Agrammatism in a usage-based theory of grammatical status: Impaired combinatorics, compensatory prioritization, or both?

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ABSTRACT

This paper proposes an understanding of agrammatism from the perspective of a recent usage-based theory of grammatical status, the ProGram theory (Boye and Harder, 2012). According to this theory, grammatical elements have two central properties: they are by convention discursively secondary (i.e. attentional background) and dependent on combination with a host item. The paper first surveys studies of agrammatic speech which, based on or reconsidered in relation to the above-mentioned criteria, show that the usage-based theory makes correct predictions about the behaviour of linguistic elements in agrammatic speech. Subsequently, the paper outlines and discusses two hypotheses about the mechanism behind agrammatism that can be derived from each of the two central properties of grammatical items. According to the prominence hypothesis, agrammatism is due to insufficient overall processing resources; this leads to a prioritization of lexical over grammatical expressions because the latter, being discursively secondary, can be dispensed with for communicative purposes. According to the dependence hypothesis, agrammatism results from an impaired capacity for combining or unifying simple elements into complex wholes: This impairment affects grammatical elements in particular, because these are dependent on (combination with) host items.

1. Introduction

Aphasia is a language disorder due to brain damage (whether trauma- or stroke-induced, or caused by neurodegeneration, as in primary progressive aphasia). Dependent on the site and the size of the brain lesion, different aspects of language may be affected. Agrammatic aphasia or agrammatism is usually associated with non-fluent aphasia. For cross-linguistic purposes, agrammatism may be defined in terms of non-fluent speech, a slow speech rate and short sentence and phrase lengths (Menn & Loraine, 1990, p. 3), but as the name suggests it is often also characterized by a limited use of grammatical elements, including grammatical words and affixes, and partially or fully schematic constructions. Accordingly, agrammatic aphasia is often associated with omissions and substitutions of

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1 In this paper we do not distinguish aphasia types according to etiology. Recent studies suggest close parallels between post-stroke aphasia and primary progressive aphasia (Thompson et al., 2013; Ingram et al., 2020; compare also Matchin et al., 2020 on post-stroke aphasia, and Wilson et al., 2010 on primary progressive aphasia). Based on these studies, the claims and hypotheses we make should apply to all cases of agrammatism irrespective of the causes.

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grammatical morphemes and words. As in other cases of aphasia, of course, symptoms vary with degree of severity (e.g., Goodglass & Kaplan, 1972; Berndt & Caramazza, 1980; Caplan, 1985; see Thompson & Bastiaanse, 2012 and references cited therein). An example of agrammatic speech is given in (1).

(1) Cinderella uh scrubbing and uh hard worker. Step fa ... mother uh go, but no. Scrubbing uh uh whatchacallit uh uh working. Stepmother ... really ugly. Dress break, stepmother and now what dress? Mother Teresa ... not exactly, uh uh magic ... godmother!

(Cinderella story; from Thompson & Bastiaanse, 2012).

Since agrammatism often affects the production of elements that are conceived of as grammatical in linguistic theory, it is natural to see agrammatic speech as a clear empirical reflection of the theoretical notion of grammar as a subdomain of the language ability (Boye & Bastiaanse, 2018) – not necessarily modular, but with properties that are not completely overlapping with those of the lexicon. This entails that a precise and empirically adequate understanding of what it means to be grammatical is necessary for a profound understanding of agrammatism and its causes.

Recent years have witnessed an increasing interaction between linguistic theory and research on agrammatism (e.g., Boye & Bastiaanse, 2018; Garraffa & Fyndanis, 2020; Hatchard, 2015; 2021; Matchin & Rogalsky, fc.), but progress is hampered by the fact that the notions ‘grammar’ and ‘grammatical’ have for a long time remained pre-theoretical and intuition-based (e.g., Geurts, 2000). Most would agree that syntax and perhaps morphology have to do with combination in a way that can be described in terms of constructions or rules, but the nature of grammatical morphemes and words has remained an open question: What is the property they have in common with syntactic and morphological constructions, and which distinguishes them from lexical elements?

This question has been circumvented by recasting the distinction between grammatical and lexical elements in terms of distinctions between “function” and “content” elements, or between “closed-class” and “open-class” elements, which are theoretically unanchored and sometimes vaguely defined (see Boye & Bastiaanse, 2018, for detailed discussion). This has led to wrong predictions when it comes to agrammatism. For instance, both pronouns and prepositions belong to closed classes, but contrary to what one would expect based on this, not all pronouns and not all prepositions are affected to a similar degree in agrammatism (e.g., Bennis, Prins, & Vermeulen, 1983; Bastiaanse & Bennis, 2018; Ishkhanyan et al., 2017). Similarly, Kean (1977; 1979) sought to capture the deficits in agrammatism in terms of a phonological distinction between clitics and fully prosodic words. However, this approach also fails to account appropriately for agrammatic speech deficits (e.g. De Bleser et al., 2012, p. 126).

A recent theory of grammatical status and grammaticalization (henceforth the ProGram theory; Boye & Harder, 2012) offers an answer to the question about the nature of grammatical elements. This theory is in all basic respects usage-based. In line with generative approaches, however, it maintains that a rather strict distinction can be made between grammatical and lexical elements. Only, it defines the distinction in a different way than extant approaches, and it entails a set of language-general criteria of grammatical and lexical status that in some cases lead to novel classifications of individual elements. A number of studies based on this theory show that it makes correct predictions about agrammatism. The production of words identified as grammatical based on these theoretically founded criteria is consistently found to be more impaired than the production of words identified as lexical – also in cases where the grammatical-lexical distinction is at odds with traditional distinctions such as the distinction between closed and open class words.

It is therefore worthwhile to consider what the theory offers in terms of understanding agrammatism and its causes, and this is the aim of the present paper. Based on the central features of grammatical status, as defined in the ProGram theory, the paper derives and develops two compatible hypotheses about agrammatism and its causes. Since, according to the ProGram theory, the central features of grammatical status are low attentional prominence and dependence on combination, one hypothesis is centered around prioritization, and the other around combination or unification. The former hypothesis is related to neurolinguistic theories that see agrammatism symptoms mainly as the result of a compensatory response to resource reduction (e.g., Kolk & Van Gruensven, 1985; Kolk, 1995); the latter hypothesis to models that give a central role to combination or unification (e.g., Bornkessel-Schlesewsky et al., 2015; Hagoort, 2016; Hickok & Poeppel, 2007). The two hypotheses are not intended to be as detailed as the theories and models with which they are related. Rather, a main point of the paper is that the hypotheses are not only mutually compatible, but also mutually dependent, and the account we propose brings compensation-oriented and unification-oriented models into a motivated relationship.

Thus, the paper starts from linguistic theory and investigates the implications for neurocognitive aspects of agrammatism. It makes no claims about neuroanatomy, however. The paper also focuses on language production (as opposed to comprehension), and on grammatical symptoms of agrammatism, such as omissions and substitutions of grammatical elements. Agrammatism is, however, also associated with linguistic symptoms that are not immediately relatable to grammatical elements. For instance, people with agrammatism tend to have problems with past time reference (e.g., Bastiaanse, 2013; Faroqi-Shah & Dickey, 2009; Faroqi-Shah & Thompson, 2007). The paper does not claim to account for such symptoms, and thus does not pretend to cover everything there is to explain about agrammatism. It will only touch upon such symptoms to the extent that they are relevant for evaluating the claims made.

