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Interpretation of pronouns in VP-ellipsis constructions in Dutch Broca's and Wernicke's aphasia

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Abstract

In this paper, we investigate the ability of Dutch agrammatic Broca's and Wernicke's aphasics to assign reference to possessive pronouns in elided VP constructions. The assumption is that the comprehension problems in these two populations have different sources that are revealed in distinct patterns of responses. The focus is primarily on the performance of the agrammatic group whose errors in comprehension are not viewed as a consequence of a breakdown of grammatical knowledge but as a result of limited processing resources (for an overview see Grodzinsky, 2000). The results of the present study provide evidence for the psycholinguistic reality of the economy hierarchy as proposed in the Primitives of Binding (Reuland, 2001). According to the economy hierarchy proposed for the non-brain-damaged, the more economical semantic dependencies are preferred over the costlier discourse dependencies. This hierarchy is reflected in agrammatic aphasia where the semantic dependencies are available on time and preferred over the discourse dependences that are not available on time as a result of the lack of processing resources with consequences for comprehension.

Keywords: Broca's aphasia; Agrammatism; Pronouns; Comprehension; Reference; VP-ellipsis; Syntax; Bound variable; Coreference; Processing

1. Introduction

Previous research on reference assignment in agrammatism has shown that the interpretation of particular anaphoric elements by agrammatic patients differs from the interpretation of the same elements in the unimpaired population (see e.g., Avrutin, 1999; Blumstein, Goodglass, Statlender, & Biber, 1983; Grodzinsky, Wexler, Chien, Marakovitz, & Solomon, 1993; Love, Swinney, & Zurif, 2001; Piñango & Burkhardt, 2001; Ruigendijk, Vasic, & Avrutin, submitted). The results of these studies point towards a selective impairment of reference assignment, which is constrained by linguistic principles. According to Grodzinsky et al. (1993), for example, agrammatic patients experience fewer problems when interpreting reflexives (*herself*) in a simple transitive sentence, such as in (1), then when interpreting pronouns (*her*) in the same construction in (2).

(1) *The girl* touched *herself*. Above chance performance
(2) The girl touched *her*. Chance performance

They correctly interpret *herself* referring to *the girl* in (1) and incorrectly allow *her* to refer to *the girl* in (2). Grodzinsky et al., also observe that when confronted with sentences where the local antecedent for the pronoun is a quantified expression, such as in (3), agrammatic patients perform above chance.

(3) Every boy pointed at *him*. Above chance performance

The good performance on pronouns in this type of sentences shows that the dissociation in performance is not necessarily related to the type of anaphor—reflexive vs. pronoun. It seems to lie deeper and is related to the type of operation through which a referent is assigned to an

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anaphoric element. Quantified elements, such as *every boy* in (3), are non-referential and can therefore only establish a (variable) binding relationship with a pronoun. Referential elements, such as NP *the girl* in (2), enter a coreferential (discourse[1]) relationship with a pronoun. These results indicate that the operations that involve variable binding are less problematic for agrammatic patients in contrast to the operations that involve an establishment of coreferential dependencies. Grodzinsky et al. (1993) argue that agrammatic patients do not have enough processing resources to compute the rules that govern intrasentential coreference.[2]

In the present study, we focus on the interpretation of pronouns in the VP-ellipsis constructions. The exceptional characteristic of these constructions is that they are ambiguous with regard to their interpretation. They represent one and the same structure where two different operations, namely, variable binding and coreference give rise to two different interpretations. Therefore, the two structures in (2) and (3) that were tested by Grodzinsky et al. (1993) where reference is assigned through two different operations are replaced by one structure where these two different operations result in two distinct interpretations.

2. VP-ellipsis

The classical elided VPs such as (4a), have received significant attention in the linguistic theory (Fiengo & May, 1994; Reinhart, 2000; Sag, 1976; Williams, 1977, among others).

(4a) Peter likes cars and Stuart does ⟨e⟩ too
(4b) Peter likes cars and Stuart ⟨likes cars⟩
(4c) Peter (λx (x likes cars)) and Stuart (λx (x likes cars))

The second conjunct in (4a) is realised as the phonetic string *Stuart does too*, nevertheless, it is interpreted as *Stuart likes cars* (4b). It has been assumed that the verb phrase in the second conjunct is reconstructed as a copy of the verb phrase of the first conjunct. Specifically, a mental representation of the first conjunct is made through the process of predicate abstraction and then pasted into the empty predicate slot indicated as ⟨e⟩ in (4a) giving rise to the interpretation represented in (4b) and (4c). The abstract semantic λ-operator in (4c) facilitates a replacement of the specific argument NP *Peter* in the first conjunct with a variable bound by this operator. This abstract predicate is then copied in the empty predicate slot. Finally, through a reversed process called conversion the variable (x) in the second conjunct receives the value of its local specific argument NP *Stuart* and the whole predicate is interpreted as *Stuart likes cars*.

In addition, the situation becomes more complex and the sentence becomes multiply ambiguous when the first conjunct contains a pronoun, as exemplified in (5a) and (5b).

(5a) Bill touches *his* dog and John does ⟨e⟩ too
(5b) Bill touches *Bill's third person's* dog and John ⟨touches *John's Bill's third person's* dog⟩

The second conjunct, when reconstructed, gives rise to different interpretations. The sentence in (5a) has three possible interpretations derived from different sources of information through which reference is assigned to the pronoun in the second (elided) conjunct. Let us look closely at the different interpretation and their sources, i.e., levels of grammatical representation at which they are established.

The *semantic interpretation* of (5a) derived from *variable binding* is represented in (6a and 6b), and is also known as the "sloppy reading."

(6a) Bill touches Bill's dog and John touches John's dog
(6b) Bill (λx (x touches x's dog)) and John (λx (x touches x's dog))

At the semantic level the pronoun is treated as a variable (x) that receives a referential value (antecedent) locally. In the first conjunct it refers to the local NP *Bill* where *Bill touches Bill's dog* and in the second conjunct to the NP *John* where *John touches John's dog*.

The second possible interpretation of (5a) is the *discourse interpretation*, derived from *coreference* and exemplified in (7a and 7b).

[1] The term discourse used here refers to the level of representation that is an interface level connecting syntax and the conceptual system, also referred to as the Conceptual-Intentional interface (Chomsky, 1995), information packaging (Prince, 1981) or Information structure (Avrutin, to appear; Lambrecht, 1994). At this level the information about the discourse referents and event structure is maintained.

[2] Grodzinsky et al. (1993) argue that not only agrammatic aphasic patients, but also children who exhibit a similar performance pattern (see Chien & Wexler, 1990) lack the resources to compute these structures. They claim it is the processing of Rule-I that causes the problems.

> *Rule-I –intrasentential coreference:*
> NP A cannot corefer with NP B if replacing A with C, C A-bound by B yields an indistinguishable interpretation.

According to this account, sentences with a pronoun require the construction of two possible representations during processing: one that involves the binding option (the syntactic-semantic operation) and another with the alternative coreference reading (involving discourse level information). These two representations must be compared, relative to their context, in order to decide whether they are distinguishable, that is, whether they yield a different interpretation. Coreference is only allowed if the two representations do yield a different interpretation. According to the authors 'the need to hold and compare two representations surpasses the processing ability of the language-deficient hearer, whether an aphasic or a child' (Grodzinsky et al., 1993, p. 410), leading to comprehension errors with sentences such as in (2).

(7a) Bill touches Bill's dog and John touches Bill's dog
(7b) Bill (λx (x touches z's dog) & z=Bill) and John (λx (x touches z's dog) & z=Bill)

The pronoun is assigned a fixed discourse referent in the first conjunct, the NP *Bill* in this case, and then the whole VP is copied in the second conjunct. The discourse interpretation is also known as the "strict reading."

