Grammatical and lexical pronoun dissociation in French speakers with agrammatic aphasia: A usage-based account and REF-based hypothesis

Byurakn Ishkhanyan [a, *], Halima Sahraoui [b], Peter Harder [c], Jesper Mogensen [d], Kasper Boye [a]

[a] Department of Nordic Studies and Linguistics, University of Copenhagen, Njalsgade 120, 2300 Copenhagen, Denmark
[b] OCTOGONE-Lordat E.A. 4156, University of Toulouse, Toulouse Brain Science Institute (ISCT), 5, Allée Antonio Machado, 31058 Toulouse Cedex 9, France
[c] Department of English, Germanic and Romance Studies, University of Copenhagen, Njalsgade 128, 2300 Copenhagen, Denmark
[d] The Unit for Cognitive Neuroscience (UCN), Department of Psychology, University of Copenhagen, Øster Farimagsgade 2A, 1353 Copenhagen, Denmark

ARTICLE INFO

ABSTRACT

Background: Pronouns have been shown to be impaired in agrammatic production but not all types of pronouns are equally affected. For instance, clitic pronouns are more impaired than non-clitic ones. A usage-based theory of grammatical status suggests a reclassification of pronouns into grammatical and lexical and predicts that grammatical pronouns are more impaired in agrammatic production. Besides, the reorganization of elementary functions (REF) model, which describes the underlying neurocognitive processes of post-injury recovery, explores the variability across individuals with agrammatism.

Aims: The current study hypothesizes that those pronouns that by the usage-based theory of grammatical status are grammatical are more affected than the lexical ones in agrammatic speech. In addition to this, the REF-model predicts that individuals with agrammatism will either build up unique strategies to cope with the deficit or they will rely more on fixed expressions.

Method: & Procedures: Spontaneous speech data collected from six French speaking individuals with agrammatism and nine non-injured controls in three different contexts (autobiography, narrative speech and descriptive speech) was used to test the hypothesis. We categorized 137 French pronouns into lexical and grammatical and calculated a grammatical pronoun index (GPI) for the groups and the individual speakers with agrammatism. We also conducted a qualitative analysis to look for adaptive strategies.

Results: Four individuals with agrammatism out of six produced significantly fewer grammatical pronouns than the non-injured group in the autobiography task. The two individuals with agrammatism who did not significantly differ from the control group were more fluent than the other four. The exclusion of pronouns containing fixed expressions did not result in drastic changes. The pronoun-verb analysis showed that there is no consistent connection between subject pronoun production and verb finiteness.

---

* Corresponding author.
  E-mail address: fhz406@hum.ku.dk (B. Ishkhanyan).

Conclusions: Grammatical pronoun production is indeed more severely impaired in agrammatic production. Moreover, the impairment pattern varies across individuals with agrammatism. Variability is observed both across participants with agrammatism and across tasks, which may indicate the use of unique adaptive strategies, as predicted by the REF-model.

1. Introduction

1.1. Pronouns in agrammatism

Agrammatism is defined in terms of omissions and substitutions of grammatical items (Goodglass, 1976). It may appear as a result of a brain damage and often accompanies Broca's aphasia (Druks, 2016). Among other symptoms speakers with agrammatism are said to have trouble producing function or closed-class words, while content or open-class words are generally preserved (Tissot, Lhermitte, & Mounin, 1973).

Pronouns belong to closed classes and are thus expected to be affected in agrammatic production (Druks, 2016). Indeed, crosslinguistic studies have shown that individuals with agrammatism produce fewer pronouns than non-injured controls (French: Nespoulous, Dordain, Perron, Jarema, & Chazal, 1990; Italian: Miceli & Mazzucchi, 1990; Swedish: Månsson & Ahlsén, 2001; Greek: Stavrakaki & Kouvava, 2003; Spanish, Catalan & Galician: Martinez-Ferreiro, 2010; Danish: Brink, 2014). Pronouns are, however, less affected than other categories in agrammatism (De Roo, 2002), which may indicate that they either have a unique position between function and content words or that various types of pronouns are affected differently in agrammatism.

Previous studies suggest that not all pronouns are equally impaired in agrammatic production. Clitic pronouns have been shown to be particularly sensitive to brain damage (Chinellato, 2004, 2006; Lonzi & Luzzatti, 1993; Rossi, 2007; Stavrakaki & Kouvava, 2003). Additionally, object clitics are more prone to omission than subject clitics (Nespoulous, Dordain, Perron, Ska, Bub, Caplan, & Lecours, 1988; Stavrakaki & Kouvava, 2003; Nerantzini, Papadopoulou, & Varlokosta, 2010), while indirect object clitics are omitted more often than direct object clitics (Rossi, 2007).

Direct object clitics (1) have also been shown to be more sensitive to damage than reflexive clitics (2) (Martinez-Ferreiro, 2010; Sanchez-Alonso, Martinez-Ferreiro & Bastiaanse, 2011). Sanchez-Alonso et al. (2011) have further shown that Spanish speakers with agrammatism have more problems producing the "unaccusative" form of the clitic *se,* (3) than its reflexive counterpart (1). Moreover, object clitic pronouns are often either substituted with a full noun phrase or they occur together with the noun phrase in the same utterance (Sanchez-Alonso et al., 2011; Martinez-Ferreiro, Reyes, & Bastiaanse, 2014)

(1) *La niña **se** lava.*
      'The girl washes herself.'
(2) *La niña **la** abre.*
      'The girl opens it.'
(3) *La puerta **se** abre.*
      'The door opens.'

Despite subject pronouns being less affected than object pronouns, a dissociation between clitic and non-clitic subject pronouns has been attested in Italian and French agrammatic speakers (Nespoulous et al., 1990; Chinellato, 2004, 2006): agrammatic speakers tend to omit clitics more often than their non-clitic counterparts. Interestingly, clitic subject pronouns are obligatory and have a higher frequency than their non-clitic counterparts (Schmitz & Müller, 2008).

Pronoun comprehension has also been shown to be impaired in agrammatism (Jarema & Friederici, 1994). In particular, French speakers with agrammatism have more difficulties comprehending direct object pronouns than homonymous articles (*le, la*). However, in general the dissociation between different types of pronouns is less evident in comprehension studies. Friederici, Weissenborn, and Kail (1991) have described a relatively preserved comprehension of direct and indirect object pronouns in three different languages. Additionally, Bos, Dragoy, Avrutin, Iskra & Bastiaanse (2014) have shown that direct object pronouns and reflexives are equally preserved in Russian speakers with agrammatism. The authors did find, however, that individuals with agrammatism were better at comprehending 'who' pronouns than 'which' pronouns.

1.2. Hypotheses accounting for pronoun impairment dissociation patterns: the variability and dissociation issue

The above findings witness several specific dissociations that have been accounted for in different ways. Avrutin's (2006) "weak syntax" theory accounts for the dissociation between direct object pronouns and reflexive pronouns in agrammatism. The theory suggests that pronouns with extrasentential reference, such as direct object pronouns, require higher processing load than pronouns with intrasentential reference, such as reflexive pronouns. Consequently, individuals with agrammatism, having processing limitations, omit the direct object pronoun or substitute it with a full noun. At the same time, pronouns

with intrasentential reference are less costly to process and therefore they are less problematic for individuals with agrammatism.

Another type of dissociation between clitic and non-clitic pronouns has been associated with impaired verb processing. Verb production has been shown to be impaired in agrammatism (Bastiaanse & Jonkers, 1998). Since, in the Romance languages investigated, clitic pronouns are dependent on verbs (Kayne, 1975), one might consider whether the dissociation between clitic and non-clitic pronouns is a result of verb production problems. In fact, speakers with agrammatism tend to omit subject pronouns in utterances where the verb is non-finite or altogether omitted (Kolk & Heeschen, 1990; De Roo, 2002). Kolk & Heeschen (1990) attribute this finding to the adaptation of processing limitations, while De Roo (2002) argues that subject pronouns are omitted because the untensed verb fails to assign nominative case to the subject pronouns. In her study, however, there are occasional occurrences of subject pronouns in non-finite utterances and omissions in finite utterances, indicating variability even within participants.

It is commonly agreed that agrammatic speech differs both across individuals and across tasks (Miceli, Silveri, Romani, & Caramazza, 1989; Tesak, 1992; Sahraoui & Nespoulous, 2012; Sahraoui, 2015). One of the reasons for this variability could be different adaptation strategies that individuals with agrammatism use, such as ellipsis (Kolk & van Grunsven, 1985; Kolk, 1995). In terms of variability, pronouns are no exception. Sanchez-Alonso et al. (2011) showed that speakers with mild agrammatism are more prone to substitute clitic direct object pronouns with another clitic or a full noun phrase, while the more severely impaired ones omitted clitic direct object pronouns. They suggested that speakers with mild agrammatism are better at handling the higher processing load.