The rest of the paper is structured as follows. It first outlines the linguistic theoretical landscape, focusing on generative linguistics as a representative of formal approaches and construction grammar as a representative of usage-based approaches (Section 2). Based on this outline, it presents the ProGram theory (Section 3), and gives a survey of existing studies of agrammatic speech that support it (Section 4). It then derives the two aforementioned hypotheses from the ProGram theory, arguing that these hypotheses are not only mutually compatible, but also mutually dependent as accounts of the causes of agrammatism (Section 5). Subsequently, the paper

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2 Not all non-fluent aphasias are typically agrammatic according to this definition. However, for the sake of clarity (and due to the lack of consensus among aphasiologists), in the present overview we use the term ‘agrammatic’ for speakers with Broca’s aphasia and other non-fluent aphasic speakers with demonstrated grammatical impairment, although in the original papers the authors may have used other terminology.
situates the proposed account relative to other theories of agrammatism, and discusses the limitations of the account (Section 6). The paper ends with a brief conclusion (Section 7).

2. Linguistic theories in agrammatism research

Until recently, linguistic research on agrammatism has been dominated by generative linguistics, especially Government and Binding theory (e.g., Thompson & Bastiaanse, 2012). The focus of generative linguistics is syntactic representation, and its hallmark is the conception of syntactic representation as based on innate universal computational mechanisms and constraints, Universal Grammar (e.g., Cook & Newson, 2007; Friederici et al., 2017). This conception entails a strict distinction between syntax and the lexicon, which is conceived of as a mental, stored inventory of learned language-specific items: while syntax and the lexicon are of course interdependent, and while some syntactic information (e.g. argument structure) may be stored in lexical items, the basic, universal aspect of syntax is a distinct type of phenomenon from the language-specific lexicon.

In some generative approaches, agrammatism is attributed wholly to a deficit pertaining to syntactic representation (e.g., the Trace Deletion Theory of Grodzinsky, 1995, and the Tree Pruning Hypothesis of Friedmann & Grodzinsky, 1997). These approaches have been fruitful in generating and testing hypotheses about various agrammatic symptoms, but for some time it has been clear that not all agrammatic symptoms can be adequately accounted for in this way, and nowadays few aphasiologists subscribe to an account focusing on syntactic representation. Rather, most view agrammatism as wholly or partly due to a processing deficit (e.g., Kolk & Heeschen, 1992; Bastiaanse & Zonneveld, 2005; Matchin & Rogalsky, fc.). Nevertheless, the majority of aphasiologists interested in agrammatism still couch grammatical description and analysis in the language of generative linguistics.

In the past decades, usage-based linguists (including cognitive and functional linguists) have established alternatives to basic claims and assumptions in generative linguistics (e.g., Tomasello, 2003; Hurford, 2011; Evans, 2014; Dąbrowska, 2015). Usage-based linguistics rejects the idea of grammar as universal, innate and autonomous in the sense of being independent of language use and function. Instead, it advocates a view of grammatical structure as shaped through entrenchment and conventionalization of usage-patterns, and as motivated by communicative function and pre-linguistic conceptual structure. While research on agrammatism has been dominated by generative approaches, there has been an undercurrent of usage-based approaches, and recent years has seen an increase in publications based on such approaches (e.g., Sahraoui & Nespoulous, 2012; Menn & Duffield, 2013; Zimmerer et al., 2014; Zimmerer et al., 2020; Hatchard, 2015; 2021; Martínez-Ferreiro, Bastiaanse, & Boye, 2019).

These approaches are well suited for capturing, for instance, frequency effects in aphasia, but some of them have an inbuilt problem when it comes to capturing central features of agrammatism. In opposition to generative linguistics’ distinction between the lexicon and basic aspects of syntax as two distinct types of phenomena (a storage of items vs. an innate and universal set of rules), usage-based approaches claim that grammar and lexicon are poles in a continuum of same-type phenomena. Now, as has been pointed out on several occasions, the existence of a continuum is fully compatible with the existence of a dividing line (e.g. Aarts, 2007). The problem is only there when a category boundary between grammatical and lexical is rejected altogether.

This is the case in construction grammars (see Croft, 2007, for an overview), which are currently the most prominent representatives of usage-based grammatical theories. Construction grammars reject the conception of grammar as rules, and instead claim that morphosyntactic structure can be fully understood in terms of “constructions”. Constructions are templates that are symbolic in the sense that they have conventional content. This means they are like lexical elements, except that they may have more abstract content, and their expression side may be partially or fully schematic, consisting partly or wholly of slots to be filled with substantial symbols. The consequence of this idea is that syntactic structures find a natural place side by side with lexical elements in an overall storage device called the “constructicon”. This construction thus both incorporates the lexicon and replaces the rules of generative linguistics. Constructions obviously differ in a number of ways – for instance, in terms of degree of schematicity – but it is a main point in construction grammars that these differences are on a continuum, and that the constructicon is not compartmentalized.

The problem with this approach is that it is in conflict with well-established neurolinguistic findings (Pulvermüller et al., 2013). More specifically, as long as construction grammars do not make a distinction between grammatical and lexical elements, they will not be able to capture the fact that gives agrammatism its name: the fact that grammatical elements tend to be selectively affected in agrammatism.

3. The ProGram theory

The ProGram theory (Boye & Harder, 2012) was developed in order to give a consistent usage-based account of grammaticalization. It’s core is a theory of what underlies the distinction between grammatical and lexical elements. This theory is usage-based in that it takes the grammatical-lexical distinction to be basically functional and the result of a conventionalization and entrenchment of patterns of usage of symbolic signs. It is thus in many respects compatible with construction grammars, including the idea that just like the lexicon, syntactic structure consists of symbolic units, i.e. constructions. However, it does not depend on the assumptions of construction grammars, and it departs from them on the central point that it maintains a distinction between grammatical and lexical status in the first place. In this respect, it sides with generative linguistics and other frameworks (including usage-based ones such as Functional Discourse Grammar, e.g. Hengeveld & Mackenzie 2008) that assume a distinction between grammatical and lexical elements.

The theoretical cornerstone is the understanding of the difference between grammatical and lexical status as a conventionalization (cum cognitive entrenchment) of attentional prioritization. Attentional prioritization has been argued to be pervasive in language (e.g. Talmy, 2007), and a number of dichotomies that relate to such prioritization have been identified. Examples are the distinction...
between figure and ground, which has to do with the relationship between two designated entities (e.g. Talmy, 1975), and the distinction between profile and base, which concerns the relationship between, respectively, a designated concept (for instance, a radius) and the concept it presupposes (a circle) (e.g. Langacker, 1987, pp. 183–189). The kind of attentional prioritization invoked by the ProGram theory in order to understand the grammatical-lexical distinction concerns syntagmatically related parts of complex linguistic messages. It is well-documented that different parts of complex messages are not attended to to the same extent, for instance, in eye-tracking and letter detection experiments (e.g., Klein & Saint-Aubin, 2016; Christensen et al., 2021). One part is the centre or foreground of attention (cp. e.g., Potts, 2004, on “at issue content”), and the other parts form the attentional background relative to that part. We will use the term discourse prominence for this attentional prioritization, and the terms discursively primary and discursively secondary for, respectively, the attentionally foregrounded part and the attentionally backgrounded part of the complex whole. In order to appreciate how we use these terms, consider (2).

(2) Stop smoking!

In a discussion of attitudes towards smoking, stop would most likely be the center of attention, as smoking provides redundant information. In other words, stop would be the discursively primary part of the message in (2), and smoking would be discursively secondary. In a discussion of habits we should cease practicing, on the other hand, smoking would most likely be discursively primary, and stop, with its redundant information, discursively secondary.