Finally, there is a third interpretation of (5a), represented in (8a and 8b), which is *non-linguistic* in its source and is derived through *deixis*, also known as the "other strict reading."

(8a) Bill touches Sam's dog and John touches Sam's dog
(8b) Bill (λx (x touches z's dog) & z=Sam) and John (λx (x touches z's dog) & z=Sam)

This interpretation is similar to the *discourse* interpretation in (7a and 7b) because here too the pronoun is assigned a fixed referent. However, the pronoun refers to a referent not present in the sentence (discourse), some individual called *Sam*, which we may call a "*non-linguistic* " interpretation because its referent is not derived from the linguistic context.

3. Processing of VP-ellipsis

The correct interpretation of elided VPs with pronouns, therefore, requires co-ordination of various kinds of information and availability of sufficient processing resources to integrate this information. The listener needs to be able to construct the syntactic representation of both conjuncts in real time. Specifically, in order to obtain the appropriate interpretation (or interpretations) of the second conjunct, first the syntactic representation of the first conjunct needs to be constructed and its meaning computed, and than this needs to be copied onto the second conjunct. As shall become clear in the discussion section, these operations need to be co-ordinated in time.

There are a few online experimental studies (Shapiro & Hestvik, 1995; Shapiro, Hestvik, Lesan, & Garcia, 2003 and Frazier & Clifton, 2000) that have examined processing of anaphoric elements in VP-ellipsis in unimpaired adults. Adult speakers exhibit a preference for the bound variable interpretation (semantic dependency), such as (6a and 6b), over coreference (discourse dependency), exemplified by (7a and 7b). The reason why the semantic dependency is preferred can be found in the economy hierarchy of referential dependencies, as proposed in the Primitives of Binding (Reuland, 2001), which guides pronominal reference assignment in the non-brain-damaged adults.[3] In the Primitives of Binding, Reuland proposes an economy-based model for pronominal reference assignment for non-brain-damaged adults.[4] In this model distinct operations that take place at different linguistic levels, see (9), yielding different interpretations serve to distinguish between various types of anaphoric relations.

(9)

Level	(Operation)
Narrow syntax	(feature checking)
↓	
Semantics	(bound variable)
↓	
Discourse	(coreference)
↓	
(Non-linguistic source)	(deixis)

On the basis of this model we predict that the increase in the number of cross-modular operation results in the increase of the cost in terms of processing resources that is incurred when interpreting pronominal elements. The operations that occur in the narrow syntax are the most automatic and economical, hence establishing a syntactic dependency is the preferred way of assigning a referent to a pronominal element. The semantic operations are more costly because they imply an extra cross-modular operation. In order to establish a semantic dependency (bound variable interpretation) the interpretative system needs to first consult narrow syntax; in case a syntactic dependency is not possible it moves to another level, in this case the semantic level and establishes a dependency there. The same is true for moving onto the next level—discourse, where two modules are crossed. Finally, the non-linguistic source (deixis) is assumed to be the most expensive since the interpretative system needs to move outside the linguistic domain and enter other domains such as world-knowledge. The cross-modular steps proposed in the Primitives of Binding are exemplified in (10).[5]

[3] The Primitives of Binding (Reuland, 2001) framework is the most current theoretical approach to anaphoric dependencies that takes into account many problems that linguists identified with previous theories of dependencies. A detailed discussion of these problems, and the way they can be solved within the Minimalist framework of Chomsky (1995, 2000) is presented in Reuland (2001) and Reuland (2003). We, therefore, adopt this approach as our theoretical tool because it represents, in our view, the most up-to-date theory of anaphora.

[4] The notion of economy has mainly been used as a representational notion, nevertheless, proposals (Avrutin, 2004; Fox, 2000; Jackendoff, 1997; Reuland, 2001) have emerged that particular aspects of economy must have an observable effect on processing. The processing literature provides evidence for this claim; numerous studies (Burkhardt, 2004; De Vincenzi, 1991, 1996; Frazier, 1978; Gibson, 1998; Piñango, Zurif, & Jackendoff, 1999; Shapiro, 2000; Shapiro, Zurif, & Grimshaw, 1987, 1989) show that processing of syntactic operations is the least costly for the human parser as opposed to semantic or discourse operations.

[5] More specifically, syntactic dependencies result in identical syntactic objects (C_1–C_2) semantic dependencies result in identical semantic objects (x_1–x_2), discourse dependencies result in identical discourse objects (a_1–a_2).

(10)

Syntactic dependencies	C_1	→	C_2	1 cross modular operation
	↓		↓	
Semantic dependencies	x_1	→	x_2	2 cross modular operations
	↓		↓	
Discourse dependencies	a_1	→	a_2	

4. Processing in aphasia

The present study addresses the comprehension of VP-ellipsis by individuals with agrammatic Broca's and Wernicke's aphasia, with a focus on agrammatism. It has been argued that as a consequence of brain damage the processing resources in agrammatic Broca's aphasics are limited (see Friederici & Frazier, 1992; Haarmann & Kolk, 1991, 1994; Linebarger, Schwartz, & Saffran, 1983; Zurif, Swinney, Prather, Solomon, & Bushell, 1993; and many others). Consequently, several researchers have argued, that the problem lies in the speed at which the agrammatic patients construct the syntactic tree, such as the Slow-Syntax model (Piñango, 1999). There are many studies that provide evidence in support of this hypothesis. In an online priming study, Swinney, Love, Nagel, and Zurif (in preparation) (for more details see Zurif, 2003) find that agrammatic speakers show a priming effect when reactivating the antecedent of the moved constituent in object relative clauses not at the gap but at a later point in the sentence; they prime at about 500 ms later than non-brain-damaged adults do. Burkhardt and Ruigendijk (in preparation), Piñango (1999, 2002), Piñango and Burkhardt (2001), Love et al. (2001), Swinney, Zurif, Prather, and Love (1996), and Zurif et al. (1993) also find that the aphasic syntax is slower than that of non-brain-damaged speakers by examining various phenomena that involve dependencies (Wh-questions, relative clauses, and pronouns). Agrammatic aphasic speakers seem to be unable to carry out the construction of syntactic structure on time. There is a point at which syntactic structure is fully formed but this point is delayed in comparison to non-brain-damaged adults. An important question to ask is why would syntax be delayed? This may be related to the slow lexical access in these patients as argued by Swinney, Zurif, and Nicol (1989) and Zurif (2003). In an online priming study Prather, Zurif, and Love (1992) and Prather, Zurif, Love, and Brownell (1997) examine the process of lexical access in agrammatism, which is crucial for the online sentence comprehension. The building of the syntactic structure is constrained by temporal factors and if these are affected by a different than normal lexical insertion then the syntactic processing will suffer. In their studies Prather et al., 1992, 1997 examined priming effects for lexically ambiguous word, such as *bug*, which can mean two things—*insect* or *spying device*. Unimpaired controls exhibit automatic priming of the most frequent (easiest to access) meaning at around 500 ms after the presented stimuli; the priming effect decays 300 ms later. The agrammatic speakers' automatic priming effect is delayed until approximately 1500 ms and it decays within 300 ms. Their conclusion is that the primary problem in agrammatic lexical activation has to do with the *speed* of activation. They have the ability to access lexical information in comprehension automatically but only if they are allowed enough time to do so. These results indicate that agrammatic patients do prime when there is enough time for the activation of lexical items to spread among associates in a network. The slower activation, as argued previously, has an adverse effect on the online sentence processing. Therefore, it is reasonable to assume that as a consequence of a slower lexical access/insertion, the building of the syntactic tree will also be delayed. Finally, Avrutin (in press) provides detailed analyses of how this view explains the most basic comprehension patterns observed in aphasia, such as in object relative clauses, subject gaps, and passive constructions.