The number of attested instances of pronoun dissociations in agrammatism raises the question whether the premises for associating impairment of pronouns *en bloc* with agrammatism are inaccurate. We believe they are, and that pronoun dissociations should be expected. The term *agrammatism* reflects an understanding that there is something about grammar (as opposed to other aspects of language, such as lexicon) that is particularly difficult for individuals with the relevant kind of aphasia. The definition poses a problem, however, as grammatical items are themselves poorly defined. Grammatical words are often contrasted with lexical words, but as pointed out by Geurts (2000), among others, the distinction between grammar and lexicon has for a long time remained pre-theoretical and intuition-based. This entails that theoretically based criteria for classifying words as grammatical have been absent. Definitions in terms of closed- vs. Open-class words or form or function vs. Content words are an attempt to circumvent this problem, but instead they add new problems. In particular, what belongs to closed classes is a highly language-specific matter. In standard average European languages, for instance, verbs belong to open classes, but in other languages they belong to closed classes. Cases in point are found in the Trans New Guinea language family, in languages such as Kalam, Kobon and the Chimbu-Wahgi languages, all of which have only between 60 and 150 inflecting verbs (Pawley, 2006). Therefore, a link between grammar and closed classes cannot be maintained. Therefore, there is no reason to expect closed-class words like pronouns to behave in a uniform way in agrammatism. Friederici (1982) showed that German prepositions when used grammatically as obligatory parts of syntactic structures were more severely affected in agrammatic speech production than when used lexically. There is no reason to exclude a similar dissociation in pronouns.

In this paper, we investigate whether (in addition to the dissociations discussed above) there is evidence for such a dissociation between grammatical and lexical pronouns. We base our distinction between grammatical and lexical pronouns on a novel theory of grammatical status and grammaticalization (Boye & Harder, 2012; see Helbig & Buscha, 2001, and Eisenberg, 2004 for related proposals pertaining specifically to German pronouns), and test whether this distinction is reflected in a pronoun dissociation in French agrammatic speech.

In addition, we suggest a neurocognitive account for variability across individuals with agrammatism. In this paper we introduce the Reorganization of Elementary Functions (REF) model (Mogensen, 2011, 2014), which may entail a possible explanation for variability of impaired pronoun processing across individuals with agrammatism.

In the next sections we will discuss the two theoretical bases of our predictions. We first present the theory of grammatical status (Boye & Harder, 2012), which will be used to reclassify pronouns. We then proceed to the REF model (Mogensen, 2011, 2014). Afterwards we briefly discuss French pronouns from the Boye and Harder (2012) point of view. Finally, we present our aims and hypotheses before proceeding to the methodology and results.

1.3. A usage-based theory of grammatical status

As discussed above, the distinction between grammar and lexicon has for a long time remained pre-theoretical and intuition-based. This entails that theoretically based criteria for classifying words as grammatical have been absent.

Generative Grammar in principle offers a solution to this, but with its focus on syntactic structure, it is not ideally equipped for dealing with the distinction between grammatical and lexical words, and often resorts to the problematic distinction between closed and open word classes (Harley, 2006).

A functionalist and cognitivist alternative is Boye & Harder's (2012) usage-based theory of grammatical status.[1] This theory offers an account of the relation between lexicon and grammar (evidenced by grammaticalization processes by which lexical

---

[1] Boye & Harder's (2012) theory is compatible with different functional-cognitive frameworks, including Cognitive Grammar (Langacker, 2008), Role and Reference Theory (Van Valin & LaPolla, 1997); Functional Grammar (Dik, 1989), Functional Discourse Grammar (Hengveld & Mackenzie, 2008); cf. Sahraoui (2015) on the relevance of functionalist approaches to agrammatism.

items give rise to grammatical ones), which entails an explanation of why grammatical items are cognitively difficult in a way that lexical items are not. The central idea of Boye and Harder (2012) is that grammatical items cannot convey the main point of an utterance, but are by convention ancillary, providing secondary information. In contrast, lexical items have the potential to convey the main point of an utterance; they are by convention potentially primary. This defining property entails that grammatical items are inevitably dependent on other items, while lexical ones are not necessarily so. Being secondary by convention, grammatical items need to co-occur with other items, in relation to which they are secondary. They cannot stand alone (cf. The fact that you cannot, outside metalinguistic or contrastive contexts, produce the article *the* or the past tense suffix *-ed* in isolation). In contrast, lexical items, as potentially primary, have the potential to stand alone (*Fire!, Run!*).

The defining property also entails a difference between grammatical and lexical items when it comes to focalizability. Focus has the effect of singling out the most prominent element in an utterance. Since only lexical elements can potentially be the most prominent element in an utterance (outside metalinguistic and contrastive contexts), only they can be focalized. Grammatical expressions, unlike lexical expressions, cannot be focalized, for example, by means of clefting or focalizing particles. This means that non-focalizability is a criterion for grammatical items, whereas focalizability is a criterion of lexical status.

To give an example of how this criterion works, compare the English pronouns *it* and *him* in the construction *Sue likes it/him*. By the above criterion, *it* comes out as grammatical. It cannot be focalized by means of clefting (4) or by means of a focus particle such as *only* (5), and even stressing it seems odd (at least outside a metalinguistic context) (6).

(4) **It is it that Sue likes.*
(5) **Sue likes only it.*
(6) ?*Sue likes IT.*

In contrast, *him* comes out as lexical. It can unproblematically be focalized by means of clefting (7), a focus particle (8) or stress (9).

(7) *It is him that Sue likes.*
(8) *Sue likes only him.*
(9) *Sue likes HIM.*

French differs from English in having more grammatical pronouns. In section 1.4 we outline how we classified French pronouns based on the criterion discussed above.

1.4. The REF-model

The REF-model offers a novel view of neurocognitive organization and suggests a mechanism for recovery after a brain injury (Mogensen, 2011, 2014). The model has three levels: Elementary Functions (EFs), Algorithmic Strategies (ASs) and Surface Phenomena.

It is at the level of Surface Phenomena that traditionally defined functions, such as language or memory, are manifested. The results of post-injury recovery of language can also be observed at the Surface Phenomena level.

Out of the three levels of the REF model only the EFs (the lowest level) are truly anatomically localized and highly modular. When brain injury occurs, EFs are irreversibly lost and consequently their functions are also lost. EFs, however, are not cognitive functions in the traditional sense (e.g. no individual EF mediates phonology or syntax). The functions (or information processing) of individual EFs should rather be described using mathematical terms.

The mid-level of the REF-model comprises ASs. Each AS consists of interacting EFs. ASs are formed as a result of experience and learning. Unlike EFs, ASs are spread across different brain regions. The activation of several related ASs may lead to Surface Phenomena that are equally proficient and apparently similar. Functional impairment may be observed after brain injury, if the ASs underlying the Surface Phenomena are compromised by brain injury. This happens because the neural substrate of the EFs composing the AS is lost.

In order to recover the impaired function, the brain will need new ASs, which involves the "Reorganization of Elementary Functions" (REF) process. The existing EFs, which previously may have not been involved in a function, unite to form a new AS. The "recovered" function will not be identical to the pre-injury one. Moreover, the function may vary in different individuals. Besides the extent of the neural loss, two factors have a major impact on the post-injury development of new ASs: (1) the post-injury experience of the patient and (2) the pre-traumatic pattern of connections between EFs − a pattern mainly determined by the pre-traumatic experiences of the patient. In the case of language, post-injury experience could involve practicing language both in a therapeutic setting and in daily life. The variety of experiences may result in variability of post-injury performance across individuals with agrammatism. It could be the case that the new adaptive strategies which the individuals with agrammatism use to cope with the deficit are the result of a new, albeit impoverished or imperfect grammar.

Regarding the present issue of pronoun dissociation in agrammatism, the REF model agrees with the predictions of the usage-based theory of grammatical status (Boye & Harder, 2012). According to the REF model (Mogensen, 2011, 2014) the normal development of the neurocognitive mechanisms underlying a given cognitive domain (e.g. grammar) is the result of

function-and-experience-driven establishment of networks of EFs. Thus, the networks representing a given class of words (e.g. pronouns) will depend on the function of these words in the language in question. If, in a given language, pronouns can both serve in a grammatical and a lexical role, the REF model predicts that this functional dissociation will also lead to a differentiation into different networks representing grammatical and lexical pronouns, respectively. Consequently, like the theory of grammatical status, the REF model predicts that grammatical and lexical pronouns will be differently impaired in agrammatism.