As illustrated by (2), discourse prominence is basically a context-dependent phenomenon. However, languages possess different means for pointing at the part of the message intended to be discursively primary (e.g. focus markers) and for indicating that a part is secondary (e.g. the parentheses of written language). The ProGram theory argues that the grammatical-lexical distinction belongs among those means. Grammatical elements (whether morphemes, words, partially or full schematic constructions, or meanings) are defined like this:

Definition of grammatical elements

Grammatical elements are by convention discursively secondary, that is, they cannot convey the discursively primary point of an utterance (except in metalinguistic, including corrective, contexts, where conventions are overridden).

In contrast, lexical elements (whether morphemes, words, constructions or meanings) are defined as follows:

Definition of lexical elements

Lexical elements are by convention potentially discursively primary, that is, they can, but need not, convey the main point of an utterance.

In other words, the main point of a complex utterance will always be conveyed by lexical elements, but depending on the context, lexical elements may be secondary (in the presence of another, primary lexical element). According to these definitions, the functional rationale behind the grammatical-lexical contrast is that it helps us decide what part of a linguistic message to direct our attention towards. For instance, in hearing (3), all language users familiar with the conventions of English immediately know that they should direct their attention towards impala, cross and river. The meanings of an (‘indefinite’), -ed (‘past’), the (‘definite’) and the declarative clause structure (‘assertion’) are not superfluous, but they are not the main point of producing (3).

(3) An impala crossed the river.

Note that discourse prominence, hence also lexical and grammatical status depends on level of analysis. A grammatical word (e.g. the article a) may be part of a phrase (e.g. a house) which is as a whole lexical, because another word in it (house) is lexical, and a grammatical morpheme (e.g. past tense -ed) may be part of word (e.g. climbed) which also contains a lexical part (climb) and is therefore lexical as a whole. Similarly, a grammatical meaning (e.g. ‘past tense’) may be part of a word (e.g. ran) which is as a whole lexical, because it also has a lexical meaning (‘run’). The theory is therefore fully compatible with the idea that lexical words may contain grammatical information (but not vice versa).

We will refer to the conventionalized discursively secondary status of grammatical elements as their prominence property. From this defining property follows a second central property which has to do with dependence, and which we will therefore call the dependence property. Since grammatical elements are discursively secondary, they depend on combination with a ‘host element’ in relation to which they are secondary. For instance, grammatical morphemes cannot be the only element in an utterance, cf. (4). In contrast, at least some lexical elements are not necessarily dependent on a host element, but can sometimes be produced in isolation, cf. (5).

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3 We understand ‘convention’ in line with Lewis (1969) and Clark (1996, pp. 70–72) as reflecting “a state of coordination between members of a community that goes beyond individual instances of linguistic communicative interaction” (Boye & Harder, 2012, p. 8). When we say of grammatical items that they are by convention discursively secondary, we claim that assigning them discursively secondary status in language use is based on knowledge of the language in which they are found, and is independent of contextual factors. Thus, we understand conventionalization in a given language community as entailing entrenchment in the members of that language community (see Schmid, 2020 for discussion).
The ProGram theory provides diagnostic criteria for distinguishing grammatical and lexical elements (cf. Boye & Harder, 2012, pp. 13–18). In contrast to criteria such as those proposed by Friederici (1982) and Stewart (2015) for distinguishing grammatical and lexical prepositions in German and Spanish respectively, these criteria are neither language- nor word-class specific. That is, they apply to all kinds of elements in all natural languages. Since lexical elements are by convention potentially discursively primary, it follows that they can be treated or marked as such. That is, they can be focalized, they can be addressed in subsequent discourse, and they can be elaborated semantically through modification (see also Messerschmidt et al., 2018). For instance, the lexical words impala, cross and river in (6a) can be focalized, as in (6b–d). In contrast, since grammatical elements are discursively secondary by convention, it follows that they cannot be treated or marked as discursively primary (as long as conventions are adhered to; see Boye & Harder, 2012, pp. 17–18 for discussion). Consequently, they cannot be focalized or addressed in subsequent discourse, and they resist semantic elaboration through modification. For instance, the article an cannot be focalized in isolation (6e–f) – at least not outside metalinguistic contexts. It can be focalized only as part of the NP an impala, which is as a whole lexical due to impala.

In most cases, classifications of linguistic elements as grammatical or lexical based on these theoretically anchored criteria are in line with widely shared intuitions. Schematic constructions come out as grammatical, and so do – at least in standard average European languages (see below) – affixes and articles (that is, they cannot be focalized outside corrective contexts), whereas nouns, adjectives and full verbs are lexical (i.e. they can be focalized). However, in some cases theoretically-based classifications are at odds with traditional ones. For instance, closed-class elements are often taken to be grammatical en bloc, and open-class elements are often taken to be lexical en bloc, but the ProGram theory suggests language-specific distinctions within word classes. Just as distinctions can be made within verbs (in many languages an open-class category) between grammatical auxiliaries and lexical full verbs, distinctions can be made between grammatical and lexical members of closed classes. This holds for pronouns, adpositions, determiners and particles, among other things (Boye & Harder, 2012, pp. 20–21; Messerschmidt et al., 2018; Nielsen et al., 2019; Sun & Boye, 2019). For instance, the English pronoun that is lexical, while it is grammatical. Only the former can be focalized (e.g., by means of exactly).

Similarly, the preposition off is lexical, whereas of is grammatical. The former can be modified by means of straight, but there is no means for modifying the latter (e.g. Rauh, 1993; cf. Messerschmidt et al., 2018 on Danish prepositions).
(8) a. It went straight off the road.
   b. *They live within 10 miles straight of the town.

(9) gives an overview of grammatical-lexical distinctions that have recently been made within various open and closed classes based on the ProGram theory.

<table>
<thead>
<tr>
<th>(9)</th>
<th>Grammatical verbs</th>
<th>Lexical verbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>modal <em>skulle</em> ‘hearsay’</td>
<td>modal <em>kunne</em> ‘ability’ (Boye, 2010)</td>
</tr>
<tr>
<td>Dutch</td>
<td><em>hebben</em> ‘have’ + participle</td>
<td><em>hebben</em> ‘have’ + NP (Boye and Bastiaanse, 2018)</td>
</tr>
<tr>
<td>b.</td>
<td>Grammatical pronouns</td>
<td>Lexical pronouns</td>
</tr>
<tr>
<td>Danish</td>
<td><em>man</em> ‘one’</td>
<td><em>hun</em> ‘she’ (Brink, 2014)</td>
</tr>
<tr>
<td>English</td>
<td><em>it</em></td>
<td><em>that</em> (Ishkhanian et al., 2017)</td>
</tr>
<tr>
<td>French</td>
<td><em>me</em> ‘me’</td>
<td><em>moi</em> ‘me’ (Ishkhanian et al., 2017)</td>
</tr>
<tr>
<td>Spanish</td>
<td><em>te</em> ‘you’</td>
<td><em>ti</em> ‘you’ (Martínez-Ferreiro et al., 2019)</td>
</tr>
<tr>
<td>c.</td>
<td>Grammatical prepositions</td>
<td>Lexical prepositions</td>
</tr>
<tr>
<td>Danish</td>
<td><em>for</em> ‘for’</td>
<td><em>for</em> ‘before’ (Messerschmidt et al., 2018)</td>
</tr>
<tr>
<td>English</td>
<td><em>of</em></td>
<td><em>off</em> (Boye and Harder 2012)</td>
</tr>
<tr>
<td>Spanish</td>
<td><em>a</em> ‘to’</td>
<td><em>en</em> ‘in’ (Martínez-Ferreiro et al., 2019)</td>
</tr>
<tr>
<td>d.</td>
<td>Grammatical determiners</td>
<td>Lexical determiners</td>
</tr>
<tr>
<td>Danish</td>
<td>indefinite article <em>en/et</em></td>
<td>numeral <em>en/et</em> ‘one’ (Nielsen et al., 2019)</td>
</tr>
<tr>
<td>e.</td>
<td>Grammatical particles</td>
<td>Lexical particles</td>
</tr>
<tr>
<td>Chinese</td>
<td><em>zhe</em> ‘durative’</td>
<td><em>zāi</em> ‘progressive’ (Sun and Boye, 2019)</td>
</tr>
</tbody>
</table>

It might be objected that in some cases it cannot be decided whether a given element is lexical or grammatical because means for focalizing, addressing or modifying the element at hand are missing. For instance, there is no means for modifying English affixes independently of their base. This argument can be turned around, however: If there is no means for focalizing, addressing or modifying a given element, it is natural to assume that this is because we do not need to focalize it, etc. – because the element is a grammatical one.