So, how can the slower-than-normal-syntax affect processing of VP-ellipsis constructions with pronouns? If building of the syntactic structure in agrammatism is indeed slower-than-normal, then all other mechanisms, other levels such as semantics and discourse, may be affected as well. Of course, as pointed out to us by an anonymous reviewer, we need to assume that the sequential order of operations as stipulated in the theoretical approach has a real time reflection. That is to say that if a certain operation proposed in the theory takes place after another operation is completed, our conservative hypothesis is that in real time processing these two operations are temporally ordered as well. The later—more costly—interpretations of the first conjunct become available "too late" for the second conjunct to receive the meaning associated with the later—more costly—possible interpretations of the first conjunct. If this is the case, we expect to find a better performance on one of the available interpretations that is "cheaper" and available earlier in time and possibly a poorer performance on the interpretation that is more "costly" and later available. According to the economy hierarchy, the semantic (bound variable) interpretation is cheaper than the discourse (coreference) interpretation. Therefore, we expect the agrammatic patients to perform better when dealing with semantic dependencies than when interpreting discourse dependencies.[6]

[6] In the case of pronouns in VP-ellipsis there are three possible sources of information when deciding on a referent for the pronoun—semantics, discourse, and deixis. Through operations performed at these different linguistic levels different meanings are derived. In this study, we focus on the semantic and the discourse levels, leaving the non-linguistic source aside.

The aim of this study is:

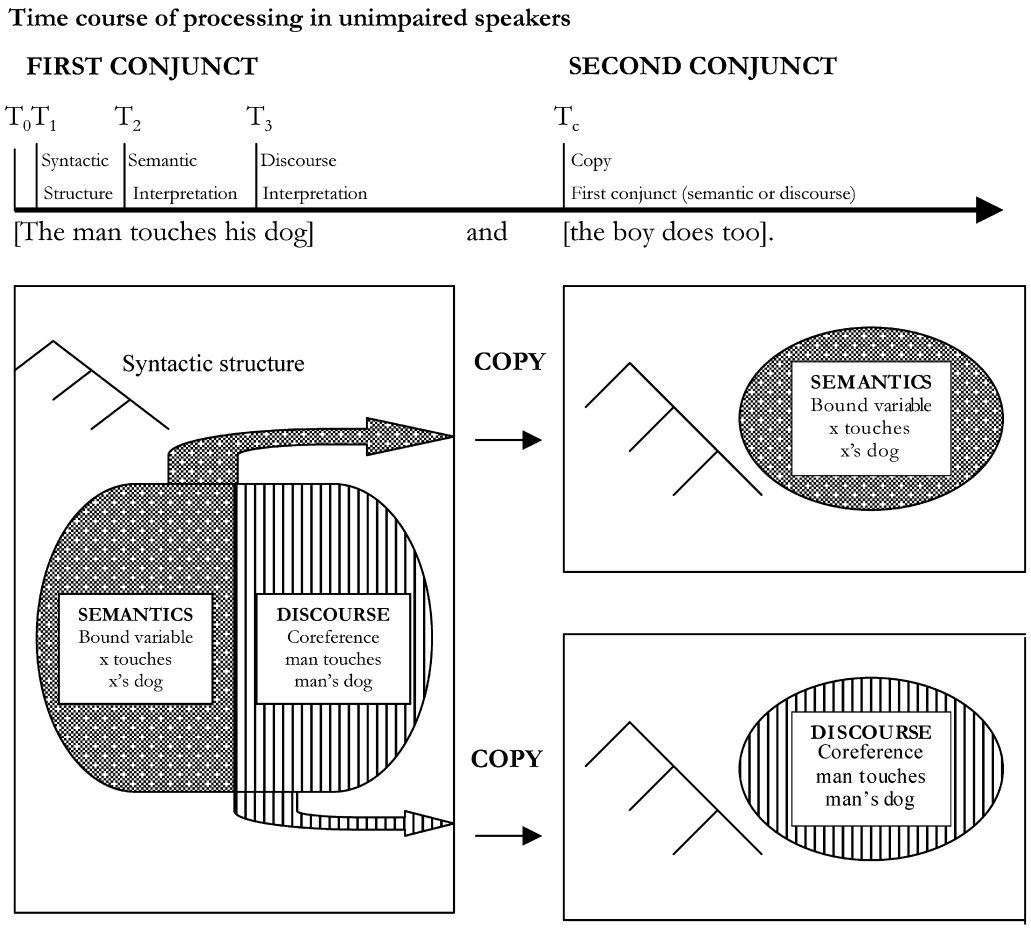
- To investigate whether agrammatic patients can obtain both *semantic* (bound variable) and *discourse* (coreference) interpretations.
- To determine whether one of the two is preferred if agrammatic patients are given a choice between the two interpretations.
- To determine whether the preference these patients exhibit correlates with the economy hierarchy.

We also examine the comprehension of VP-ellipsis by Wernicke's patients, who serve as a control group in our study. Similar to the agrammatic patients, these patients are known to exhibit comprehension difficulties with anaphoric reference assignment; however, their problems seem to be more general in nature (for details see Grodzinsky et al., 1993; Ruigendijk & Avrutin, 2003). The initial syntactic structure building appears to be intact in Wernicke's aphasia (Shapiro, Gordon, Hack, & Killackey, 1993; Swinney & Zurif, 1995), which is not the case with agrammatism. Therefore, we expect this subject group to show a different pattern of errors when interpreting pronouns in VP-ellipsis structures.

In the remainder of this paper, the experiment testing the aphasic comprehension of pronouns in the VP-ellipsis constructions is presented and its results are discussed.

5. Experiment

We tested six Dutch-speaking agrammatic aphasic patients and three Wernicke's patients. Of the six agrammatic patients, four were female and two male with an average age of 58 years (range 41–73 years). All of them were aphasic due to a single lesion in the left hemisphere, and all were right-handed. Individual patient data can be found in Appendix A All patients were diagnosed with the Dutch version of the Aachen Aphasia Test (AAT, Graetz, De Bleser, & Willmes, 1992). Five of them were classified as having Broca's aphasia on the



Semantic – *bound variable interpretation:* man touches man's dog and boy touches boy's dog.

Discourse – *coreference interpretation:* man touches man's dog and boy touches man's dog.

Fig. 1. Processing of VP-ellipsis in unimpaired adults.

basis of the AAT results, as well as by their speech therapist and an experienced clinical linguist. One of the patients (AD) could not be classified into one of the major syndromes with the help of AAT at the moment of testing. Since an earlier AAT did classify her with Broca's aphasia and her speech production did fit the pattern of agrammatism, we decided to include her in this study. The AAT scores of each of these patients are given in Appendix A.

The speech production of all Broca's aphasic patients was characterised as moderately to severely agrammatic based on the description of agrammatism in Menn, O'Connor, Obler, and Holland (1995), i.e., their speech production was non-fluent with non-finite utterances and relatively few pronouns and determiners.

The same as the agrammatic patients, the Wernicke's patients were diagnosed with the Dutch version of Aachen Aphasia Test. Individual patient data are also given in Appendix A, and the AAT scores of each of these patients can be found in Appendix A.

The performance of both agrammatic and Wernicke's patients was compared to the performance of a control group of 11 Dutch non-brain-damaged speakers (2 male, 9 female; mean age 31, range 19–69 years).

6. Method

A picture selection task was used to test the participants' comprehension of target sentences. Prior to the presentation of the target sentence, the characters represented in the pictures that were performing actions on their own or another person's animals were introduced on a separate picture presented on the left side (see Fig. 2, for an example). The introduction of characters was done extremely carefully, making sure that the participants would pay close attention to the animals that the characters were associated with. Each participant was presented with the target sentence orally and then asked to choose one out of three pictures that corresponds best to the sentence they heard. The experiment consisted of three conditions with 10 items per condition and 30 filler sentences (total 60 items, see Appendix B for all items from the test conditions).

