (nó *nò) ɛwɔ dwa nim
Yaw is the one that Kwasi is beating up in the market'
56 Kwame na Maame ɛtea nò nó (nó *nò) ɛwɔ fie hɔ
Kwame is the one that Maame is reprimanding in the house'
57 Kwasi na Kwame ɛha nò nó (nó *nò) ɛwɔ nfikyere hɔ
Kwasi is the one that Kwame is disturbing over there'
58 Akosua na Kofi ɛware nò nó (nó *nò) ɛwɔ asɔre hɔ
Akosua is the one that Kofi is marrying at church'
59 Abena na Maame adware nò nó (nó *nò) ɛwɔ anim hɔ
Abena is the one that Maame is bathing over there'
60 Akosua na Kwaku ɛsusu nò nó (nó *nò) ɛwɔ dan nim
Akosua is the one that Kwaku is taking measurement of in the room'

**Sentences for the animacy conditions (the difference was the first NP. Animacy should match with RP)**

| | Ungram. Cond. NP1 (Inanimate) | Gram.Cond. NP1 (animate) | FOC | NP2 | Verb | RP | Prepositional Phrase |
|---|---|---|---|---|---|---|---|
| 1 | *Dua (Stick) | Paapa | na | Maame | ɛka | nò | ɛwɔ hɔ nom |
| | *Stick/ Paapa is the thing/ one that Maame is biting over there' | | | | | | |
| 2 | *Kyensen (Plate) | Abena | na | Kwame | epia | nò | ɛwɔ anim hɔ |
| | *Plate/ Abena is the thing/ one that Kwame is pushing over there' | | | | | | |
| 3 | *Nsuo (Water) | Kwesi | na | Mansa | ɛtwen | nò | ɛwɔ dan nim |
| | *Water/ Kwesi is the thing/ one that Mansa is waitng | | | | | | |
| 4 | *Ɛpo (Sea) | Yaa | na | Akua | etwa | nò | ɛwɔ abɔnten |
| | *Sea / Yaa is the thing / one that Akua is photographing outside' | | | | | | |
| 5 | *Ɛmo (Rice) | Wofa | na | Kwame | ɛkyeky ere | nò | ɛwɔ dan neho |
| | *Rice/ Wofa is the thing/ one that Kwame is tying in the room' | | | | | | |
| 6 | *Ntoma (Cloth) | Kwame | na | Kwajo | emia | nò | ɛwɔ car nim |
| | *Cloth/ Kwame is the thing/ one that Kwame is pressing over there' | | | | | | |
| 7 | *Fɔm (Ground) | Kwesi | na | Akua | etia | nò | ɛwɔ hɔ nom |
| | The ground / Kwesi is the thing/ one hat Akua is stepping on over there' | | | | | | |
| 8 | *Aduane (Food) | Yaa | na | Akua | etin | nò | ɛwɔ dan nim |
| | *Food/ Yaa is the thing / one that Akua is taking/ pinching in the room' | | | | | | |
| 9 | *Bɔɔl (Ball) | Kofi | na | Kwame | ɛbɔ | nò | ɛwɔ anim hɔ |
| | *Ball/ Kofi is the thing / one that Kwame is hitting over there' | | | | | | |
| 10 | *Akonwa (Chair) | Paapa | na | Maame | ɛdane | nò | ɛwɔ hɔ nom |
| | *Chair/ Paapa is the thing/ one that Maame is turning over there' | | | | | | |
| 11 | *Bage (Bag) | Mansa | na | Kofi | epagya | nò | ɛwɔ hɔ nom |
| | *Bag/ Mansa is the thing/ one that Kofi is lifting up over ther' | | | | | | |
| 12 | *Ataadeɛ (Dress) | Kwesi | na | Akua | ɛsane | nò | ɛwɔ nwura nim |
| | *Dress / Kwesi is the thing / one that Akua is changing in the bush' | | | | | | |
| 13 | *Efin (Dirt) | Mansa | na | Kwesi | ɛprɛ | nò | ɛwɔ dan nim |
| | *Dirt/ Mansa is the thing/ one that Kwesi is carefully cleaning/hitting in the roomt' | | | | | | |
| 14 | *Nfuturo (Dust) | Kofi | na | Akosua | ɛpamo | nò | ɛwɔ dan nim |
| | *Dust/ Kofi is the thing/ one that Akosua is getting rid of in the room' | | | | | | |
| 15 | *Trɔsa (trousers) | Akua | na | Maame | ɛposa | nò | ɛwɔ dwa nim |
| | *Trousers/ Akua is the thing/ one that Maame is washing/dealing with in the market' | | | | | | |
| 16 | *kubedua (coconut tree) | Kofi | na | Okuani | ɛpoma | nò | ɛwɔ afuo nim |
| | *Coconut tree/ Kofi is the thing/ one that the farmer is hitting in the farm' | | | | | | |
| 17 | *Adwumam (Workplace) | Kwabena | na | Mansa | ɛfrɛ | nò | ɛwɔ dan nim |
| | *Workplacce/ Kwabena is the thing/ place that Mansa is calling in the room' | | | | | | |
| 18 | *Dadeɛ (Metal) | Kwame | na | Kwesi | ekyim | nò | ɛwɔ dua n'ase |
| | *Metal/ Kwame is the thing/ one that Kwesi is bending under the tree' | | | | | | |
| 19 | *Sukuu (School) | Tikyani | na | Maame | ɛyeyɛ | nò | ɛwɔ kuro nim |
| | *School/ the teacher is the thing/ one that Maame is disrespecting in the village' | | | | | | |
| 20 | *Suapɔn (University) | Yaw | na | Adjoa | ehu | nò | ɛwɔ kuro nim |