What can be modified (etc.), and what means there are for modifying (etc.), depend on the language at hand. In contrast to English, West Greenlandic allows modification of some affixes. In (10), the manner affix _-pallap_ ‘fast’ is modified by another affix, _-ngaar_ ‘very’.

(10) West Greenlandic (Naja Trondbjøm, p. c.)

_Suli-palla-ngaar-mat tupiga-ara_

work-fast-very-CAUS-3SG wonder-DECL.3sg.3sg

'I am surprised how fast he worked'.

This supports the claim that some languages (at least polysynthetic ones) may have lexical affixes (e.g., Mattissen, 2017, pp. 72–73), and this claim may be crucial in order to understand why West Greenlandic speakers with agrammatism produce almost no omissions or substitutions of affixes (Nedergaard et al., 2020).
4. Aphasiological support for the ProGram theory

The ProGram theory was developed as a strictly linguistic theory in order to account for grammaticalization. Subsequently, hypotheses entailed by the theory were tested and confirmed in behavioral experiments (Christensen et al., 2021; Messerschmidt et al., 2018; Michel Lange, Messerschmidt, & Boye, 2018; Michel Lange et al., 2017), and in aphasiological studies where the theory was confronted with agrammatic speech data (and on a couple of occasions, fluent aphasic speech data for contrast). The basis for the aphasiological testing is theory-specific classifications like those exemplified in (9) above. Based on the ProGram theory, it is predicted that in agrammatism, elements classified as grammatical are more severely affected (in terms of omissions and/or substitutions) than elements classified as lexical.

Although the distinction between lexical and grammatical elements has been a widely addressed topic in the literature on aphasia (see for example Berndt & Caramazza, 1980; Miceli et al., 1989; Menn & Loraine, 1990; Caramazza & Hillis, 1991; Bird, Franklin, & Howard, 2002; among many others), the analysis of certain classes of words such as prepositions and pronouns poses problems for traditional accounts which do not assume the possibility of hybrid categories (see e.g., Mardale, 2011, p. 35). Friederici et al. (1991) show that distinctions based on open vs. closed classes are insufficient to account for pronoun comprehension in German, French and Dutch agrammatic speakers. Within-class differences pertaining to the distinction between grammatical and lexical pronouns are taken as crucial to predict patients’ performance. Also for prepositions, dissociations between different members or usages have been demonstrated (e.g., Bennis, Prins, & Vermeulen, 1983; Friederici, 1982, 1985; Friederici et al., 1982; Grodzinsky, 1988; Schwartz et al., 1980). Semantic content (Friederici, 1985; Friederici et al., 1982; Schwartz et al., 1980), obligatoryness (Friederici, 1985) and a contrast between governed and ungoverned forms (Grodzinsky, 1988), among other factors, have been invoked to explain the dissociations. However, most of the preposition studies focus on specific subsets of prepositions, and the classification criteria cannot be generalized across different word classes.

If the ProGram theory is right, its classifications should provide a consistent analysis across word classes and forms. A growing number of empirical studies confirm that elements classified as grammatical based on the theory are more severely affected in non-fluent aphasias than those classified as lexical (Messerschmidt et al., 2018; Ishkhanyan et al., 2017; Boye & Bastiaanse, 2018; Bastiaanse & Bennis, 2018; Martínez-Ferreiro, Ishkhanyan, et al., 2019; Nielsen et al., 2019).

4.1. Lexical vs. grammatical verbs

Within the class of verbs, it is fairly uncontroversial to distinguish grammatical members (“auxiliaries”) and lexical ones (“full verbs”) (see Boye, 2010, for discussion). In a study of Dutch verbs, Boye and Bastiaanse (2018) anchored this distinction in the ProGram theory. They made a distinction between grammatical verb variants, which depend on combination with a host verb, and lexical verb variants, which do not, and confronted this distinction with agrammatic speech data. In an analysis of semi-spontaneous speech samples, the authors compared the grammatical and lexical variants of the same verb forms in agrammatic and non-brain-damaged (NBD) speakers. The grammatical condition included the verb hebben ‘have’ + participle, and modal verbs + infinitive. The lexical condition included the verb hebben ‘have’ + NP (e.g., de jongen heeft een boek: ‘the boy has a book’), and modal verbs + NP (e.g., de jongen wil een boek: ‘the boy wants a book’). As hypothesized, agrammatic speakers had a reduced proportion of grammatical instances both with hebben and with modal verbs when compared to the NBDs. In the agrammatic sample, 38.2% of the instances of hebben and 35.7% of the instances of the modal verbs were grammatical variants. In the control sample of NBD speech, in contrast, 48.7% of the instances of hebben and 78.8% of the instances of modal verbs were grammatical variants. Importantly, Boye and Bastiaanse also analyzed speech data from fluent aphasic speakers. They showed that the reduced proportion of grammatical use of hebben and modal verbs is typical for agrammatic speakers and not for aphasia in general: For fluent aphasic speakers, the pattern of grammatical and lexical use is similar to that of NBD speakers. In fact, fluent aphasic speakers overuse grammatical verb variants.4

The contrast between grammatical and lexical verbs has also been studied for Danish. Messerschmidt et al. (2018) analyzed the production of the auxiliary have (‘perfect’) and the homonymous full verb have (‘possess’) in the spontaneous speech of a Danish agrammatic speaker and a matched NBD. As expected, the informant with agrammatism produced a lower proportion of grammatical verb tokens than the NBD. Grammatical verbs represented only 8.13% of the total number of verbal forms produced by the informant, in contrast to 36.70% in the case of the NBD.

4.2. Lexical vs. grammatical prepositions

Unlike the distinction between grammatical and lexical verbs, the distinction between grammatical and lexical prepositions is still rather controversial (see e.g., Mardale, 2011 for discussion). However, this distinction is also supported by aphasiological studies. Martínez-Ferreiro, Ishkhanyan, et al. (2019) made a distinction between grammatical and lexical Spanish prepositions based on the modification criterion discussed in Section 3 (only lexical prepositions readily allow modification). They then analyzed the prepositions in semi-spontaneous speech samples from 6 Spanish speakers with non-fluent aphasia from the Rosell-Clari (2005) corpus. They found that, as predicted, these speakers produced significantly less of the prepositions classified as grammatical than did 15 NBD

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4 As pointed out by a reviewer, Boye and Bastiaanse (2018) looked only at the relative prevalence of grammatical and lexical verbs. They did not investigate to what extent verb use was disordered, and thus did not assess the role of paragrammatism in fluent aphasia. Similar limitations apply to the other studies of fluent aphasia discussed in Section 4.
controls, whereas for prepositions classified as lexical there was not a significant difference. Martínez-Ferreiro, Ishkhanyan, et al. (2019) also analyzed speech samples from 3 speakers with fluent aphasia from the Rosell-Clariñ corpus. In these samples they found the opposite pattern: the fluent speakers produced significantly less of the prepositions classified as lexical than did the NBD controls, whereas for prepositions classified as grammatical there was not a significant difference. These results should be appreciated in light of the fact that the non-fluent speakers included in the study had mixed and transcortical aphasias rather than prototypical cases of agrammatic aphasia.