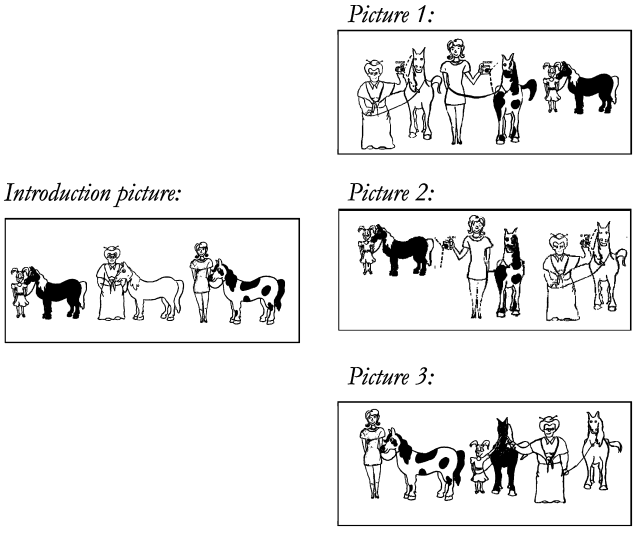


Fig. 2. Example Bound variable-only condition.

6.1. Introduction of characters

Dit is een meisje met haar eigen paard dat zwart is, een oma met haar eigen paard dat wit is en een vrouw met haar eigen paard dat zwart-wit is.

This is a girl with her own horse who is black, a grandmother with her own horse who is white and a woman with her own horse who is black and white.

In the first half of the experiment patients were presented with the following conditions:

1. Bound variable only (BV-only)

Target sentence

De oma fotografeert haar paard en de vrouw doet dat ook.

The grandmother photographs her horse and the woman does too.

Picture 1 (correct picture): grandmother photographs grandmother's horse and woman photographs woman's horse (girl standing next to them with her own horse);
Picture 2 (related distracter): grandmother photographs grandmother's horse and woman photographs girl's horse;
Picture 3 (unrelated distracter): the same participants as in *Picture 1* and *Picture 2* performing a different action or different participants than in *Picture 1* and *Picture 2* performing the same action (photographing).

If the bound variable interpretation (semantic dependency) is available, then *Picture 1* should be chosen; otherwise the participants could choose a related distracter—*Picture 2* or an unrelated distracter *Picture 3*.

2. Coreference only (CO-only)

Target sentence

De oma fotografeert haar paard en de vrouw doet dat ook.

The grandmother photographs her horse and the woman does too.

Picture 1 (correct picture): grandmother photographs grandmother's horse and woman photographs grandmother's horse (girl standing next to them with her own horse);
Picture 2 (related distracter): grandmother photographs grandmother's horse and woman photographs girl's horse;

Picture 3 (unrelated distracter): the same participants as in *Picture 1* and *Picture 2* performing a different action or different participants than in *Picture 1* and *Picture 2* performing the same action (see Fig. 3).

If the coreference interpretation (discourse dependency) is available *Picture 1* should be chosen, otherwise the participants could chose an action related filler—*Picture 2* or an unrelated distracter *Picture 3*.

To test a possible preference, in the second half of the experiment subjects were presented with the condition where they could choose between the two possible interpretations:

3. Bound variable vs. coreference (BVCO)

Target sentence

De oma fotografeert haar paard en de vrouw doet dat ook.

The grandmother photographs her horse and the woman does too.

Picture 1 (correct picture, bound variable): grandmother photographs grandmother's horse and woman photographs woman's horse (girl standing next to them with her own horse);
Picture 2 (correct picture, coreference): grandmother photographs grandmother's horse and woman photographs grandmother's horse (girl standing next to them with her own horse);
Picture 3 (unrelated distracter): the same participants as in *Picture 1* and *Picture 2* performing a different action.

Notice that in this case two pictures are correct (*Picture 1* and *Picture 2*), corresponding to the two readings that are, in principle, available to the unimpaired adults: bound variable and coreference. Thus, this condition was included to determine the preferred interpretation (see Fig. 4).

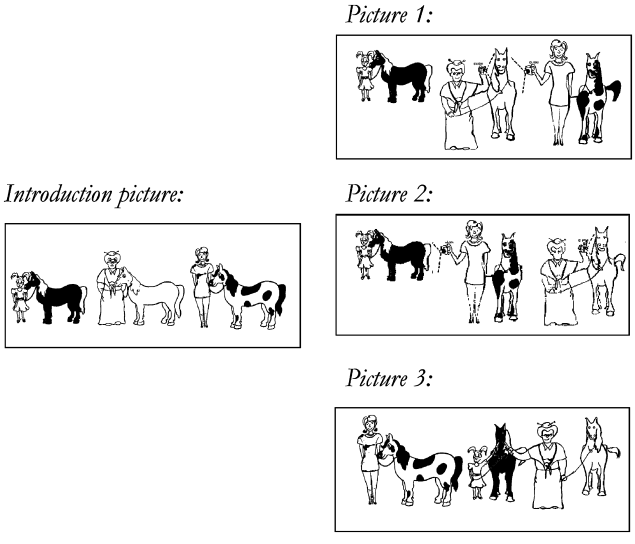


Fig. 3. Example Coreference-only condition.

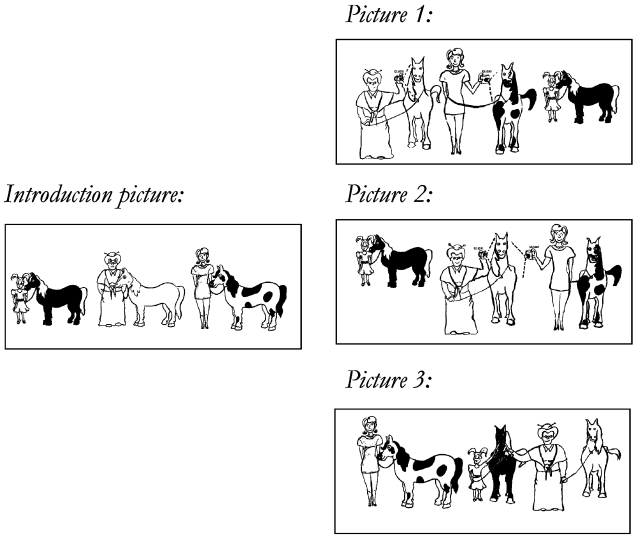


Fig. 4. Example Bound variable vs. Coreference condition.

Since the main focus of our study is these phenomena in agrammatism we decided to test the agrammatic subjects twice with the same test with a period of six months between the two test moments. The main reason for the repeated measurement is to increase the number of experimental items in order to have more data points (2×10 items per condition, total 2×30 items), which in turn gives more statistical power. In the analysis we first look at the two tests separately and compare their outcomes. Consequently, we combine the results of two measurements into one test.

7. Results

The results for agrammatic Broca's aphasics of each measurement separately (Test 1 and 2) and both taken together are presented in Table 1 as percentages correct responses for the Bound variable-only and Coreference-only conditions.[7] In the case of the choice condition, Bound variable vs. Coreference (BVCO) where they are offered both interpretations, the numbers represent percentages of bound variable interpretation chosen.

A binomial test indicates that in both the first and the second measurement the agrammatic patients score significantly above chance in the Bound variable-only condition (Test 1, $p < .0001$; Test 2, $p < .0001$). In the Coreference-only condition there is a difference between the two measurements; in the first one they score significantly above the chance level (Test 1: $p = .03$) and in the repeated measurement they are at chance (Test 2:

[7] Individual patient data for both agrammatic and Wernicke's patients are given in Appendix A.