*University /Yaw is the thing/ one that Adjoa is seeing in the town'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21 | *Efuo (Farm) | Mansa | na | Paapa | ɛboa | nò | ɛwɔ hɔ nom |

*Farm/ Mansa is the thing/ one that Paapa is helping over there'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 22 | *Komadeɛ (necklace) | Kwadjo | na | Akose | ɛkyerɛ | nò | ɛwɔ dan nim |

*Necklace/ Kwadjo is the thing/ one that Akos is showing in the room'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 23 | *Ɛnwom (Music) | Ama | na | Kwame | etie | nò | ɛwɔ dan nim |

*Music/ Ama is the thing/ one that Kwame is listening to in the room'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 24 | *Sika (Money) | Yaa | na | Akua | ɛtwɛn | nò | ɛwɔ fie nim |

*Money/ Yaa is the thing/ one that Akua is waiting for in the house'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 25 | *Ahomaa (Rope) | Kofi | na | Paapa | ɛtwe | nò | ɛwɔ dwa nim |

*Rope/ Kofi is the thing/ one that Paapa is pulling in the market'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 26 | *Lɔre (Lorry) | Kwabena | na | Wofa | ehyia | nò | ɛwɔ abɔten |

*Lorry/ Kwabena is the thing/one that Wofa is meeting outside'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 27 | *Sini (Movie) | Kwame | na | Maame | ɛhwɛ | nò | ɛwɔ fie hɔ |

*Movie/ Kwame is the thing/ one that Maame is watching in the house'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 28 | *Nsa (a drink) | Mansa | na | Maame | ɛhwe | nò | ɛwɔ anim hɔ |

*A drink/ Mansa is the thing/ one that Maame is sweeping away over there'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 29 | *Neɔma (package) | Kwame | na | Wofa | agyina | nò | ɛwɔ hɔ nom |

*Package/ Kwame is the thing/ one that Wofa is stopping over there'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 30 | *Kontomire (Cocoyam Leaves) | Abena | na | Maame | ɛkra | nò | efri krom hɔ |

*Cocoyam leaves/ Abena is the thing/ one that Maame is ordering for from the village'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 31 | *Lɛtɛ (Letter) | Kofi | na | Maame | ɛsoma | nò | ɛwɔ hɔ nom |

*Letter/ Kofi is the thing/ one that Maame is sending over there'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 32 | *Ɛmo (Rice) | Akua | na | Akose | ɛtɔn | nò | ɛwɔ dwa nim |

*Rice/ Akua is the thing/ one that Akose selling out in the market'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 33 | *Ntos (Tomatoes) | Kwame | na | Paapa | ɛtete | nò | ɛwɔ sukuu nim |

*Tomatoes/ Kwame is the thing/one that Paapa is plucking/grooming in the school'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 34 | *Ekuo (Group) | Akua | na | Abena | ɛdaada | nò | ɛwɔ nhyiamu n'ase |

*The group/ Akua is the thing/ one that Abena is deceiving in the meeting'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 35 | *Nkyene (Salt) | Kofi | na | Paapa | ɛsrɛ | nò | ɛwɔ kuro nim |

*Salt/ Kofi is the thing/ one that Paapa is asking for/ apologizing to in the village'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 36 | *Pono (door) | Akwadaa | na | Mansa | ɛsra | nò | ɛwɔ asa neso |

*Door/ the Child is the thing/ one that Mansa is staining/pomading in the living room'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 37 | *Adaka (Box) | Kwadjo | na | Akosua | ebie | nò | ɛwɔ hɔ nom |

*Box/ Kwadjo is the thing/ one that Akosua is allowing in over there'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 38 | *Ɛkwan (a path) | Abofra | na | Maame | esiesie | nò | ɛwɔ fie hɔ |

*Road / the child is the thing/ one that Maame is fixing in the house'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 39 | *Mpaboa (Shoe) | Afia | na | Akosua | ɛsesa | nò | ɛwɔ kuro nim |

Shoe / Afia is the thing/ one that Akosua is changing in the village'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 40 | *Bodeɛ (Plantain) | Kwame | na | Kwasi | ɛhweh wɛ | nò | ɛwɔ fuo nim |

*Plantain/ Kwame is the thing /one that Kwasi is looking for in the farm'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 41 | *Ɛhyɛn (Car) | Paapa | na | Kwasi | etwi | nò | ɛwɔ mantam hɔ |