Messerschmidt et al.’s (2018) case study of a Danish agrammatic speaker provides evidence for a similar distinction between grammatical and lexical prepositions in Dutch. The matched NBD control was found to produce more instances of grammatical prepositions than lexical prepositions in the semi-spontaneous speech samples analyzed (53.61% grammatical vs. 46.39% lexical). The reverse pattern was found in the speech of the agrammatic speaker (41.76% grammatical vs. 58.24% lexical; note that unclassifiable instances of prepositions were counted as grammatical, i.e. against the hypothesis). These results are more striking if diversity is taken into account; not only did the agrammatic speaker produce a more reduced number of preposition types (11 vs. 17 for the NBD), but almost 91% of her total of 365 occurrences consisted of the preposition *ilt* (‘to’) (which only accounts for 10% of the NBD’s prepositions).

Also earlier studies support a distinction between grammatical and lexical prepositions similar to the distinction entailed by the ProGram theory. These studies are based on classifications that differ from those based on the ProGram theory both in being word-class specific and in being based on other (and to some extent pretheoretical) criteria.

Bennis, Prins, and Vermeulen (1983) distinguished between “lexical”, “subcategorized” and “syntactic” prepositions in Dutch. “Lexical” prepositions (as in *he was walking in the garden*) are prepositions which “indicate a relational concept” – a locational or temporal relation, it seems. They seem to correspond to modifiable prepositions and thus to prepositions that are lexical by the ProGram theory. “Subcategorized” prepositions (as in *he counted on John*) are prepositions which are selected by a verb stem, and which “form one lexical unit in combination with a verb”. They cannot be independently modified, but this is obviously due to the fact that they are inseparable from the larger unit of which they are part. Since this larger unit is modifiable (e.g., by means of a manner adverb, as in *he reluctantly counted on John*), they may be considered as inseparable parts of a lexical unit. Finally, “syntactic” prepositions (as in *He gave a book to John*) are prepositions which depend on “the syntactic configuration of the sentence”. They are non-modifiable and clearly grammatical by the ProGram theory. Bennis, Prins, and Vermeulen contrasted these three types of prepositions in a sentence completion task. In line with predictions based on the ProGram theory, they found that agrammatic speakers (speakers with Broca’s aphasia) made more errors (cross-category substitutions) in the “syntactic” than in the other two conditions (in contrast to Friederici, 1982, they found no differences between those two, arguably lexical, conditions). In contrast, fluent aphasic speakers (speakers with Wenicke’s aphasia) tended to have less problems with the “syntactic” prepositions than with the other types.

For agrammatism, similar results were found by Grodzinsky (1988) and Froud (2001) in studies of English. For fluent aphasia, similar results were found by Bastiaanse and Bennis (2018) in a study of Dutch speakers: The production of grammatical (“syntactic”) prepositions was relatively spared in fluent aphasia, while the production of the other (arguably lexical) types of prepositions was severely affected.

It should be pointed out that contradictory results for both agrammatic and fluent aphasia have been found by Branchereau & Nespolous (1989) in a sentence completion task contrasting what they define as “lexical”, “idiosyncratic” and “syntactic” prepositions. Differences across preposition types were not large, and variability between the aphasic speakers was considerable, but “lexical” prepositions were reported to be more susceptible of substitution than the other types of prepositions.

4.3. Lexical vs. grammatical pronouns

Like prepositions, pronouns are often considered a homogeneous word class. They are often considered grammatical *en bloc* (cf. the fact that in many languages they form closed classes). Again, however, there is empirical evidence for the distinction entailed by the ProGram theory between grammatical and lexical members. Ishkhanyan et al. (2017) made a distinction between grammatical and lexical pronouns in French based on the focalization criterion discussed in Section 3. Grammatical pronouns include “weak” personal pronouns such as *je* (‘I’) and *me* (‘me’), but also other pronouns such as *y* (‘there’). Lexical pronouns include “strong” personal pronouns such as *moi* (‘me’). Ishkhanyan et al. confronted this distinction with speech samples from 6 French agrammatic speakers and comparable speech samples from 9 controls. They found that the pronouns classified as grammatical were more compromised in agrammatic autobiographic speech than pronouns classified as lexical: the mean GPI (“Grammatical Pronoun Index”; number of grammatical pronoun tokens divided by total number of pronoun tokens) was significantly higher for the NBD controls (0.89; SD = 0.05) than for the group of agrammatic speakers (0.55; SD = 0.33). For two agrammatic speakers, the GPI did not differ considerably from that of the controls. Interestingly, these two participants scored much higher than the other participants on a fluency scale (words per minute); it may thus be the case that they were either wrongly diagnosed or had mild forms of agrammatism only.

A similar study of Danish pronouns (Brink, 2014) gave even clearer results. Based on the focalization criterion, Brink made a distinction between grammatical pronouns (e.g., *man* ‘one’) and lexical ones (e.g., *hun* ‘she’) and analyzed the grammatical vs. lexical ratio in five speech samples from a person with aggrammatism and speech samples from 15 matched NBD controls. She found that both in ‘free speech’ tasks and in more constrained descriptive tasks, the grammatical-lexical ratio was consistently significantly lower in the

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5 In narrative and descriptive speech tasks, significant differences between the agrammatic group and the control group were not detected. A likely reason for this is that these speech genres put more restrictions on the speakers.
4.4. Lexical vs. grammatical determiners

Based on the focalization criterion, Nielsen et al. (2019) made a distinction in Danish between grammatical determiners (the unstressed indefinite articles *et* (neuter gender) and *en* (common gender)) and lexical ones (the numerals *et* (neuter gender) and *en* (common gender)). In a structured task (adapted from Michel Lange, Messerschmidt, & Boye, 2018), they elicited both kinds of determiners as part of NPs (consisting of a determiner, an adjective and a noun) from five persons with agrammatism and four matched NBD controls. They found that, as predicted, the agrammatic group of speakers omitted significantly more grammatical determiners than lexical ones; in fact, the agrammatic speakers omitted almost no lexical determiners. In contrast, the NBD controls omitted almost no grammatical or lexical determiners. Additionally, Nielsen et al. (2019) looked at agreement errors (both grammatical and lexical determiners agree with their head noun for gender in Danish), and found that the agrammatic group made significantly more errors than the NBD group in both grammatical and lexical determiner production. The authors also predicted this finding and accounted for it as due to the fact that agreement markers are grammatical elements common to both the grammatical and the lexical determiners.

4.5. Summary

The ProGram theory entails that in at least some languages, distinctions must be made between grammatical and lexical members of the classes of verbs, prepositions, determiners and pronouns. Such distinctions find support in the data discussed above. There is now a considerable body of data from different tasks and from several languages that suggest that pronouns, prepositions, determiners and verbs classified as grammatical based on the ProGram theory are more severely affected in agrammatism than those classified as lexical. Moreover there are data indicating that elements classified as grammatical are more severely affected in fluent aphasia than elements classified as grammatical. These neurolinguistic data accordingly support the ProGram theory.