Table 1
Results agrammatic patients only: for BV-only and CO-only percentages correct, for BVCO percentage bound variable picture chosen

Agrammatics ($n = 6$)	BV-only	CO-only	BVCO
Test 1	76.6	65.0	83.3
Test 2	83.3	41.7	96.7
Tests 1 and 2 combined	80.0	53.3	90.0
Controls ($n = 11$)	93.6	90.9	61.8

Table 2
For BV-only and CO-only percentages correct, for BVCO percentage bound variable picture chosen

Subject groups	BV-only	CO-only	BVCO
Wernicke's ($n = 3$)	56.6	53.3	53.3
Agrammatics ($n = 6$)	80.0	53.3	90.0
Controls ($n = 11$)	93.6	90.9	61.8

$p = .12$). It should be noted that in all erroneous responses subjects chose the related distracter, the unrelated distracter is never chosen. Therefore, we assume that chance corresponds to 50% and not 33%, which would be chance level when choosing between three pictures.

To test whether their overall performance is worse than that of controls we use the Mann–Whitney test. In the first measurement they perform significantly worse than the controls on both—Bound variable-only condition (Test 1: $Z = -2.577$, $p < .010$) and Coreference-only condition (Test 1: $Z = -2.666$, $p < .008$). In the repeated test they score equally well as the controls on the Bound variable-only condition (Test 2: $Z = -1.712$, $p < .122$), but worse on the Coreference-only condition (Test 2: $Z = -3.443$, $p < .001$) The agrammatic patients prefer bound variable interpretation above coreference in both measurements (Test 1 and Test 2: $p < .0001$). In Test 1 there was no significant difference between their scores on the Bound variable-only and Coreference-only conditions (Test 1: Wilcoxon Signed Ranks test—$Z = -1.361$, $p < .17$), but in the repeated measurement their performance on the Coreference-only condition was significantly worse than on the Bound variable-only condition (Test 2: Wilcoxon Signed Ranks test—$Z = -2.207$, $p < .03$).

From these results we observe that the only difference between the first and the repeated measurement is in magnitude and not in the direction of the results. The subjects' scores are in the same direction and their performance is significantly worse on the Coreference-only condition in Test 2 versus Test 1 ($Z = -2.041$, $p < .04$). Typically, in a repeated measurement one would expect an improvement of performance as an effect of repetition, nevertheless, our subjects perform worse which makes the effect of poorer performance on the Coreference-only condition more robust. Therefore, we treat the two measurements as one test with 20 items per condition and the analysis that follows deals with all the data grouped together in one pool.

The Table 2 and Fig. 5 exhibit the overall results for agrammatic Broca aphasics (total of Tests 1 and 2), Wernicke's aphasic and controls (for the individual patient results see Appendix A).

Overall, the agrammatic patients score significantly above chance in the Bound variable-only condition ($p < .0001$) and are at chance ($p = .26$) in the Coreference-only condition. They perform significantly worse than the controls on both—Bound variable-only condition ($Z = -3 = 2.303$, $p < .021$) and Coreference-only condition ($Z = -3.337$, $p < .001$). Both the agrammatic patients and controls prefer bound variable interpretation above coreference (agrammatics: $p < .0001$; controls: $p = .02$—binomial test). Their performance on the Coreference-only condition was significantly worse than on the Bound variable-only condition (Wilcoxon Signed Ranks test—$Z = -2.003$, $p < .05$).

Wernicke's aphasic patients exhibit chance performance on both Bound variable-only ($p = .86$) and Coreference-only ($p = .59$) conditions. Their overall performance is worse than the performance of the unimpaired subjects—Bound variable-only ($Z = -2.750$, $p < 006$) and Coreference-only ($Z = -2.345$, $p < .02$). Unlike the agrammatics and controls, Wernicke's patients do not have a preference for bound variable or coreference interpretation in the choice condition (BVCO) ($p = .58$). Finally, we compare the agrammatics' to the Wernicke's performance and find that agrammatic patients perform significantly better on the Bound variable-only condition (Mann–Whitney test: $Z = -2.119$, $p < .05$). No difference is found in their performance on the Coreference-only condition (Mann–Whitney test: $Z = -.654$, $p < .55$).

8. General discussion

The results of our experiment point towards a distinct pattern of errors for the agrammatic versus Wernicke's aphasic patients. Both patient groups also perform differently than the unimpaired subjects; nevertheless, they deviate from the unimpaired behaviour in very different ways. Let us first consider the performance of the agrammatic subject group.[8] The agrammatic aphasic speakers score significantly above chance in the condition testing whether they can interpret the pronoun in the elided VP as a bound variable. This indicates that they can represent a semantic dependency, which is established at the level immediately following the syntactic level in the economy hierarchy of referential

[8] In General discussion we refer to the combined results of Tests 1 and 2 as *the results* for the agrammatic group of subjects.

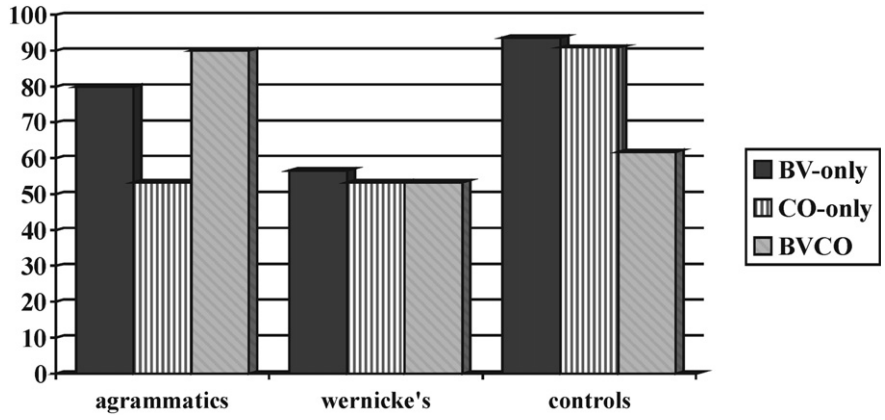


Fig. 5. Results all three groups. For BV-only and CO-only percentages correct, for BVCO percentage bound variable picture chosen.

dependencies proposed by Reuland (2001). Their performance on the condition where coreference is the only possible correct interpretation offered to them is at chance level. The guessing pattern implies that the agrammatic patients cannot process discourse dependencies that are, according to the economy hierarchy, more costly even for the unimpaired speakers. We conclude that the levels following syntax, semantic, and discourse levels in the economy hierarchy are not equally accessible in agrammatism. Specifically, Broca's agrammatic patients can process semantic dependencies (bound variable), but fail to process discourse related dependencies (coreference) in real time.

Another aim of our study is to examine whether the agrammatic speakers, when confronted with the choice between the bound variable (semantic) interpretation and the coreference (discourse) interpretation, exhibit a preference for either of the two interpretations. If the order of levels in the economy hierarchy is preserved in agrammatism, we expect them to exhibit a preference for semantic dependencies, the same as the unimpaired subjects. The responses show that the agrammatic patients clearly prefer the bound variable interpretation to coreference (90%), which is not surprising when the chance performance on the Coreference-only condition is taken into account. The unimpaired control subjects in our experiment do not seem to have a strong preference for one of the two interpretations. This result, at first sight, may seem not to be in concordance with the results obtained by previous studies (Frazier & Clifton, 2000; Shapiro & Hestvik, 1995; Shapiro et al., 2003) where the unimpaired adults exhibit a preference for a bound variable interpretation in an online task. It seems that the controls in our experiment were affected by the fact that in the first half of the experiment they were offered either the bound variable or coreference picture only in an experimental item and not both possibilities. This primed both interpretations and was carried over to the second half of the experiment where they were presented with items containing the pictures of both possible interpretations, and had to choose the more preferred interpretation. To find out whether this was the case, we tested an additional group of controls ($N = 10$) where the order was reversed; in first half of the experiment the choice condition (BVCO) was presented to the subjects followed by the second half with the Bound variable-only and Coreference-only conditions. The control subjects exhibited a higher preference for the bound variable interpretation (80%) when the experimental conditions were presented in this order. It should be noted what these results indicate in relation to the agrammatic performance. There was no such priming in the case of the aphasic patients. Although the agrammatic speakers were also presented with both interpretational options in the experimental items in the first half of the task, this clearly did not 'prime' coreference interpretation, as indicated by their very strong preference for the bound variable interpretation in the second half of the task. These results also predict that there should be no difference in the performance of agrammatic patients with the reversed order, i.e., the choice condition (BVCO) presented in the first half of the experiment followed by the Bound variable-only and Coreference-only conditions in the second half of the experiment.