*Car/ Paapa is the thing/ one that Kwasi is driving in the neighbourhood'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 42 | *Ahwehwɛ (Mirror) | Abrewa | na | Maame | ayi | nò | ɛwɔ dan nim |

*Mirror/ an old woman is the thing/ one that Maame is taking out in from the room'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 43 | *Asɔre (Church) | Kwame | na | Akua | agyae | nò | ɛwɔ kuro nim |

*Church/ Kwame is the thing/ one that Akua is breaking away from in the village'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 44 | *Kasanoma (Telephone) | Abena | na | Wofa | ɛkanfo | nò | ɛwɔ kuro nim |

*Telephone/ Abena is the thing/ one that Wofa is admiring in the village'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 45 | *Asumadeɛ (Earring) | Mansa | na | Kwaku | ɛwia | nò | ɛwɔ fie hɔ |

*Earring/ Mansa is the thing/ one that Kwaku is stealing (from) at the house'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 46 | *Pampro (Bamboo) | Akosua | na | Yaa | ayi | nò | efri kwayɛ nim |

*Bamboo/ Akosua is the thing/ one that Yaa is taking from the forest'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 47 | *Franka (Flag) | Kwame | na | Nana | ɛsɛn | nò | ɛwɔ ahenfie hɔ |

*Flag/ Kwame is the thing/ one that th chief is hanging in the palace'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 48 | *Kɔmputa (Computer) | Akua | na | Kwabena | ɛsɛe | nò | ɛwɔ hɔ nom |

*Computer/Akua is the thing/ one that Kwabena is discrediting over there'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 49 | *Asɔre (Church) | Kwame | na | Mansa | ehuro | nò | ɛwɔ anim hɔ |

*Church/ Kwame is the thing/ one that Mansa is mocking over there'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 50 | *Bankye (Cassava) | Afia | na | Akosua | ɛpenpem | nò | ɛwɔ fie ne mu |

*Cassava/ Afia is the thing/ one that Akosua is hitting in the house'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 51 | *Sakre (bicycle) | Afia | na | Paapa | ɛtene | nò | ɛwɔ hɔ nom |

*Bicycle/ Afia is the thing/ one that Paapa is straightening over there'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 52 | *Efidie (Machine) | Kwesi | na | Mansa | ɛha | nò | ɛwɔ fie hɔ |

*Machine/ Kwesi iis the thing/ one that Mansa is disturbing in the house'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 53 | *Aduro (Medicine) | Kwame | na | Paapa | adware | nò | ɛwɔ hɔ |

*Medicine/ Kwame is the thing/ one that Paapa is using/bathing over there

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 54 | *Dadesɛn (Pot) | Afia | na | Akua | ɛmoa | nò | ɛwɔ pono n'ano |

*Pot/ Afia is the thing/ one that Akua is bending infront of the door'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 55 | *Nwoma (Book) | Kronfoɔ | na | Nana | ɛhye | nò | ɛwɔ kro nim |

*Book/a thief is the thing/ one that the chief is burning in the village'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 56 | *Ayaresabea (Hospital) | Maame | na | Paapa | ɛha | nò | fa aduro neho |

*Hospital/ Maame is the place / one that Paapa bothering for drugs'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 57 | *Duawa (Chewing Stick) | Kwesi | na | Kwabena | atwitwa | nò | ɛwɔ ayie n'ase |

*Chewing stick/ Kwesi is the thing/ one that Kwabena is cutting at the funeral'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 58 | *Kɛntɛn (basket) | Abofra | na | Maame | ɛwoso | nò | ɛwɔ asa neso |

*Basket/ the child is the thing/ one that Maame is shaking/rocking in the living room'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 59 | *Kukuo (pot) | Odiifoɔ | na | Maame | ɛsɔre | nò | ɛwɔ fie nim |

*Pot/ a prophet is the thing/ one that Maame is worshipping in the house'

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 60 | *Sapɔ (Sponge) | Akosua | na | Kwaku | esusu | nò | ɛwɔ dan nim |

*Sponge/ Akosua is the thing/ one that Kwaku taking measurement of in the room

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# Propositions

1) Akan focused *wh*-questions undergo syntactic derivation. *(Chapters 2 & 3)*

2) The presence of the resumptive pronoun worsens comprehension of *wh*-questions but not of focused declaratives in agrammatic speakers of Akan. *(Chapter 2)*

3) Agrammatic speakers of Akan have problems producing sentences with derived word-order whilst production of resumptive pronoun and clause determiner is spared. *(Chapter 3)*

4) Agrammatic speakers of Akan are sensitive to lexical tone differences. *(Chapters 2 & 3)*

5) Native speakers of Akan are sensitive to the tonal difference between the resumptive pronoun and the clause determiner. *(Chapter 4)*

6) The LAN and the P600 inform us of how tone-triggered animacy and word-order violations in Akan pronominal resumption are processed. *(Chapter 4)*

7) Wisdom is like a baobab tree, no one individual can embrace it. *(Ewe proverb)*

8) Education is a progressive discovery of our own ignorance. *(Will Durant)*

9) Research is formalized curiosity. It is poking and prying with a purpose. *(Zora Neale Hurtson)*