5. The ProGram theory and the cognitive mechanisms behind agrammatism

The fact that the ProGram theory makes correct predictions about language processing and aphasia (see Section 4) makes it a natural starting point for exploring the possible cognitive mechanisms behind grammatical aspects of agrammatism. In what follows we will put forward an account of the mechanism behind agrammatism, based on the theory. The account consists of two hypotheses each of which is derived from one of the two central features of grammatical elements: i.e. the prominence property and the dependence property (cf. Section 3):

1. The prominence hypothesis: Agrammatism arises as a response to resource limitations in which grammatical elements get lower priority than lexical elements because they are by convention discursively secondary and therefore less crucial for communicative purposes.
2. The dependence hypothesis: Agrammatism is (also) caused by a more specific resource problem, namely an impaired capacity for combining simple elements into complex ones; such an impairment affects grammatical elements more severely because they are dependent on combination with a host element in relation to which they are discursively secondary.

Both hypotheses account for the same central features of agrammatism in language production (see Section 5.1 and 5.2 below), but they entail specific and distinct ‘collateral’ predictions which allow us to differentiate between them (see Section 5.3). Still, the hypotheses are mutually compatible, and neither of them can stand alone (see Section 5.4).

5.1. The prominence hypothesis and good enough production

The prominence hypothesis complements neurocognitive theories that do not necessarily postulate an impaired processing mechanism, but see agrammatism as a result of capacity limitations – for example, limitations to parsing work space (e.g. Caplan & Hildebrandt, 1988). In particular, it complements theories that see agrammatism symptoms as a result of a compensatory response to resource reduction (e.g., Kolk & Van Grunsven, 1985; Kolk, 1995). In order to account specifically for grammatical deficits associated with agrammatism, such theories must postulate rather specific capacity limitations, rather than a general “resource reduction” (Caplan, 2012) associated with all kinds of aphasia. Under the assumption that such specific limitations are at work, these theories raise the question why exactly grammatical elements are affected, and not (to the same extent at least) lexical ones. In other words, there is a missing link between agrammatism-specific capacity limitations and grammar.
The ProGram theory provides the missing link. Agrammatism can be understood as the result of a compensation for capacity limitations in terms of a prioritization that disfavours grammatical elements because these elements are inherently discursively secondary. Agrammatic speakers do not have the resources to produce full-fledged linguistic strings and compensate for this by giving top priority to discursively primary lexical elements, while dispensing with the grammatical contribution to the attentional background.

The prominence hypothesis may be thought of as related to Ferreira’s (2003) theory of language comprehension in terms of “good enough processing”. According to Ferreira’s theory, linguistic input is not always processed in full detail. Rather, partial or superficial representations may be developed to comprehend linguistic inputs when the listener is confronted with the challenge of keeping up with complex information that comes with a high processing load. In line with the ProGram theory, the lexical-grammatical contrast may be seen as presenting an instruction for such prioritization of processing resources. Lexical elements as potentially discursively primary elements call for in-depth processing, whereas grammatical elements as discursively secondary ones are candidates for superficial processing. Agrammatic language comprehension may then be understood as an extreme outcome of ‘good enough’ processing: Due to pathological resource reduction, grammatical elements are de-prioritized to the extent that some are not processed at all. As for language production, we suggest that agrammatic speakers may implement a similar strategy for good enough production in order to compensate for a reduced cognitive capacity: Production resources are allocated to lexical expressions, as these are crucial for communicative purposes.

In terms of the prominence hypothesis, agrammatic speech is not much different from other cases of elliptical language produced in response to time, space, financial or other limitations. Consider, for instance, a situation where you want to convey the message in (11a), but do not have time (for instance, if you are drowning), money (if you are dictating a telegram) or space (if you are writing a tweet).

(11) a. Bob has always hated dancing.

b. Bob hate dance.

c. Always hate dance.

d. Hate Bob dance.

e. Dance hate always.

f. has ed ing.

Instead of producing (11a), you can omit the grammatical elements and say (11b) or (11c). If you have the right context and a prepared recipient, you may even ‘omit’ the schematic syntactic construction and try your luck with (11d) or (11e). But if you retain only the grammatical elements, as in (11f), the exchange is doomed to failure.

As mentioned in Section 2, construction grammars assume that not only phonologically concrete words and morphemes, but also schematic constructions (i.e. morphosyntactic templates) are linguistic signs with an expression and a content side. For instance, just as cloud, blue and go are linguistic signs, so are constructions such as ‘declarative word order’ and ‘noun phrases’. On this assumption, the prominence hypothesis can explain not only why phonologically concrete grammatical signs are omitted or substituted in agrammatism, but also why agrammatic speech tends to be disfluent. According to the ProGram theory, schematic constructions are clearly not lexical, but grammatical. The main point in uttering a noun phrase is not to indicate ‘thingness’ (or whatever the abstract meaning of a noun phrase may be), but to say something about a thing by means of one of the lexical fillers (e.g., a noun or an attributive adjective) of the noun phrase slots. Similarly, the main point of uttering a declarative clause is not to indicate that you are making an assertion, but to make an assertion concerning a proposition specified by the fillers of the declarative clause slots. This entails that also schematic constructions are good candidates for being ‘omitted’ as a result of prioritization, and omission of schematic constructions must inevitably lead to disruption of phrase and sentence structure (including, e.g., word order), and thus cause disfluency. As will be discussed later, this illustrates the close relationship between the prominence and the dependence properties of grammatical elements.

This fits with Hatchard’s (2015) finding that in a group of six case study participants, those with greater spoken language impairment (mainly diagnosed with agrammatism) appeared to lack schematic constructions. Hatchard’s finding also supports the dependence hypothesis (cf. Section 5.2); in fact, Hatchard proposed that the lack of schematic constructions was due to an impaired ability for combining or unifying constructions.

The prominence hypothesis is not only concerned with omissions and substitutions of grammatical elements, but also entails predictions about other aspects of agrammatism. One such prediction allows us to differentiate between the prominence hypothesis and the dependence hypothesis: Based on the prominence hypothesis, it must be predicted that in agrammatic speech, not only grammatical elements are given low priority, but also lexical elements that are discursively secondary, for instance lexical elements...
that represent so-called given information. This prediction has to our knowledge not yet been tested systematically, but it is evident for anyone who has compared agrammatic speech with NBD speech that the former comprises fewer words – also lexical ones – than the latter. Agrammatic speakers focus their effort on the main points of the utterance and relatively rarely supply the detailed background information found in NBD speech. In addition, one may find support for the prediction in the fact that anaphoric pronouns (including lexical ones) are much more severely affected in agrammatism than deictic ones (Westergaard et al., 2019). While lexical anaphoric pronouns have the potential to be discursively primary, they are often secondary: they often represent given information, and given information tends to be non-focal. (Note, however, that the deictic-anaphoric dissociation may alternatively be due to 1. the fact that anaphoric reference resolution depends on memory, whereas deictic reference resolution does not, or 2. the fact that anaphoric reference resolution requires processing of grammatical information).

Another piece of support for the prediction is found in Nielsen et al. (2019). As discussed in Section 4.4, Nielsen et al. elicited NPs consisting of a determiner, an adjective and a noun. While primarily concerned with determiner production, they also looked at adjective production. They found that three of the five agrammatic speakers that were tested omitted more adjectives or produced less correct adjectives in the condition where focus was on the determiner than in the condition where focus was on the adjective. Clearly, when focus is on the determiner, the determiner is discursively primary (cf. the focalization criterion), and the adjective is thus discursively secondary relative to the determiner. Based on the prominence hypothesis, it is natural to expect that the discursively secondary adjectives are given low priority in language production, as reflected in omissions and errors.

While there is thus empirical support for the prominence hypothesis, we will argue in Section 5.4 below that it cannot stand alone, but is complemented by the dependence hypothesis, to which we now turn.