Our results show that the pattern in agrammatism does not fully resemble the pattern in the unimpaired speakers. The economy hierarchy is preserved in agrammatism, nevertheless, the agrammatic patients score significantly worse than the unimpaired subjects, which indicates that they do have difficulties interpreting constructions that involve pronouns in elided VPs. When we compare agrammatic performance on the condition where the only correct option available involves a semantic dependency to the condition where the only correct response involves a formation of a discourse dependency, we find a significant difference between their performances. In combination with the overwhelming preference for semantic dependencies in the choice condition, we argue that the more cross-modular

steps need to be made to get a particular interpretation the more difficult it becomes for the agrammatic patients. According to the economy hierarchy, the discourse level follows the syntactic and the semantic levels, respectively. The more cross-modular operations are performed the more cost is incurred in terms of processing resources required for pronoun resolution. The same is true for the controls; however, their processing system is unimpaired and can deal with more costly operations in real-time processing. Hence, the difference between the two populations is in the amount of resources available to perform certain operations in time.

There is more evidence supporting the reality of the economy hierarchy in the non-brain-damaged and agrammatism. In a cross-modal lexical decision task testing the interpretation of reflexives (logophors vs. anaphors) in unimpaired adults Piñango, Burkhart, Brun, and Avrutin (2001) and in agrammatism Piñango and Burkhardt (2001) (see also Burkhardt, 2004) examine the processing load related to the syntactic versus discourse dependencies. The results of all of these studies show that for both non-brain-damaged adults and Broca's aphasics more cost is associated with processing of discourse dependencies than with processing of syntactic dependencies. It is, therefore, not surprising that in our experiment the problems in agrammatism are more expressed at the discourse level. The costlier the operations by which reference is assigned in particular sentences become, the more difficulty agrammatic patients will encounter in processing these sentences.

As expected, Wernicke's patients show a very different pattern of performance with regard to the pronoun interpretation in these sentences. They are at chance with both Bound variable-only and Coreference-only conditions, and they also do not have a preference for either of the two interpretations. They are guessing all the time and have problems with executing the task of choosing a picture. These results point towards a more general type and different source of the problem in these patients as opposed to the agrammatic patients (cf. Grodzinsky et al., 1993). This means that the pattern found in agrammatism is typical for this particular type of aphasia and is not just the effect of language breakdown or brain damage.

8.1. Real-time processing considerations

As already mentioned in Introduction, the processing of VP-ellipsis constructions in real-time entails a few steps that are necessary for the appropriate interpretation of the elided VP (second conjunct) and the pronoun in the elided VP (second conjunct). Let us look at this process more closely with the help of the example in (11, 11a, and 11b).

(11) [The man touches his dog] and [the boy does ⟨e⟩ too]

(11a) Man touches man's dog & boy touches boy's dog—*semantic—bound variable interpretation*

(11b) Man touches man's dog & boy touches man's dog—*discourse—coreference interpretation*

The hearer first constructs the first VP—*the man touches his dog*—and assigns reference to the pronoun *his*. At the same time the second conjunct is being processed. To be able to process the second conjunct the hearer must construct the syntactic structure and assign reference to the pronoun in the first conjunct in order to copy this information onto the second conjunct where the VP is elided. According to the hierarchy of referential dependencies the semantic (bound variable) interpretation is less costly than the discourse (coreference) interpretation. This has received support from the online studies mentioned previously, which show that adult speakers have a preference for the bound variable interpretation. Therefore, the bound variable interpretation of the pronoun in the first conjunct will be available sooner in time than the coreference interpretation because it is more economical. The bound variable interpretation will also be copied faster as the interpretation of the pronoun in the elided second VP. Nevertheless, the bound variable interpretation does not block coreference interpretation, which will also become available, but at a later point. The coreference interpretation will not be the preferred one in an off-line task simply because it is a more costly option for the unimpaired adult (see Fig. 1).

So, why do agrammatic patients perform worse than the unimpaired subjects? It could be the case, as argued by Kolk (1995), that the problems in agrammatic patients' comprehension arise as a consequence of a too fast decay of information that needs to be held in short-term memory in order for it to be integrated at a later point in time. The disintegration of information causes problems in cases where particular elements must be kept in store in order to be integrated with other elements that they form a dependency with. The VP-ellipsis structures with pronouns represent such cases. As the comprehension of these structures unfolds, the previously heard and not yet integrated material, such as the antecedent for the pronoun, needs to be connected to the pronoun once it is encountered. Because the information about the antecedent disintegrates too quickly, the patient fails to find an antecedent for the dependent element and the structure cannot be comprehended. If this is indeed the case then we expect the agrammatic patients to not be able to interpret VP-ellipsis constructions at all. Our results indicate that the agrammatic patients can interpret the pronoun as a bound variable in the elided VP. This undermines the claim that the comprehension problems in agrammatism are caused

by a too fast decay of information proposed by Kolk (1995). If agrammatic patients indeed had problems with maintaining the information about the possible antecedent for the pronoun in the second conjunct then they would simply fail to interpret the pronoun overall regardless of the type of dependency that is offered to them as the correct response.

The results of our study support a different view. Following the studies on lexical priming (Prather et al., 1992, 1997; Zurif, 2003), which provide evidence for a considerable slow down of the lexical activation process, we assume that, as a consequence of this delay, the building of the syntactic structure is also affected. Specifically, the syntactic structure building is delayed, which in turn affects the comprehension process in agrammatism. The structure building is a dynamic process that takes place in real time, therefore, the availability of particular bits of information that come from different sources is crucial for an adequate interpretation. In the elided VP constructions first the syntactic structure of the initial VP phrase *the man touches his dog* has to be built and a referent needs to be assigned to the pronoun *his*. At the same time the second conjunct is being constructed as a copy of the first one. As we have seen from the results, the unimpaired adults are capable of interpreting the pronouns in VP-ellipsis as a bound variable