1.5. Pronouns in French

We used the focus test introduced in Section 1.2 above to classify 137 French pronouns as grammatical or lexical. We included the following types of pronouns: clitic personal pronouns (e.g. *je, tu, il*), non-clitic personal pronouns (e.g. *moi, toi, lui*), adnominal demonstratives (e.g. *ce, c', cette*), free-standing demonstratives (e.g. *celui, celle*), adnominal possessive pronouns (e.g. *mon, ton, son*), free-standing possessive pronouns (e.g. *le mien, le tien, le sien*), indefinite pronouns (e.g. *on, tout le monde, quelqu'un*), interrogative pronouns (e.g. *qui, qu'est-ce que*), and relative pronouns (e.g. *qui, que, dont*). Some of these form homonymous pairs, which can, however, be distinguished on distributional grounds. For instance, the interrogative pronoun *qui* can be found in main clauses, while the relative pronoun is found in subordinate clauses. One type of pronouns, the adnominal possessive pronouns, are traditionally referred to as possessive adjectives (*adjectifs possessifs*) in Romance linguistics, rather than as pronouns (but see also e.g. Franks & Schwartz, 1994 on the classification of these forms as pronouns). However, this is a purely terminological issue. The relevant items (e.g. *mon, ton, son*) distributionally and semantically correspond to items classified as personal pronouns in other languages (e.g. English *my, your, his*), and like the rest of the items included as pronouns in the present paper, they meet a standard definition of pronouns as items that have no descriptive content, but are used to refer anaphorically to NPs and/or deictically to entities in the extralinguistic context (Matthews, 2007).

Based on the focus test, the pronouns were classified as shown in Table 1 (see Appendix B for the full list).

The distinction between grammatical and lexical pronouns can be exemplified by the contrast between *il* and *lui*, both 3rd person masculine pronouns. *Il* cannot be focalized, for instance in a cleft construction, as illustrated in (10), but *lui* can, as illustrated in (11).

(10) **C'est **il** qui mange une pomme.*
     Intended reading: 'It is **he** who eats an apple.'
(11) *C'est **lui** qui mange une pomme.*
     'It is him who eats an apple.'

In fact, *lui* can be used to focalize reference to a 3rd person masculine entity (12).

(12a) ***Lui**, **il** mange une pomme.*
      'Him, he eats an apple.'
(12b) ***Lui** mange une pomme.*
      'Him eats an apple.'

This means that according to the focus criterion, *il* comes out as grammatical, while *lui* comes out as lexical. In the third example, the focusing and stressed pronoun *lui* in an appositive construction (6b) or as a pronoun in the place of *il* (equivalent to *he* in English) is commonly used in spoken French. In 6b, the focus is on *lui* as one of the entities previously introduced in discourse or in the context, contrasting with some another entity.

Il is often referred to as a weak or clitic pronoun, while *lui* is strong or non-clitic. According to the focus criterion, all weak French pronouns (including also *je, me, tu, te, ils*) are grammatical, while all strong ones (including also *moi, toi, eux*) are lexical. Some pronouns (including *elle, nous, vous*) have both a weak and a strong variant. In the written language at least, these can be distinguished only on distributional grounds. For instance in (13), the first instance of *elle* is strong (stressed, focalized) and the second weak.

Table 1
Classification of French pronouns using the focus test.

Grammatical pronouns	Lexical pronouns
clitic personal pronouns (e.g. *je, tu, il*)	non-clitic personal pronouns (e.g. *moi, toi, lui*)
adnominal demonstratives (e.g. *ce, c', cette*)	free-standing demonstratives (e.g. *celui, celle*)
adnominal possessive pronouns (e.g. *mon, ton, son*)	free-standing possessive pronouns (e.g. *le mien, le tien, le sien*)
non-focalizable indefinite pronouns (*on*)	focalizable indefinite pronouns (e.g. *tout le monde, quelqu'un*)
relative pronouns (e.g. *qui, que, dont*)	interrogative pronouns (e.g. *qui, qu'est-ce que*)

(13) **Elle**, **elle** *mange une pomme.*
　　'She eats an apple.'

Thus, we classified pronouns like the first one in (13) as lexical, and pronouns like the second one in (13) as grammatical.

In the case of personal pronouns, then, our classification is coextensive with traditional distinctions between clitic and non-clitic or between weak and strong pronouns. In the case of possessive pronouns, similarly, our classification may be seen as coextensive with traditional distinctions between 'possessive adjectives' and possessive pronouns proper. The classification we suggest brings these two traditional distinctions under the grammatical-lexical distinction as a common umbrella, which in addition covers three other distinctions (see the five distinctions in Table 1).

1.6. The predictions of the current study

Based on the Boye and Harder (2012) theory and the diagnostic criteria of grammatical and lexical status that go with it, we predict that grammatical pronouns are more severely affected than lexical ones in agrammatic connected speech. So far, this theory has only been tested in a case study of a Danish speaker with agrammatism, showing that grammatical pronouns are more impaired than the lexical ones (Brink, 2014). We further test this prediction in a study of French speakers with agrammatic aphasia. In order to investigate the possibility that impaired production of grammatical pronouns is merely an effect of impaired verb production (as some grammatical pronouns are enclitic on verbs), we also conduct an analysis of verb-pronoun combinations.

The current study has both linguistic and psycholinguistic implications. From the linguistic point of view, the distinction suggested in Boye and Harder (2012) between grammatical and lexical pronouns is at odds with the traditional view of pronouns according to which all pronouns are grammatical. This means that if we show dissociation between the two kinds of pronouns in agrammatic speech, the linguistic theory will have better predictive power as an account of grammatical status than other theories, such as generative theories that define grammatical words as words belonging to closed classes (Harley, 2006).

The psycholinguistic implication is that this study may provide evidence for distinct processing patterns between grammatical and lexical items, evidence that would set new directions for psycholinguistic research.

We hypothesize that speakers with agrammatism produce fewer grammatical pronouns than lexical ones because grammatical pronouns according to Boye and Harder (2012) are discursively secondary, and therefore are omitted more often than the lexical ones in agrammatic production, when processing load is limited. We also expect more substitutions of grammatical pronouns than of lexical ones. In terms of adaptive strategies, we predict that individuals with agrammatism will rely more on fixed expressions or will build up their own unique strategies to cope with the deficit. For that reason, after a detailed quantitative analysis, we will provide an analysis of the relationship between pronoun and verb production.

2. Method

In order to test our hypothesis, we used the transcribed and pre-processed data of Sahraoui (2009) and Sahraoui and Nespoulous (2012).

2.1. Participants

The speech samples were obtained from six speakers with agrammatism (aged between 41 and 56, 5 males, 1 female, 1–9 years post-onset) and nine non-injured controls (aged between 32 and 61, 6 males, 3 females), all of them native speakers of French. All of the speakers with agrammatism had a lesion as a result of a left hemisphere stroke leading to Broca's aphasia. The aphasia type and the severity were determined by a speech and language pathologist. Based on fluency, four of the participants were classified as having severe aphasia (words per minute 25–38; mean length of utterance 3,7–6,8) and two of them as having mild aphasia (words per minute 66 and 68; mean length of utterance 9,7 and 9,9 respectively). Information about the individuals with agrammatism (handedness, etiology, education and diagnosis) and speech samples can be found in Appendix A.

2.2. Materials & procedure

Connected discourse was elicited in three production tasks, gradually increasing the constraints. In the first task the participants were asked to talk about his or her history of illness (autobiography). In the second task the participants were asked to retell the well-known fairy tales Cinderella and Little Red Riding Hood (narrative speech). In the third task unknown sequences of four pictures were presented to the participants and they were asked to construct a story (descriptive speech). The sample size, words per minute (WPM) and mean length of utterance (MLU) per task can be found in Appendix A. For detailed information about the data see Sahraoui (2009) and Sahraoui and Nespoulous (2012).

2.3. Pronoun count and scoring

As discussed above, 137 French pronouns were classified as grammatical or lexical based on Boye and Harder's (2012) focus criterion (see section 1.4 for details).

A potential confounding factor when comparing the occurrence of simple expressions such as pronouns is the fact that pronouns may be part of larger 'fixed phrases', i.e. idioms or constructions that are lexicalized as whole units (for examples, see the discussion below). Such larger units may be stored and retrieved as unitary lexical items (or holophrases). The pronoun forms that enter into such units would not be predicted to have occurrence patterns reflecting their properties as either grammatical or lexical pronouns, but would be expected to be merely side effects of the choice of the larger units as such. If so, raw occurrences of pronoun expressions contained as parts would not be relevant for throwing light on the differences between grammatical and lexical pronouns in aphasic speech. In addition, people with aphasia may rely more than controls on fixed phrases, precisely because freely constructed combinations present problems for them.