5.2. The dependence hypothesis and unification impairment

As mentioned, the dependence hypothesis is that agrammatism is a result of an impaired capacity for combining or unifying simple linguistic elements into complex ones, and that such an impairment severely affects grammatical elements as they are dependent on combination with a host element in relation to which they are discursively secondary. This hypothesis is compatible with neurolinguistic models of language processing that give a central role to combination or unification (e.g. Borinkessel-Schleseswky et al., 2015; Hagoort, 2016; Hickok & Poeppel, 2007). Like the prominence hypothesis, the dependence hypothesis is capable of capturing not only the tendency for phonologically concrete grammatical elements to be omitted or substituted in agrammatic speech, but also the fact that agrammatic speech tends to be disfluent. Disfluency would be a straightforward consequence of an impaired capacity for combining simple elements into complex wholes (cf. Hatchard, 2015, discussed in Section 5.1). This capacity has received little attention in usage-based linguistics, but it is clearly presupposed by dominant frameworks such as Cognitive Grammar and all variants of construction grammar: The mechanism is needed in order to fit filler material into the slots of schematic constructions (see Boye & Harder, 2020, for discussion). As mentioned in Section 5.1, schematic constructions are grammatical elements and as such discursively secondary in relation to – and dependent on combination with – these fillers (Boye & Harder, 2017, pp. 50–51).

Like the prominence hypothesis, the dependence hypothesis is not only concerned with omissions and substitutions of grammatical elements, but also entails predictions about other aspects of agrammatism. One such prediction specifically concerns dependence, and thus – like the prediction discussed in Section 5.1 – allows us to differentiate between the two hypotheses we have proposed. Based on the dependence hypothesis, it must be predicted that in agrammatic speech, not only grammatical elements present problems, but also lexical elements that are dependent on (and, thus, require combination with) other elements. Verbs are an example of this, as they (possibly via the schematic constructions they evoke) depend on combination with (obligatory) arguments. In support of the hypothesis, a large amount of studies have found that agrammatic speakers have problems related to verbs. Problems with verb processing in agrammatism have been documented for a number of different languages (Miceli et al., 1984; Bastiaanse & Zonneveld, 1998). Also problems with tense inflection (Friedmann & Grodzinsky, 1997; Miceli et al., 1989; Nespolous et al., 1988; Wenzlaff & Clahsen, 2004), and problems with argument structure (Grodzinsky, 1995; Kegl, 1995; Kim & Thompson, 2000; Thompson et al., 1997; Bastiaanse & Zonneveld, 2005; Sánchez-Alonso et al., 2011) can arguably be attributed to verb problems, as can the finding that in agrammatism plural noun inflection is better preserved than verb inflection (Goodglass & Hunt, 1958).

Both hypotheses thus generate predictions that affect lexical elements, but while the prominence hypothesis is about non-prominent lexical elements, the dependence hypothesis is about structurally dependent lexical elements (e.g., verbs).

Like the prominence hypothesis, the dependence hypothesis cannot stand alone. We will argue in Section 5.4 below that the two hypotheses are not only mutually compatible, but complement each other.

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6 This is not to say that agrammatic speakers do not pay attention to non-linguistic backgrounds, for instance the background of a picture they are to describe. Some actually seem to get into difficulties picking out canonical non-linguistic foregrounds for their messages (see Marshall, 2009, for discussion). What is relevant to our discussion is the tendency for agrammatic speakers not to include much background items in their utterances.

7 Note that we use the term dependent in a slightly different way than it is used in syntactic dependence analysis and in dependency grammars. In dependency analysis, dependency is a relationship by which one expression (e.g. a verb) licenses another one (e.g. a complement) such that the latter is said to be dependent on the former. The way we use the term, an expression (e.g. a grammatical item or a verb) is said to be dependent on another one (e.g. a lexical host item or an obligatory complement) if it requires combination with it.
5.3. Differences between the two hypotheses

There are significant differences between the two hypotheses. The prominence hypothesis entails an understanding of agrammatic speech as the result of a compensation for a general capacity limitation: Grammatical elements are given low priority in order to compensate for resource limitations. In contrast, the dependence hypothesis entails an understanding of agrammatic speech as involving an impaired specific processing mechanism: Agrammatic speech is what you get when your capacity for combining simple elements into complex wholes is impaired.

This difference entails another one. As discussed in Section 5.1, the prominence hypothesis works for both language production and language comprehension. In contrast, the dependence hypothesis may work only for language production. At least, it is not clear to us to what precise extent dependence and elements in combination play a role in comprehension; inferencing may do (most of) the work instead.

Finally, while both hypotheses account for problems with grammatical elements in agrammatism, they entail different ‘collateral’ predictions. As discussed in Section 5.1, the prominence hypothesis entails the prediction that it is not only grammatical elements that are sparse in agrammatic speech, but that this is the case with all discursively secondary elements, including lexical ones. As discussed in Section 5.2, the prominence hypothesis entails that agrammatism is associated with problems pertaining not only to the production of grammatical elements, but to the production of all elements that depend on combination with other elements, e.g., verbs.

5.4. The two hypotheses are mutually compatible and complement each other

These differences notwithstanding, the two hypotheses are mutually compatible, and it is natural to see the two mechanisms they invoke as two aspects of the same complex problem. Firstly, prominence and dependence are inherently linked in terms of the ProGram theory. Secondly, there is evidence and theoretical backup for both hypotheses. As discussed in Section 5.1 and 5.2, the two hypotheses entail predictions that specifically concern either prominence or dependence, and which thus allow us to differentiate between the two hypotheses we have proposed. As also discussed, there is support for both sets of predictions. That is, there is reason to believe that a full understanding of agrammatism must take both prominence and dependence into consideration. Finally, it seems intuitively plausible that both prominence and dependence can be at work at the same time (at least in the case of language production): A brain-damaged individual who experiences resource limitations, will also be likely to have problems combining elements into complex wholes.

While each of the two hypotheses provide motivations for agrammatic speech patterns, neither of them can stand alone in explaining them. On the one hand, speakers suffering from a resource reduction of the kind addressed by the prominence hypothesis could in principle compensate for it in other ways than by prioritizing lexical elements above grammatical ones. They could consistently produce fully grammatical, but very simple utterances such as: He left. Do they? Let’s go! However, fully grammatical constructions are not characteristic of agrammatic speech. Thus, the prominence hypothesis calls for a more specific impairment of the sort addressed by the dependence hypothesis.

On the other hand, speakers suffering only from a combination or unification impairment, as suggested by the dependence hypothesis, would in principle be able to produce long utterances consisting of lexical elements, the ordering of which is not syntactically, but pragmatically determined. However, agrammatic speech is generally characterized by limited utterance lengths. This calls for a more general resource limitation of the sort presupposed by the prominence hypothesis.

Thus, the two hypotheses are not only mutually compatible, but also complement each other in accounting for characteristic features of agrammatic speech. Since, as mentioned, the prominence hypothesis is related to theories that model agrammatism as a compensatory response to resource limitations (e.g., Kolk, 1995), and the dependence hypothesis to neurolinguistic theories centered on combination or unification (e.g., Hagoort, 2016), the account we propose may be argued to bring these two types of theories into a motivated relationship.

As a project for the future, it may be envisaged that it may be possible to throw light on the relative importance of the specific lack of the capacity for combination in relation to the importance of the prioritization of scarce general processing resources in a range of different cases.

6. The account in a wider context

The fact that our account consists of two compatible and, we would argue, mutually dependent hypotheses, and that there is support for both hypotheses does not mean that anything goes. Our proposal is not multivocal; we just cannot pretend to have exhausted the issue of precisely how much can be accounted for in terms of each hypothesis. In order to be precise about what is claimed in the account we have proposed, we would like to position it relative to other accounts, and to point out its limitations.