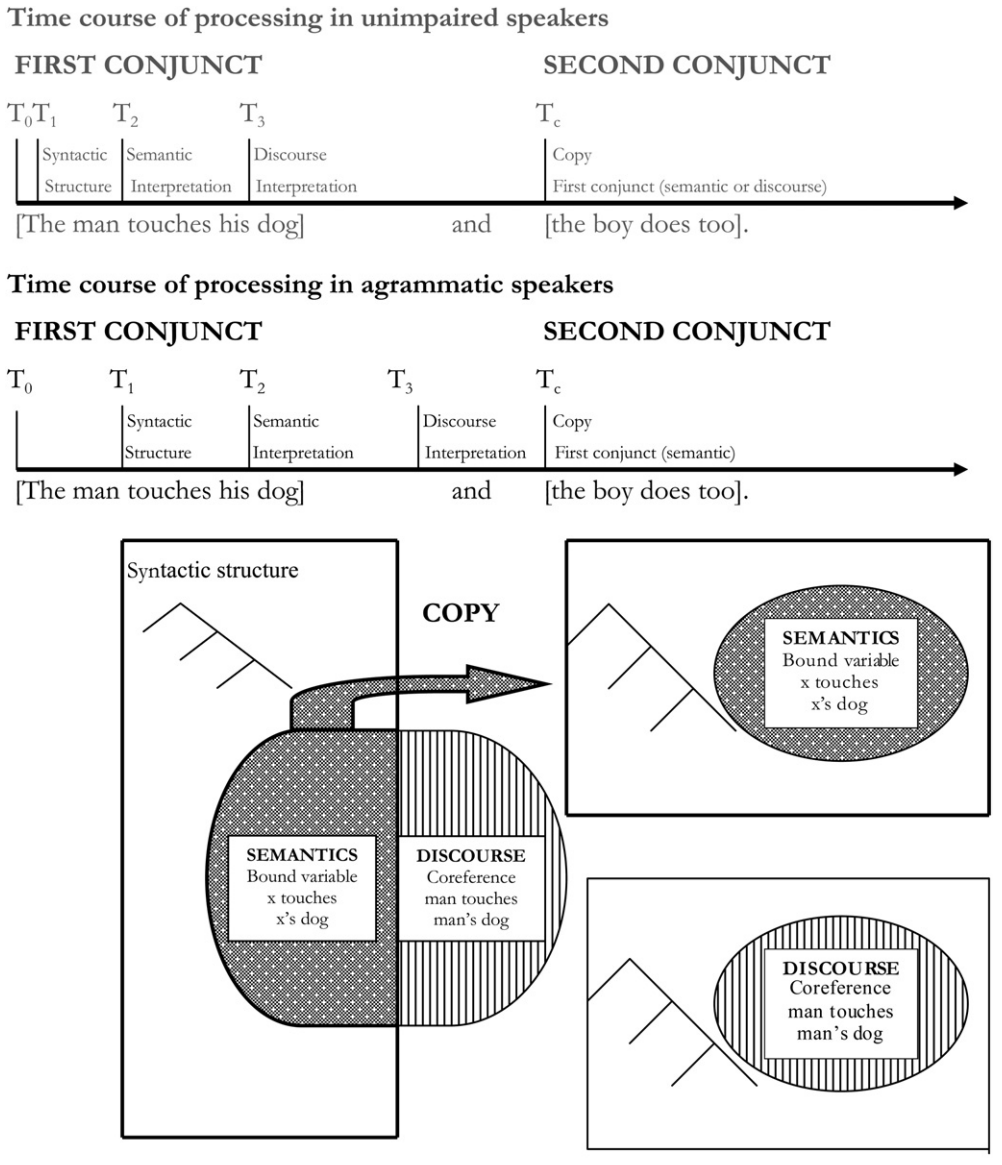


Fig. 6. Processing of VP-ellipsis in agrammatic aphasics.

(semantics) and coreferring (discourse). They also have a preference for the bound variable interpretation because that is the more economical option according to the economy hierarchy of reference assignment (see Fig. 1).

In agrammatism, on the other hand, in an off-line task such as ours the picture becomes different (see Fig. 6). Because the syntactic structure is built slower, the assignment of reference is also affected. While the agrammatic patients are trying to construct the first conjunct and assign reference to the pronoun in the first conjunct, they are confronted with the second conjunct *the boy does too*. To interpret the second conjunct, they will have to have built the structure and assigned reference to the pronoun in the first conjunct. Because they take longer to build the syntactic structure, which needs to be consulted and copied onto the empty slot in the elided VP, they will rely more heavily on the hierarchy of referential dependencies in the sense that the economy considerations will become more important to them than to the unimpaired speakers. The semantic dependency is cheaper and established faster than the coreference dependency; therefore the pronoun in the second conjunct can receive this interpretation before the system is out of resources, specifically, out of time. It seems as if it is easier for them to copy a semantic formula (*x touches x's dog*) than to assign a discourse referent to the pronoun (*boy touches boy's dog*) and then copy all this information in the elided VP. When the agrammatic patients are confronted with the condition where the only correct response is coreference they resort to guessing between the correct picture and the erroneous related distracter (53% correct). This indicates that the coreference interpretation of the pronoun in the first conjunct is not ready on time for it to be copied in the second conjunct. In the conditions where bound variable is the only correct response they make significantly fewer mistakes (80% correct), and when they are given a choice between the two possible interpretations they prefer the bound variable interpretation (90% bound variable chosen).[9]

So, the agrammatic patients fail to obtain the coreference interpretation because their system runs out of time and resorts to the cheaper and faster available option. It could be the case that if these sentences, first conjunct in particular, are presented to the agrammatic patients in a slower-than-normal speech-rate,[10] then the coreference interpretation could become equally available as the bound variable interpretation. At this point we cannot say more than that this issue needs further investigation.

9. Conclusion

The main conclusions of our study can be summarised as follows. The agrammatic Broca's aphasics are capable of obtaining both semantic (bound variable), however, they are incapable of establishing a discourse (coreference) dependency for the possessive pronoun in the VP-ellipsis constructions. We propose that their grammatical knowledge of these constructions is not impaired and that their errors have a different source. They also exhibit a preference for the bound variable interpretation that is much stronger than the controls. This strong preference reflects the processing hierarchy, which is related to complexity of these constructions. Finally, our results are consistent with the approach that views agrammatism as a reflection of an insufficiency of resources that are necessary to carry our linguistic operations in real time.

Acknowledgments

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[9] As one of the anonymous reviewers pointed out, one could argue that the distance between the site of the reconstruction of the elided VP and the local NP (bound variable interpretation) is shorter than the distance to the non-local NP subject of the first conjunct (coreference interpretation). As such the more local NP could be more active in memory and easier accessed. However, the more active NP at the point of reconstruction is actually the non-local NP because at this point the whole VP (the event) of the first conjunct is being reconstructed and copied so the more active NP is the local NP of the first conjunct. This would actually predict that the coreference interpretation should be easier for the agrammatic patients, which is obviously not the case. Another way of interpreting the data would be to assume that frequency plays a role and that the more frequent interpretation (bound variable) is less difficult. Online results obtained by Shapiro and Hestvik (1995) and Shapiro et al. (2003) show that this cannot be the case. Both interpretations are activated at the point of the reconstruction of the elided VP.

[10] Swinney et al. (in preparation) (see also Zurif, 2003) conducted a priming study where they presented agrammatic patients with non-canonical sentences at a slower-than-normal speech rate (input rate reduced from six syllables per second to one syllable per second). Broca's patients did reactivate the displaced constituents at the gap positions. In other words, they could establish the dependency between the gap and the antecedent.

Appendix A

Individual scores of the aphasic speakers on the Aachen Aphasia Battery

Subject	Spontaneous speech	Token Test	Repeating	Written language	Naming	Comprehension	Diagnosis
AD	3/5/5/4/4/2	17	115	73	110	112	Non-classifiable
AN	3/3/2/4/4/1	17	122	97	104	82	Broca
JW	3/5/3/4/4/2	18	112	82	99	107	Broca
IH	3/3/5/3/4/2	26	113	67	95	60	Broca
EM	2/3/2/4/2/1	24	99	48	100	86	Broca
MK	2/3/3/3/4/1	34	108	39	94	98	Broca
MS	2/5/5/3/2/4	37	54	33	44	86	Wernicke
VN	3/5/5/3/3/4	28	97	65	60	91	Wernicke
TB	3/5/5/4/3/3	40	113	40	34	92	Wernicke

The numbers under spontaneous speech refer to: communicational behaviour, articulation and prosody, automatic language, semantic structure, phonological structure, and syntactic structure, respectively. Scores go from 0 to 5, 0 referring to maximum disorder, 5 minimal problems, except for syntactic structure, where 1 or 2 refer to short and syntactic incomplete utterances. Under Token Test the number of errors is given (max 50). The maximum score for repeating is 150, for written language 90, for naming 120, and for comprehension also 120.