In order to counteract this potential source of error, we attempted to provide figures that did not include pronouns occurring in such fixed phrases. This raises problems of identification, since there are no clear-cut criteria for separating cases where properties of the larger units override all properties of internal parts; the concept of 'partial compositionality' as invoked by Langacker (1987) reflects the existence of a grey zone where some properties are compositional (and hence reflect the properties of the smaller components) while other properties are due to the combination rather than the components. What is more, one man's fixed phrase may be another man's freely constructed combination.

We chose the following procedure: from the corpus we selected a number of collocations containing pronouns that appeared as plausible candidates for being 'fixed phrases' in a broad sense. Within that group, we identified those in which phrasal meaning did not include those functions that are associated with standard pronoun meanings: deictic or anaphoric reference. For instance, the expression *ça va* (a greeting, lit: 'it goes') we classed as a greeting that did not involve identification of a deictic referent for *ça,* and *il* in the phrase *il faut* we similarly classed as an impersonal verb construction that does not involve anaphoric reference. A list of the expressions we removed as part of this operation are the following: *c'est ça* ('that's it'), *il faut* ('it is necessary'), *il paraît* ('it seems'), *il semble* ('it seems'), *s'en aller* ('to leave'), *ça va* (a greeting, lit: 'it goes'), *ça veut dire* ('it means'), *il y a* ('there is').

In contrast, we did not exclude either the deictic or the anaphoric pronoun in the collocation *ça c'est* ('it is'), since both occurrences arguably involve picking out a referent. The selection was independently checked by two French linguists.

For the current study we first included all the pronouns in the count, except for the ones that were purely conversational fillers (such as sentences ending in *quoi* ('what')). We then did a separate count, excluding pronouns occurring in fixed expressions based on the selection mentioned above. A total number of 139 elements from the agrammatic samples and 254 elements from the control samples were excluded. In order to calculate the number of grammatical and lexical pronouns in the data, we created.cut files containing all the 137 French pronouns. Using the *freq* command in CLAN (MacWhinney, 2003), we first found the frequencies of each pronoun in each sample and then we used the *combo* command to go through each utterance one by one to check the contexts and to exclude the definite articles, which are homonymous to object pronouns.

We then calculated the total number of pronouns in relation to the total number of words. In order to compare the production of grammatical vs. Lexical pronouns, we introduced the grammatical pronoun index (GPI), which is the proportion of grammatical pronouns in the total number of pronouns. The GPIs were calculated both for all pronouns found and for the pronouns remaining after excluding items found in fixed expressions. We also calculated proportions of pronoun subgroups within the lexical and grammatical groups, based on the classification in Table 1.

For the purpose of taking into account grammatical-lexical pronoun substitutions, we classified personal pronouns as correctly or incorrectly produced. An example of an incorrectly produced pronoun is found in (14).

(14) *Il va le manger.* 'He is going to eat him.'

In this example the participant replaces the pronoun *la*, which refers to the grandmother in Little Red Riding Hood with *le*. Thus, the feminine direct object pronoun *la* is substituted with *le*, which has the wrong (masculine) gender.

We did the substitution count for personal pronouns only, as clitic subject pronouns are obligatory and therefore it is possible to predict the intended pronoun in an utterance when substitutions occur. We then compared correctly produced grammatical pronouns to correctly produced lexical ones. Finally, we made an analysis for each utterance where the production of a subject pronoun was inevitable (based on context). In each of these utterances we checked various combinations of clitic/non-clitic and finite/nonfinite verb production. We also looked at the data from the mildly affected participants qualitatively.

For each of the measurements mentioned above we obtained mean scores for the control group in each task. Participants with aphasia as a group, as well as individually, were compared to those means in each task separately. We used Fisher's exact for statistical analysis. The significance threshold was set to $p < 0.05$.

3. Results

3.1. Quantitative analysis

3.1.1. Pronouns in total number of words

Speakers with agrammatism produced significantly fewer pronouns (876 occurrences in 9476 words) compared to the non-injured control group (3530 occurrences in 15 593 words, p < 0.0001 in all tasks All speakers with agrammatism individually produced significantly fewer pronouns than the control group in each task, except for TH. Her performance reached significance only in the descriptive speech task (Table 2).

3.1.2. Grammatical pronoun indices

The group of speakers with agrammatism had a significantly lower GPI(mean = 0.55, SD = 0.33) in the autobiography task compared to the control group (mean = 0.89, SD = 0.05). In the other two tasks the GPI was not significantly lower for the group of speakers with agrammatism. When we looked at each speaker with agrammatism individually, it turned out that two participants with agrammatism out of six, PB and TH (the two most fluent ones), did not have significantly different GPIs compared to the control group in any of the three tasks (Table 3). The remaining four speakers with agrammatism showed a significant difference in the autobiographical task. In the narrative task the difference reached significance only for BR, while in the descriptive speech task, the difference was significant for three individuals with agrammatism. Apart from PB and TH, the GPI of one more patient (PC) failed to reach significance in the descriptive speech task (Table 3). The grammatical-lexical pronoun proportions are illustrated in Fig. 1.

When fixed expressions were excluded, one more figure reached significance: In the narrative task SB also showed significant impairment of grammatical pronoun production, compared to the control group. The other participants' performances remained the same (Table 4).

3.1.3. Grammatical and lexical pronoun subgroups

We also broke down the results for grammatical and lexical pronouns into smaller subgroups to see whether the statistical significance of the GPIs was caused by a certain subgroup (type-token ratios, Table 5) (see section 1.5 for the subgroups). However, we did not perform statistical tests on those numbers due to the small sample and the risk of increasing the possibility of a type 1 error (detecting significant findings when in reality they are not there). As it can be seen from the table, there are no consistent subgroups of grammatical pronouns that cause the dissociation. The interrogative and possessive subgroups in the lexical category are either zero or close to zero both in speakers with agrammatism and control speakers.

3.1.4. Subject pronoun substitutions

The ratio of correctly produced grammatical subject pronouns in the total number of subject pronouns was not significant for any of the individuals with agrammatism, except for BR in the autobiographical and narrative tasks, and MC in the autobiographical task. The ratio was not possible to obtain for BR in the descriptive task because the formula involved division by zero (Table 6).

Table 2
Pronoun/word ratio for speakers with agrammatism and the control group in the three different connected speech tasks.

Pron/Word	Autobiography	Narrative	Descriptive
BR	0.04****	0.02****	0.01****
MC	0.14****	0.05****	0.04****
PB	0.14**	0.11****	0.08****
PC	0.04****	0.04****	0.03****
SB	0.09****	0.04****	0.06****
TH	0.21	0.18	0.14*
Control	0.18	0.18	0.17

*p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001, ****p ≤ 0.0001.

Table 3
Grammatical pronoun indices (GPI) for speakers with agrammatism and control group in the three different connected speech tasks.

GPI	Autobiography	Narrative	Descriptive
BR	0****	0.33****	0***
MC	0.30****	0.73	0.68*
PB	0.61	0.98	0.74
PC	0.66**	0.81	0.90
SB	0.67**	0.73	0.67**
TH	0.85	0.88	0.89
Control	0.89	094	0.90

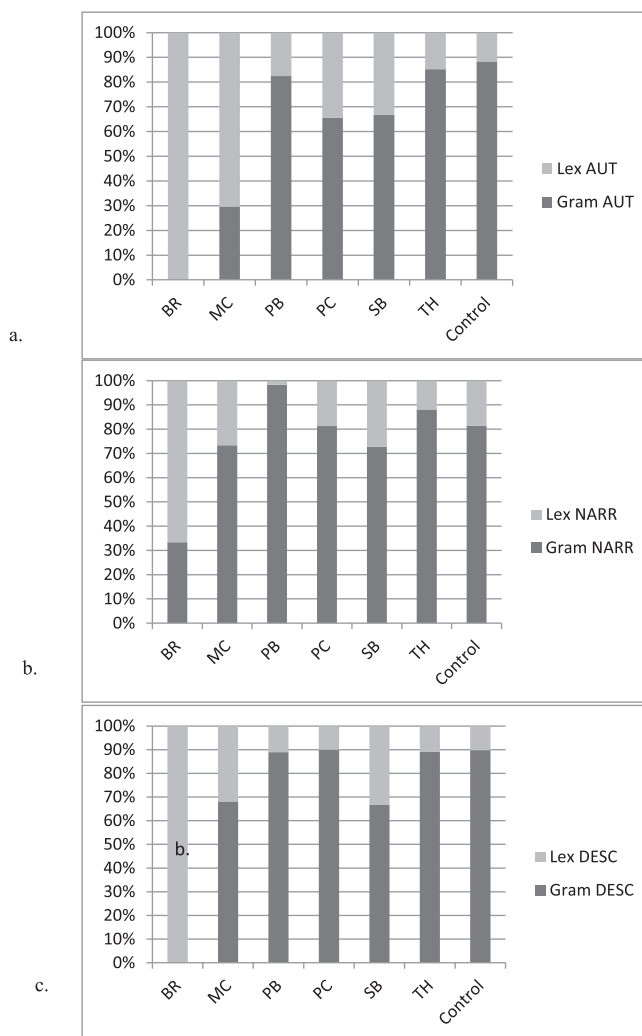*p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001, ****p ≤ 0.0001.