6.1. The account relative to other accounts of aphasia

As already mentioned, the account we have proposed differs from most other accounts of aphasia in being built on a linguistic theory which is usage-based, but differs from some usage-based approaches (especially construction grammars) and aligns with generative approaches in maintaining a distinction between grammatical and lexical status.

Three features may serve to place the account specifically in relation to other accounts of agrammatism. First, our proposal is intended to account for all grammatical aspects of agrammatic speech production across the board. In this respect, it differs from...
theories that deal with a specific grammatical phenomenon such as Bastiaanse and Zonneveld’s (2005) Derived Word Order Problem Hypothesis, which is aimed at explaining word order problems in agrammatism, Thompson’s (2003) Argument Structure Complexity Hypothesis, which deals specifically with argument structure, and Kean’s (1977; 1979) proposal which focuses on the omission of words and inflections.

Secondly, our proposal is a processing account as opposed to a representational account. Many of the most influential theories of agrammatism are representational in the sense that they assume that the central deficit pertains to syntactic representation. This is the case, for instance, with Grodzinsky’s Trace Deletion Hypothesis (e.g., Drai & Grodzinsky, 2006), Hickok and Avrutin’s Differential Chain Deficit Hypothesis (e.g., Hickok & Avrutin, 1996), Mauner, Fromkin and Cornell’s (1993) Double Dependency Hypothesis, and Friedmann and Grodzinsky’s (1997) Tree Pruning Hypothesis.

In contrast, neither of our two hypotheses assumes a representation deficit. The storage of grammatical elements may be unaffected by the brain damage that causes agrammatism. What is affected, according to our hypotheses, is the capacity for actually combining the elements (the dependence hypothesis), and/or some more general processing capacity, an impairment of which forces speakers to de-prioritize production of grammatical elements (the prominence hypothesis). Thus, both the prominence and the dependence hypothesis go naturally with neurolinguistic theories that view agrammatism as the result of a processing deficit. These theories assume an intact linguistic representation and hypothesize that agrammatism is due to, for instance, limitations to parsing work space (e.g., Caplan & Hildebrandt, 1988), slowed-down processing (e.g., Avrutin, 2000, 2006; Pinango, 2000), slowed-down activation or increased rate of decay of grammatical information causing desynchronization of parts of the syntactic representation (e.g., Haarmann & Kolk, 1991; Kolk & Van Grunsven, 1985; Kolk & Weijts, 1996).

Thirdly, our account assumes that grammatical elements are directly affected in agrammatism. That is, it assumes a direct link between grammatical aspects of agrammatism and the central properties of grammatical elements, viz. dependence and discursively secondary status. In this respect, our account differs from theories which take omissions and substitutions of grammatical elements to be a side effect of a more central problem, and which in this sense assume that grammatical elements are indirectly affected in agrammatism (see Nielsen et al., 2019 for discussion). One example of such theories is Ruigendijk and Friedmann’s (2008) Preserved Case Hypothesis. According to this hypothesis, problems with determiners and other case-bearing elements are a side-effect of more basic problems with syntactic structure building, which affect first verb production and then case-assignment (thus, the hypothesis is an attempt to reduce grammar to syntactic structure). Nielsen et al. (2019) showed that at least the Preserved Case Hypothesis cannot stand alone as an account of determiner problems in agrammatism. Based on the ProGram theory, they contrasted grammatical determiners (articles) and lexical ones (numerals), which behave exactly in the same way with respect to case. They demonstrated that whereas grammatical determiners are often omitted in agrammatism, lexical determiners that represent discursively primary information are almost never omitted (cf. Section 4.4). This is evidence that whatever causes agrammatism has a direct effect on grammatical elements.

6.2. Limitations to the proposed account

A full picture of agrammatism in all its complexity requires that the subject is approached both from a linguistic and a neurocognitive perspective. The account we have proposed here approaches it from a linguistic perspective. We have tried to show what implications the ProGram theory – a purely linguistic theory – has for an understanding of agrammatism. We have taken the step from this linguistic perspective into considering what light this may throw on neurocognitive mechanisms, but we do not claim to have provided an in-depth neurolinguistic account – only to have generated hypotheses which are supported by some data, but which need to be followed up.

What is clear from the linguistic perspective is that the characteristic grammatical features of agrammatism are partly the result of a compensatory response to some sort of resource reduction, partly due to an impaired capacity for combining simple linguistic elements into complex ones. What, more precisely, the reduced resource is, and what exactly the combination capacity looks like, can only be revealed by further work from the neurocognitive perspective. We would like to suggest that Working Memory looks like a good place to dig deeper. Working Memory is an obvious candidate for a general resource which can be reduced due to brain damage, and reduction to which could elicit a response in the form of a prioritization of the sort we outlined in our prominence hypothesis. Moreover, Working Memory is likely to play a role in element combination (impairment of which is presupposed by the dependence hypothesis), as different linguistic elements need to be activated at the same time for combination to take place.

Also from a linguistic perspective there are limitations to our proposal. The ProGram theory is a theory of the grammatical-lexical distinction. Therefore, the account of agrammatism that we have derived from this theory is focused on grammatical aspects. It does entail ‘collateral’ predictions about other aspects of agrammatism: The prominence hypothesis entails the prediction that lexical elements with discursively secondary status will also be affected in agrammatism (cf. Section 5.1). Likewise, the dependence hypothesis entails the predictions that lexical elements that are dependent on other elements will be problematic (cf. Section 5.2).

With respect to many aspects, however, our proposal is agnostic. For instance, it offers no explanation of why past time reference seems to cause more problems in agrammatism than present or future time reference (e.g., Bastiaanse, 2013; Faroqi-Shah & Dickey, 2009; Faroqi-Shah & Thompson, 2007). Similarly, it offers no explanation of why persons with agrammatism tend to produce existing full words, and hence do not, for example, produce bound roots in isolation of obligatory affixes (e.g., Grodzinsky, 1990). Entrenchment may play a role here, but while the account we have proposed is fully compatible with accounts in terms of entrenchment, it does not itself imply anything about entrenchment.
7. Conclusion

According to the ProGram theory, grammatical elements have two central properties: they are by convention discursively secondary and therefore dependent on combination with host elements. The theory is supported by recent psycholinguistic and aphasiological studies, and it gives rise to two hypotheses about the grammatical aspects of agrammatism – hypotheses that are neither language-specific nor word-class specific. According to the prominent hypothesis, agrammatic speakers do not have the resources to produce full-fledged linguistic strings and compensate for this by giving lexical elements top priority, while dispensing with the communicatively less salient grammatical ones. According to the dependence hypothesis, agrammatic speakers have a deficit in the capacity for combining linguistic elements, which leads to omissions or substitutions of grammatical elements since these elements are dependent on and thus require combination with other elements. The two hypotheses entail ‘collateral’ predictions that allow us to discriminate between them. However, they are mutually compatible, neither of them can stand alone, and there is empirical support for both.

The account centered on these two hypotheses bring compensation-oriented and unification-oriented models of agrammatism into a motivated relationship. While it does not pretend to be anywhere near as detailed as those models, it has other features that these models lack: it is based on a theory that 1) enables precise language- and word-class specific predictions about which linguistic elements are more compromised in agrammatism (see Section 4), 2) entails correct behavioral predictions about language processing in NBD speakers (e.g. Christensen et al., 2021), and 3) provides an account of grammaticalization (Boyé & Harder, 2012). The proposed account approaches agrammatism from a strictly linguistic perspective, however. A full picture requires that agrammatism is approached also from a compatible neurocognitive perspective.

Author statement

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