Patient IH has been tested with a shorter version of the AAT that has been developed by Heesbeen and van Loon-Vervoorn (2002). Their scores are derived from their scores on the shorter version using to the Heesbeen and van Loon-Vervoorn method.

Patient data

Subject	Sex	Age	Tpo	Diagnosis	Cause
AD	Female	52	3y4m	Non-classifiable aphasia	CVA-l, ACM
AN	Male	73	20y	Agrammatic Broca's aphasia	CVA-l, ACM
JW	Male	41	2y6m	Agrammatic Broca's aphasia	CVA-l
IH	Female	57	5m	Agrammatic Broca's aphasia	CVA-l
EM	Female	58	12y4m	Agrammatic Broca's aphasia	CVA-l
MK	Female	64	1y6m	Agrammatic Broca's aphasia	CVA-l
MS	Male	75	10m	Wernicke's aphasia	CVA-l
VN	Female	75	6m	Wernicke's aphasia	CVA-l
TB	Female	75	4m	Wernicke's aphasia	Intracerebral bleeding

Tpo, time post onset; y, year; m, months; CVA-1, cerebro vascular accident left; ACM, arteria cerebri media.

Individual patient results Broca's agrammatic patients

Patients	BV-only Test 1	BV-only Test 2	BV-only Total	CO-only Test 1	CO-only Test 2	CO-only Total	BVCO Test 1	BVCO Test 2	BVCO Total
JW (Broca)	90.0	80.0	85.0	70.0	50.0	60.0	100	100	100
AD (Broca)	90.0	90.0	90.0	60.0	30.0	45.0	90.0	100	95.5
EM (Broca)	60.0	70.0	65.0	30.0	30.0	30.0	100	100	100
MK (Broca)	70.0	100	85.5	60.0	40.0	50.0	100	90.0	95.0
IH (Broca)	70.0	70.0	70.0	90.0	60.0	75.0	90.0	90.0	90.0
TN (Broca)	80.0	90.0	85.0	80.0	40.0	60.0	20.0	100	60.0

Individual patient results Wernicke's aphasic patients

Patients	BV-only	CO-only	BVCO
TB (Wernicke)	60.0	40.0	50.0
VN (Wernicke)	60.0	40.0	50.0
MS (Wernicke)	50.0	80.0	60.0

Appendix B. Experimental items

B.1. Bound variable Only condition

1. V=aaien; Subj gender=masculine; Object=animal/dog
   De man aait zijn hond en de jongen doet dat ook.
   The man pats his dog and the boy does that too.
2. V=voeren; Subj gender=feminine; Object=animal/kat
   De boerin voert haar kat en de heks doet dat ook.
   The female farmer feeds her cat the witch does that too.
3. V=borstelen; Subj gender=masculine; Object=animal/schaap
   De clown borstelt zijn schaap en de tovenaar doet dat ook.
   The clown combs his sheep and the magician does that too.
4. V=wassen; Subj gender=feminine; Object=animal/paard
   De vrouw wast haar paard en het meisje doet dat ook.
   The woman washes her horse and the girl does that too.
5. V=aanraken; Subj gender=masculine; Object=animal/hond
   De man raakt zijn hond aan en de jongen doet dat ook.
   The man touches his dog and the boy does that too.
6. V=fotograferen; Subj gender=feminine; Object=animal/kat
   De heks fotografeert haar kat en de fee doet dat ook.
   The witch fotographs her kat and the fairy does that too.
7. V=schoppen; Subj gender=masculine; Object=animal/schaap
   De tovenaar schopt zijn schaap en de clown doet dat ook.
   The magician kicks his sheep and the clown does that too.
8. V=knippen; Subj gender=masculine; Object=animal/hond
   De opa knipt zijn hond en de man doet dat ook.
   The grandfather cuts hair of his dog and the man does that too.
9. V=duwen; Subj gender=feminine; Object=animal/kat
   De fee duwt haar kat en de boerin doet dat ook.
   The fairy pushes her kat and the female farmer does that too.
10. V=trekken Subj gender=feminine; Object=animal/paard
    De vrouw trekt haar paard en het meisje doet dat ook.
    The woman pulls her horse and the girl does that too.

B.2. Coreference Only condition

1. V=aaien; Subj gender=feminine; Object=animal/kat
   De heks aait haar kat en de fee doet dat ook.
   The witch pats her kat and the fairy does that too.
2. V=voeren; Subj gender=masculine; Object=animal/hond
   De jongen voert zijn hond en de opa doet dat ook.
   The boy feeds his dog and the grandfarher does that too.
3. V=borstelen; Subj gender=feminine; Object=animal/paard
   De oma borstelt haar paard en de vrouw doet dat ook.
   The grandmother combs her horse and the women does that too.
4. V=wassen; Subj gender=masculine; Object=animal/schaap
   De tovenaar wast zijn schaap en de boer doet dat ook.
   The magician washes his sheep and the farmer does that too.
5. V=aanraken; Subj gender=feminine; Object=animal/paard
   Het meisje raakt haar paard aan en de oma doet dat ook.
   The girl touches her horse and the grandmother does that too.
6. V=fotograferen; Subj gender=masculine; Object=animal/hond
   De jongen fotografeert zijn hond en de opa doet dat ook.
   The boy photographs his dog and the grandfather does that too.
7. V=schoppen; Subj gender=feminine; Object=animal/kat
   De boerin schopt haar kat en de heks doet dat ook.
   The female farmer kicks her cat and the witch does that too.
8. V=knippen; Subj gender=feminine; Object=animal/paard
   Het meisje knipt haar paard en de oma doet dat ook.
   The girl cuts the hair of her horse and the grandmother does that too.
9. V=duwen; Subj gender=masculine; Object=animal/schaap
   De clown duwt zijn schaap en de boer doet dat ook.
   The clown pushes his sheep and the farmer does that too.
10. V=trekken Subj gender=masculine; Object=animal/hond
    De man trekt zijn hond en de jongen doet dat ook.
    The man pulls his dog and the boy does that too.

B.3. Bound variable vs. Coreference condition

1. V=aaien; Subj gender=masculine; Object=animal/schaap
   De boer aait zijn schaap en de clown doet dat ook.
   The farmer pats his sheep and the clown does that too.
2. V=voeren; Subj gender=feminine; Object=animal/paard
   Het meisje voert haar paard en de oma doet dat ook.
   The girl feeds her horse and the grandmother does that too.
3. V=borstelen; Subj gender=masculine; Object=animal/hond
   De opa borstelt zijn hond en de man doet dat ook.
   The grandfather combs his dog and the man does that too.
4. V=wassen; Subj gender=feminine; Object=animal/kat
   De fee wast haar kat en de boerin doet dat ook.
   The fairy washes her cat and the female farmer does that too.
5. V=aanraken; Subj gender=masculine; Object=animal/schaap
   De boer raakt zijn schaap aan en de clown doet dat ook.
   The farmer touches his sheep and the clown does that too.
6. V=fotograferen; Subj gender=feminine; Object=animal/paard
   De oma fotografeert haar paard en de vrouw doet dat ook.
   The grandmother photographs her horse and the woman does that too.
7. V=schoppen; Subj gender=masculine; Object=animal/hond
   De man schopt zijn hond en de jongen doet dat ook.
   The man kicks his dog and the boy does that too.
8. V=knippen; Subj gender=masculine; Object=animal/schaap
   De boer knipt zijn schaap en de tovenaar doet dat ook.
   The farmer cut the hair of his sheep and the magician does that too.
9. V=duwen; Subj gender=feminine; Object=animal/paard
   De oma duwt haar paard en de vrouw doet dat ook.
   The grandmother pushes her horse and the woman does that too.
10. V=trekken Subj gender=feminine; Object=animal/kat
    De boerin trekt haar kat en de heks doet dat ook.
    The female farmer pulls her cat the witch does that too.

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