Fig. 1. The proportions of grammatical and lexical pronouns for individual patients and the control group in a. Autobiography (AUT) b. Narrative speech (NARR) c. Descriptive speech (DESC).

3.2. Pronoun production in relation to verbs

In order to investigate whether the omission of clitic pronouns is related to the finite verb omission, we analyzed the relationship between verb and clitic vs. Non-clitic pronoun production. In doing so, we were conservative when assessing the utterances where both a finite verb and a pronoun were required, as it is far from always clear how to reconstruct verbs and pronouns that seem to be omitted.

Table 4
Grammatical pronoun index (GPI) for speakers with agrammatism and control group in the three different connected speech tasks, excluding fixed expressions.

GPI	Autobiography	Narrative	Descriptive
BR	0****	0.33*	0****
MC	0.35****	0.78	0.65**
PB	0.85	0.98	0.87
PC	0.68*	0.81	0.9
SB	0.71*	0.80*	0.73*
TH	0.90	0.88	0.87
Control	0.88	0.95	0.89

*p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001, ****p ≤ 0.0001.

Table 5
Percentages of various subgroups of pronouns produced by the participants. The total pronouns at the bottom of the table indicate the raw number of pronouns produced by participants per task (A = autobiography, N = narrative, D = descriptive).

		BR			MC			PB			PC			SB			TH			Control (mean)		
	Pronoun types (%)	A	N	D	A	N	D	A	N	D	A	N	D	A	N	D	A	N	D	A	N	D
Grammatical	Personal	0	0	0	16	60	54	18	47	44	16	56	80	46	45	33	53	51	57	51	51	52
	Demonstrative	0	0	0	11	0	14	51	4	32	47	25	10	19	14	33	19	15	8	14	9	8
	Indefinite	0	0	0	1	0	0	4	0	1	3	0	0	0	0	0	0	2	0	9	2	2
	Relative	0	0	0	1	0	0	5	11	12	0	0	0	2	9	0	6	08	10	11	15	14
	Possessive	0	33	0	0	13	0	6	0	0	0	0	0	0	5	0	8	12	12	3	11	13
Lexical	Personal	81	67	0	15	0	9	1	0	1	0	0	0	4	0	0	6	3	3	3	1	2
	Demonstrative	0	0	0	49	20	13	10	1	5	22	13	10	29	23	33	8	3	1	7	3	5
	Indefinite	19	0	1	6	7	9	7	1	1	12	6	0	0	5	0	1	5	7	1	1	3
	Interrogative	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,1	0,1	0,3
	Possessive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total pronouns (raw)		16	3	4	81	15	22	108	120	145	32	16	10	48	22	36	142	59	73	89	148	156

We found the following constellations (n = 253):

- (15) Clitic pronoun present, verb omitted
  avant euh je beaucoup d'images
      before euh I.clitic many pictures
      'Before I many pictures.'
- (16) Non-clitic pronoun present, verb omitted
  peut-être moi site internet
      maybe I.non-cl site internet
      'Maybe I website.'
- (17) Clitic pronoun present, nonfinite verb present
  je partir un peu plus tôt
      I leave-INF a bit more early
      'I to leave a bit earlier.'
- (18) Clitic pronoun omitted, finite verb present
  alors regarde la vitrine
      so looks the glasscase
      'So looks at the glasscase.'
- (19) Clitic pronoun present, finite verb present
  il un vendeur lance un boomerang
      he a salesman releases a boomerang
      'He a salesman releases a boomerang.'

In (18) and (19) the intended verb form is derived from the context. It should have been *il regarde* ('he looks'). Phonologically, the form *regarde* could be present tense first, second or third person singular and also imperative.

In this group the vast majority of utterances were expressions like *je sais pas*, *je connais pas* ("I don't know"), *je pense* ("I think") and *je ne comprends pas* ("I don't understand"), some of which may be considered as fixed expressions (see the discussion below).

- (20) Clitic pronoun present, non-clitic pronoun present, finite verb present
  après moi je suis muet

Table 6
The ratio of correctly produced grammatical subject pronouns (i.e. clitics) (cGRAM) in total number of correctly produced subject pronouns (cTOTAL).

cGRAM/cTOTAL	Autobiography	Narrative	Descriptive
BR	0***	0**	NA
MC	0.36***	1	0.88
PB	0.94	1	0.93
PC	1	1	1
SB	0.91	1	1
TH	0.88	0.90	0.93
Control	0.96	0.98	0.94

*p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001, ****p ≤ 0.0001.

afterwards I.strong I.clitic am mute
'Afterwards I am mute.'

Despite the fact that (20) contains both the obligatory and non-obligatory pronouns and the finite verb to make the sentence grammatical, the finite verb is in present tense, although it is referring to the past. The quantitative summary of these findings are shown in Table 7.

3.3. Qualitative analysis

As PB and TH were more fluent than the other participants with agrammatism, we decided to have a closer look at their speech samples. PB produced more grammatical pronouns in the narrative task than the control mean. What we found was that he used only two lexical pronouns in total. As Table 5 illustrates, the extensive number of grammatical pronouns occurred at the cost of clitic and demonstrative pronouns. Further analysis showed that quite often he started the utterances with the expression *c'est* ('it is'), in which the demonstrative *c'* is classified as a grammatical pronoun. For example, in order to express that Cinderella and the prince got married, he used the utterance *C'est un mariage* ('It's a marriage'). The control speakers or the other speakers with agrammatism did not overuse *c'est.* PB also continuously used the clitic pronoun *il* ('he'), even when the referent was present in the sentence. Moreover, quite often it was ungrammatical substitution of *elle* ('she').

TH was the second outlier with a relatively fluent speech, based on WPM and MLU. We had a closer look at her sample to see whether there are signs of agrammatism or whether she was using adaptive strategies. The WPM and MLU measurements indicate that TH's agrammatic symptoms were milder and the verb omissions or inflectional errors were not as common. In one instance, for example, she omitted the finite verbs while producing the correct pronouns (21).

(21) *Elle lui ce qu'il va faire*
    'She him [verb omitted] what he will do.'

TH often substituted pronouns with the wrong gender (*elle* with *il*). Also, she tended to use cleft constructions, which she did not always complete (22).

(22) *C'est une petite fille qui …*
    'It's a little girl who … '

4. Discussion

4.1. Grammatical and lexical pronoun dissociation in agrammatism

4.1.1. Fewer grammatical pronouns in agrammatic speech

The findings are in line with previous research showing that speakers with agrammatism tend to omit pronouns (Brink, 2014; Martinez-Ferreiro, 2010; Miceli & Mazzucchi, 1990; Månsson & Ahlsén, 2001; Nespoulous et al., 1990; Stavrakaki & Kouvava, 2003). Previous findings include pronoun dissociations such as reflexive-direct object (Martinez-Ferreiro, 2010; Sanchez-Alonso et al., 2011), subject-direct object (Nespoulous et al., 1988; Stavrakaki & Kouvava, 2003; Nerantzini et al., 2010), and direct-indirect object (Rossi, 2007). In our study we found that what we classified as grammatical pronouns based on Boye and Harder (2012) theory are more impaired than lexical pronouns in agrammatic aphasia. This classification also adds an explanation for why clitic pronouns are more sensitive to brain damage than non-clitic ones, as previously found (Chinellato, 2004, 2006; Lonzi & Luzzatti, 1993; Nespoulous et al., 1990; Rossi, 2007; Stavrakaki & Kouvava, 2003). Moreover, by looking into smaller subgroups of grammatical and lexical pronouns we show that it is not only a matter of non-clitic-clitic dissociation but also a wider range of pronouns that fall into the groups of grammatical as opposed to lexical pronouns.

Table 7
Subject pronoun production or omission in relation to verb production or omission. The numbers indicate the occurrences of each combination (NCl = non-clitic, Cl = clitic, V = verb, F = finiteness).

NCl	Cl	V	F	BR	MC	PB	PC	SB	TH
+	+	+	+	0	3	1	0	1	0
−	+	+	+	0	12	63	0	20	84
−	−	+	+	4	1	0	0	5	0
−	−	+	−	20	3	0	0	24	0
−	+	−	−	0	0	2	0	1	1
+	−	+	+	0	0	0	0	0	2
+	−	+	−	5	2	0	0	0	0
+	−	−	−	11	11	1	0	1	0
−	+	+	−	0	0	0	0	1	7
−	+	−	−	0	0	2	0	1	1

Analysis of individual participants, however, shows that the grammatical-lexical pronoun dissociation does not occur in all the speakers with agrammatism in all three tasks. The only task in which all four severely impaired speakers with agrammatism produced fewer grammatical pronouns was the autobiography. It is not surprising that autobiography should stand out in this way. Autobiographical speech is considered the task with the least constraints, as no pictures are used to elicit speech and there is a larger variability in the linguistic forms the participants produce. The narrative task has more constraints than the autobiographical one because the participants were instructed to tell a well-known story with pictures to aid them. In this particular analysis the task with the most constraints is the descriptive one, where the participants are under pressure to tell a certain story based on a sequence of pictures. Using the same data, Sahraoui and Nespoulous (2012) have shown that as constraints are added to the task, the speakers with agrammatism produce fewer agrammatic constructions. A task variation effect has also been found in Dutch and German speakers with agrammatism (Hofstede & Kolk, 1994). A similar pattern emerges in terms of grammatical and lexical pronoun production in the current study.

4.1.2. Reliance on fixed expressions

The exclusion of fixed expressions did not change the picture drastically. Only SB's grammatical pronoun production in the narrative task became significant compared to the control speakers. It might therefore be concluded that at least when it comes to pronouns in the more constrained tasks, the individuals with agrammatism did not extensively rely on fixed expressions, except for SB. Note, however, that our identification of fixed expression was rather conservative. For speakers with agrammatism as well as non-injured speakers the inventory of fixed expressions may very well extend considerably beyond the group we identified. For instance, at least some cases of "epistemic stance" expressions like *je sais pas* ('I don't know') and *je pense* ('I think') may very well be fixed, as argued by Thompson (2002) (but see Boye & Harder, 2007 for discussion). If we had identified and excluded a larger group of fixed expressions, we might have found an even clearer dissociation between grammatical and lexical pronouns.

4.1.3. Substitutions

As for the substitutions, we expected that the less impaired individuals would rely more on substitutions rather than omissions of grammatical pronouns, as was the case in Sanchez-Alonso et al.'s (2011) study. Those substitutions could either be the production of grammatical pronouns with the wrong gender and number or simply by replacing them with the lexical counterpart. In order to adapt to the processing load, it is also possible that the participants with agrammatism substituted the pronouns with noun phrases (i.e. lexical items other than lexical pronouns), as described in Sanchez-Alonso et al. (2011). Our finding that all speakers with agrammatism produced a smaller number of pronouns in general compared to the control group is an indicator that substitution with a noun phrase could be a strategy they were using.

Despite the fact that the two moderately impaired participants did have substitutions, the results were not significant. This may be because the study of substitutions was only carried out on a subset of the pronouns, namely the subject pronoun, which have been shown to be relatively spared compared to object pronouns (Nespoulous et al., 1988; Stavrakaki & Kouvava, 2003; Nerantzini et al., 2010). We did not, however, want to include all the pronouns in this analysis because in many contexts it was difficult to reconstruct the intended utterance. Consequently, we only had a small number of pronouns to perform statistical analysis on. It is possible that the subset was too small and therefore the statistical power was lost. We therefore need larger samples and perhaps experimental data to look at substitutions.

4.1.4. Pronouns in relation to verbs

The dissociation we found might theoretically be an artefact of problems pertaining to verb production: since many grammatical pronouns are clitic and thus dependent on verbs, the group of grammatical pronouns might, considered as a whole, be affected by verb production problems (De Roo, 2002). In our pronoun-verb analysis we found all sorts of constellations of verbs and pronouns. In particular, the existence of utterances where the clitic pronoun is present and the verb is non-finite suggests that verb production problems need not affect the production of clitic pronouns in agrammatism. This means that the dissociation between grammatical and lexical pronouns in agrammatic speech is not likely to be an artefact, but rather may be attributed entirely to the grammar-lexicon distinction.

4.1.5. Boye & Harder's theory as an addition to processing theories

Boye & Harder's (2012) theory also supplements missing links in certain agrammatism processing theories. For example, Kolk (1995) argued that grammatical ("function") words are more demanding and therefore they are omitted in order to simplify the sentences. He does not, however, provide a motivation for why grammatical words would be more demanding. Boye & Harder's theory provides a possible motivation: grammatical items are omitted because they represent secondary information and are thus less important for communicative purposes. In other words, they can be dispensed with, in cases of resource limitations, because in contrast to lexical items they are not carriers of potentially main communicative points. Consider for instance (23):

(23) *I have hidden the money under the bed.*

In case of resource limitations you can omit the grammatical items and still convey the main point, as in (24).

(24) *I hide money under bed.*

In contrast, you cannot omit the lexical items, as in (25), and still make sense.

(25) *have -en the the.*

We have shown in this study that grammatical pronouns are particularly vulnerable to processing deficits. Future studies basing their predictions on the Boye and Harder (2012) theory may provide additional evidence about agrammatic impairment.

4.2. Adaptive strategies

Not all of our results fully support the grammatical-lexical pronoun dissociation in individuals with agrammatism. Interestingly, TH and PB, who did not have significant impairment of grammatical pronoun production in any of the tasks, are more mildly impaired compared to the other four (based on WPM and MLU). It could be the case that the grammatical pronoun deficit is too subtle to be detected in mild impairments, or that PB and TH are not speakers with prototypical agrammatism as their aphasia showed mixed patterns (Sahraoui & Nespoulous, 2012).

PB's patterns of pronoun production may be evidence for the development of a new, idiosyncratic grammar as a result of recovery, from the REF-model point of view (Mogensen, 2011, 2014). His language pattern still meets the criteria of agrammatism (Saffran, Berndt, & Schwartz, 1989), but he is using adaptive strategies unique to him to cope with the deficit. For instance, he overuses *il* ('he'), even when the antecedent is *le cendrillon*, a noun with masculine grammatical gender but feminine natural gender and should be referred to with an *elle* ('she'). PB often begins utterances with *c'est* ('it is'). Most likely, these strategies (which may reflect unique patterns of connections between EFs) have developed as a result of his post-injury experiences (in the form of informal "training" or even training in rehabilitation program). In fact, the form *c'est + NOUN* is often used by speech therapists to "re-activate" or to "train" naming abilities. But his pre-traumatic experiences may also have contributed − by providing him with a pattern of neural connectivity favoring such processes.

SB's reliance on fixed expressions and TH's overuse of incomplete relative clauses could also be examples of adaptive strategies. Moreover, the varied dissociations of the grammatical and lexical pronoun subgroups among all of the participants (Table 6) may also be taken as evidence for the development of distinct unique strategies. The variation found is a good indication of the fact that injury associated symptoms (in agrammatism and other cognitive impairments) are not simple reflections of loss of a specific process. Rather, the symptoms represent active and experience-dependent processes. Thus, if studies like the present one exclusively rely on the combined data from a group of individuals with agrammatism, important information may be lost.

One of the above presented examples may illustrate the involved mechanisms. Some of the EFs underlying the AS of grammar were lost to injury. Thus, in order to regain grammar, the existing EFs need to interact to create a new AS for grammar. This new AS will consist of some of the spared EF previously involved in the mediation of grammar as well as other EFs., Through experience and training PB's brain creates the new grammar AS (in the terminology of the later versions of the REF model an Algorithmic Module (AM)). This experience dependent creation of a new AS is based on feedback based reorganization of the connectivity and interaction between individual EFs. However, the post-injury grammar AS is slightly different from the pre-injury one. For instance, in this grammar the pronoun *il* carries information about grammatical gender but it is not used to refer to natural gender. Thus, *le cendrillon* is referred to as *il* in this particular new grammar. Such a situation − that is, such an organization of the grammar associated AS − occurs because:

a) that type of information processing can be achieved by combination of the EFs spared by injury,
b) when that AS is activated (and the described type of grammar produced) the feedback to the patient is positive since the produced grammar is understandable and serves communicative purposes.

The current data are a starting point for investigating the patterns of language recovery after stroke in relation to the REF-model. However, it is difficult to capture the whole picture with these data. Longitudinal data are necessary to further explore the REF-model in terms of post-injury recovery and to construct the steps each individual with agrammatism takes to build a new grammar.

5. Conclusion

This study provides a new view on pronoun processing impairment in agrammatic aphasia. Based on Boye & Harder's (2012) theory of the distinction between lexical and grammatical elements, we show that in agrammatism grammatical pronoun production is more affected than lexical pronoun production. This generalization covers the findings, reported also in earlier studies, that clitic personal pronouns (grammatical) are more impaired than the non-clitic personal pronouns (lexical) (Chinellato, 2004, 2006; Lonzi & Luzzatti, 1993; Nespoulous et al., 1990; Rossi, 2007; Stavrakaki & Kouvava, 2003).

The data from individual speakers with agrammatism also support the REF-model (Mogensen, 2011, 2014) and the possibility of reorganization in the brain as a result of brain injury.

Future research involving pronoun eliciting experiments may include larger groups of individuals with agrammatism to investigate predictions based on Boye and Harder's (2012) theory. Moreover, it would be interesting to see what the results would be for other languages, as so far this theory has been tested only on French and Danish speakers with agrammatism (Brink, 2014). More data are necessary to investigate the new, often impoverished and imperfect grammars which the individuals with agrammatism may develop (as well as to address the neural substrate of these new processes) in order to further test the predictions of the REF-model.

Funding

Appendix A. Information about the participants

Table A.1 Individual information about the participants with aphasia taken from Sahraoui and Nespoulous (2012).

	Age	Gender	Years of education after junior high school	Handedness	Etiology	Post-onset (years; months)	Aphasia type and severity
BR	52	M	6	Ambidexter	LH ischemic stroke	6; 7	Broca's aphasia with agrammatism, severe
MC	44	M	14	Right	LH ischemic stroke	4; 0	Broca's aphasia with agrammatism, mild
PB	41	M	9	Left	LH ischemic stroke	9; 1	Broca's aphasia with agrammatism, mild
PC	51	M	2	Right	LH ischemic stroke	1; 3	Broca's aphasia with agrammatism, severe
SB	56	M	7	Ambidexter	LH ischemic stroke	4; 6	Broca's aphasia with agrammatism, severe
TH	74	F	0	Right	LH ischemic stroke	2; 8	Broca's aphasia with agrammatism, mild, well recovered

Table A.2 The sample sizes (number of words), words per minute (WPM) and mean length of utterance (MLU) for each participant with aphasia and the range for the control group per task.

Participant	Autobiography			Narrative			Descriptive		
	Sample Size (words)	WPM	MLU	Sample Size	WPM	MLU	Sample Size	WPM	MLU
BR	705	32	3,8	177	23	3,4	297	23	4,1
MC	599	55	5,8	323	41	7,2	580	39	7,5
PB	777	69	7,5	1081	69	10,6	1379	62	11
PC	760	38	5	383	32	7,5	327	23	5,1
SB	541	47	4,8	542	34	7,3	619	34	8,3
TH	671	75	8,5	324	43	11,57	530	57	9,6
Control (range)	339−841	122−191	9−13	342−1233	111−179	8,1−14,6	467−1139	137−201	9,8−13,2

Speech samples of individual participants with agrammatism

BR: Un petit euh euh toi une un petit fille… aller… aller euh euh… beaucoup des arbres [ave] une euh …

Exp: Alors c'est dans.

BR: La forêt pour aller rendre visite en une dame euh euh grand-père non non …

MC: Et euh le loup euh "bonjour ça va" euh. et après après euh la fillette voit le loup. et… décédée. Ou je sais pas… je sais pas.

PB: Et hum la femme qui euh fait euh euh c'est euh une course dans la forêt. Euh c'est hum je sais pas si c'est euh une ferme ou c'est euh ou c'est un… je sais pas … et euh la mère c'est euh u- un un pot de de de de ah d- confit- de confiture non de …

PC: Elle [ef] e- elle fait elle fait la elle fait la galette. Elle porter… hum la maman euh oui la maman. Alors [ɛk] euh [ɛlRakot] non elle rencontre oui elle rencontre euh euh le loup un loup… bon. Et hum… le loup euh non euh non non euh le loup… ah-non.

SB: Donc hum… la maman euh… vient vient non en-fait euh vient non. A- aller le chaperon rouge. Hum… traverser la forêt pour la rencontrer le grand-mère. Euh… dans le panier alors je sais pas-du-tout du beurre non. Je sais pas c'est ça.

TH: Et elle s'en va. Et euh elle rencontre le loup. En deux alors elle lui ce qu'il va faire. Alors elle il est parti avant. Et il a pris mangé le [lɑ̃] grand-mère prend sa place dans le lit. Alors euh le la petite fille me dit que la tête de son p- son son ah sa grand-mère a changé de tête.

Appendix B

Table B.1List of pronouns classified as grammatical or lexical in the current study

Pronoun	Type of pronoun	Grammatical or lexical
je, me, m', tu, te, t', il, ils, se, s', en, y, le, la, l', les, nous, vous, elle, elles, lui, leur	clitic personal pronouns	grammatical
moi, toi, lui, soi, eux, nous, vous, elle, elles	non-clitic personal pronouns	lexical
ce, c', cet, cette, ceux	adnominal demonstrative pronouns	grammatical
celui, celui-ci, celui-là, celle, celle-ci, celle-là, celles, celles-ci, celles-là, ceci, cela, ça, le premier, la première, les premiers, les premières, le dernier, la dernière, les derniers, les dernières	free standing demonstrative pronouns	lexical
mon, ton, son, ma, ta, sa, mes, tes, ses, notre, votre, leur, nos, vos, leurs	adnominal possessive pronouns	grammatical
le mien, le tien, le sien, la mienne, la tienne, la sienne, les miens, les tiens, les siens, les miennes, les tiennes, les siennes, le nôtre, le vôtre, le leur, la nôtre, la vôtre, la leur, les nôtres, les vôtres, les leurs	free standing possessive pronouns	lexical
On	non-focalizable indefinite pronouns	grammatical
un, une, l'un, l'une, les uns, les unes, un autre, une autre, d'autres, l'autre, les autres, aucun, aucune, aucuns, aucunes, certain, certaine, certains, certaines, telle, tels, tells, tout, toute, tous, toutes, le même, la même, les mêmes, nul, nuls, nulls, quelqu'un, quelqu'une, quelques uns, quelques unes, personne, autrui, quiconque, d'aucuns, plusieurs	focalizable indefinite pronouns	lexical
dont, qui, que, quoi, où, lequel, auquel, duquel, laquelle, à laquelle, de laquelle, lesquels, auxquels, desquels, lesquelles, auxquelles, desquelles, à qui, de qui, à quoi, de quoi	relative pronouns	grammatical
qui, que, quoi, où, à qui, de qui, à quoi, de quoi, qu'est-ce, qui, que, quoi	interrogative pronouns	lexical

References

Avrutin, S. (2006). Weak syntax. In Y. Grodzinsky, & K. Amunts (Eds.), *Broca's region* (pp. 49–62). Oxford: Oxford University Press.

Bastiaanse, R., & Jonkers, R. (1998). Verb retrieval in action naming and spontaneous speech in agrammatic and anomic aphasia. *Aphasiology, 12*(11), 951–969.

Bos, L. S., Dragoy, O., Avrutin, S., Iskra, E., & Bastiaanse, R. (2014). Understanding discourse-linked elements in aphasia: A threefold study in Russian. *Neuropsychologia, 57,* 20–28.

Boye, K., & Harder, P. (2007). Complement-taking predicates: Usage and linguistic structure. *Studies in Language, 31*(3), 569–606.

Boye, K., & Harder, P. (2012). A usage-based theory of grammatical status and grammaticalization. *Language, 88*(1), 1–44.

Brink, E. T. (2014). *Sproglig progression i kronisk afasi – et longitudinalstudium af en Broca-afatikers sproglige udvikling over 14 år [Language progression in chronic aphasia – a longitudinal study of language development over 14 years in a patient diagnosed with Broca's aphasia].* MA thesis. Denmark: University of Copenhagen.

Chinellato, P. (2004). The recovery of subject clitics in mild agrammatism: Implications for treatment and linguistic analysis. *Cortex, 40*(1), 162–163.

Chinellato, P. (2006). Functional categories in Italian agrammatism. In A. Belletti, E. Bennati, C. Chesi, E. Di Domenico, & I. Ferrari (Eds.), *Language acquisition and development* (pp. 117–129). Cambridge: Cambridge University Press.

De Roo, E. (2002). Pronoun omission in Dutch and German agrammatic speech. In H. J. Simon, & H. Wiese (Eds.), *Pronouns:Grammar and representation* (pp. 253–284). Amsterdam/Philadelphia: John Benjamins Publishing.

Dik, S. C. (1989). *The theory of functional grammar. Part 1: The structure of the clause. Part 2: Complex and derived constructions* (1997: 2nd ed.). Berlin & New-York: Mouton de Gruyter.

Druks, J. (2016). *Contemporary and emergent theories of agrammatism: A neurolinguistic approach.* Psychology Press.

Eisenberg, P. (2004). *Grundriss der deutschen Grammatik, Band 2: Der Satz.* Stuttgart/Weimar: Verlag J. B. Metzler.

Franks, S., & Schwartz, L. (1994). Binding and non-distinctness: A reply to burzio. *Journal of linguistics, 30*(01), 227–243.

Friederici, A. D. (1982). Syntactic and semantic processes in aphasic deficits: The availability of prepositions. *Brain and Language, 15*(2), 249–258.

Friederici, A. D., Weissenborn, J., & Kail, M. (1991). Pronoun comprehension in aphasia: A comparison of three languages. *Brain and language, 41*(2), 289–310.

Geurts, B. (2000). Explaining grammaticalization (the standard way). *Linguistics, 34*(4), 781–788.

Goodglass, H. (1976). Agrammatism. In H. Whitaker, & H. A. Whitaker (Eds.), *Studies in neurolinguistics* (pp. 237–260). New York: Academic Press.

Harley, H. (2006). *English words: A linguistic introduction.* Malden, MA: Blackwell.

Helbig, G., & Buscha, J. (2001). *Deutsche Grammatik. Ein Handbuch für den Ausländerunterricht.* Berlin/München: Langenscheidt.

Hengeveld, K., & Mackenzie, J. L. (2008). *Functional discourse grammar: A typologically-based theory of language structure.* Oxford: Oxford University Press.

Hofstede, B. T., & Kolk, H. H. (1994). The effects of task variation on the production of grammatical morphology in Broca' s aphasia: A multiple case study. *Brain and Language, 46*(2), 278–328.

Jarema, G., & Friederici, A. D. (1994). Processing articles and pronouns in agrammatic aphasia: Evidence from French. *Brain and Language, 46*(4), 683–694.

Kayne, R. S. (1975). *French syntax: The transformational cycle.* Cambridge, Mass: MIT Press.

Kolk, H. (1995). A time-based approach to agrammatic production. *Brain and language, 50*(3), 282–303.

Kolk, H., & Heeschen, C. (1990). Adaptation symptoms and impairment symptoms in Broca's aphasia. *Aphasiology, 4*(3), 221–231.

Kolk, H. H., & Van Grunsven, M. M. (1985). Agrammatism as a variable phenomenon. *Cognitive neuropsychology, 2*(4), 347–384.

Langacker, R. W. (1987). *Foundations of cognitive grammar: Theoretical prerequisites* (Vol. 1). Stanford, CA: Stanford university press.

Langacker, R. W. (2008). *Cognitive grammar: A basic introduction.* Oxford: Oxford University Press.

Lonzi, L., & Luzzatti, C. (1993). Relevance of adverb distribution for the analysis of sentence representation in agrammatic patients. *Brain and Language, 45*(3), 306–317.

MacWhinney, B. (2003). *Child language analyses (CLAN) (version 23 September 2003) [Computer software]* (Pittsburgh, PA: Author).

Månsson, A. C., & Ahlsén, E. (2001). Grammatical features of aphasia in Swedish. *Journal of Neurolinguistics, 14*(2), 365–380.

Martinez-Ferreiro, S. (2010). *Towards a characterization of agrammatism in ibero-romance* (Doctoral dissertation, Universitat Autonoma de Barcelona).

Martinez-Ferreiro, S., Reyes, A. F., & Bastiaanse, R. (2014). *Strategies in non-fluent aphasia: Object clitic substitutions and redundant structures*. Science of Aphasia, September 19-24, Venice.

Matthews, P. H. (2007). *Oxford concise dictionary of linguistics* (2nd ed). Oxford: Oxford University Press.

Miceli, G., & Mazzucchi, A. (1990). Agrammatism in Italian: Two case studies. *Agrammatic aphasia: A cross-language narrative sourcebook, 1*.

Miceli, G., Silveri, M. C., Romani, C., & Caramazza, A. (1989). Variation in the pattern of omissions and substitutions of grammatical morphemes in the spontaneous speech of so-called agrammatic patients. *Brain and Language, 36*(3), 447—492.

Mogensen, J. (2011). Reorganization of the injured brain: Implications for studies of the neural substrate of cognition. *Frontiers in Psychology, 2*(7), 1—10.

Mogensen, J. (2014). Reorganization of elementary functions (REF) after brain injury and in the intact brain: A novel understanding of neurocognitive organization and reorganization. In J. Costa, & E. Villalba (Eds.), *Horizons in neuroscience research* (Vol. 15, pp. 99—140). New York: Nova Science Publishers, Inc.

Nerantzini, M., Papadopoulou, D., & Varlokosta, S. (2010). Clitics in Greek aphasia: Evidence from production and grammaticality judgment. *Procedia-Social and Behavioral Sciences, 6*, 178—179.

Nespoulous, J. L., Dordain, M., Perron, C., Ska, B., Bub, D., Caplan, D., & Lecours, A. R. (1988). Agrammatism in sentence production without comprehension deficits: Reduced availability of syntactic structures and/or of grammatical morphemes? A case study. *Brain and language, 33*(2), 273—295.

Nespoulous, J. L., Dordain, M., Perron, C., Jarema, G., & Chazal, M. (1990). *Agrammatism in French-speaking aphasics. Agrammatic aphasia: A cross-language narrative sourcebook*. Philadelphia: John Benjamins Publishing Company.

Pawley, A. (2006). Where have all the verbs gone? Remarks on the organisation of languages with small, closed verb classes. 11th Biennial Rice University Linguistics Symposium, 16—18 March 2006.

Rossi, E. (2007). *Clitics in Italian agrammatism (unpublished thesis)* (Groningen, Netherlands).

Saffran, E. M., Berndt, R. S., & Schwartz, M. F. (1989). The quantitative analysis of agrammatic production: Procedure and data. *Brain and language, 37*(3), 440—479.

Sahraoui, H. (2009). *Contribution à l'étude des stratégies compensatoires dans l'agrammatisme [Contribution to the study of compensatory strategies in agrammatism](unpublished thesis)* (Toulouse, France).

Sahraoui, H. (2015). Describing and interpreting variability in agrammatic speech production. In C. Astésano, & M. et Jucla (Eds.), *Neuropsycholinguistic perspectives on language cognition. Essays in honor of jean-luc nespoulous* (pp. 131—143). New-York: Psychology Press. Routledge Taylor & Francis Group. Series: Explorations in Cognitive Psychology.

Sahraoui, H., & Nespoulous, J. L. (2012). Across-task variability in agrammatic performance. *Aphasiology, 26*(6), 785—810.

Sanchez−Alonso, S., Martinez−Ferreriro, S., & Bastiaanse, R. (2011). Clitics in Spanish agrammatic aphasia: A study of the production of unaccusative, reflexive and object clitics. In S. L. Devi, R. Mitkov, I. Hendrick, & A. Branco (Eds.), *Anaphora processing and applications* (pp. 184—197). Berlin/Heidelberg: Springer.

Schmitz, K., & Müller, N. (2008). Strong and clitic pronouns in monolingual and bilingual acquisition of French and Italian. *Bilingualism: Language and Cognition, 11*(01), 19—41.

Stavrakaki, S., & Kouvava, S. (2003). Functional categories in agrammatism: Evidence from Greek. *Brain and Language, 86*(1), 129—141.

Tesak, J. (1992). Factors influencing surface manifestations of agrammatism. *Journal of neurolinguistics, 7*(1), 91—101.

Thompson, S. A. (2002). "Object complements" and conversation: Towards a realistic account. *Studies in language, 26*(1), 125—163.

Tissot, R., Lhermitte, F., & Mounin, G. (1973). *L'agrammatisme*. Dessart; Brussels.

Van Valin, R. D., & LaPolla, R. J. (1997). *Syntax: Structure, meaning, and function*. Cambridge: Cambridge University Press.