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Grammatical versus lexical words in theory and aphasia: Integrating linguistics and neurolinguistics

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The distinction between grammatical and lexical words is standardly dealt with in terms of a semantic distinction between function and content words or in terms of distributional distinctions between closed and open classes. This paper argues that such distinctions fall short in several respects, and that the grammar-lexicon distinction applies even within the same word class. The argument is based on a recent functional and usage-based theory of the grammar-lexicon distinction (Boye & Harder 2012) and on the assumption that aphasic speech data represent the ideal testing ground for theories and claims about this contrast. A theoretically-based distinction between grammatical and lexical instances of Dutch modal verb forms and the verb form *hebben* was confronted with agrammatic and fluent aphasic speech. A dissociation between the two aphasia types was predicted and confirmed.

1 Introduction

Two of the central features that distinguish human language from animal communication systems are a large inventory of symbolic units and a mechanism for combining these units into complex symbols (see Hockett 1960 on more "design features" of human language). At least since Chomsky (1965), much of the effort to understand what language is has been focused on these two features, i.e. grammar and its contrast with the lexicon. There is wide consensus that while the lexicon consists of symbolic items, grammar consists of procedures/rules/templates for combing such units, but also of a set of items (Table 1).

There is however no consensus when it comes to understanding what grammar is and how it differs from the lexicon (see e.g. Evans 2014; Dąbrowska 2015; Ibbotson & Tomasello 2016 for recent attacks on the Chomskyan position). Part of the disagreement is centered on the problem of capturing at the same time both the combination aspect and the item aspect of grammar. The two dominating theoretical positions propose solutions to this problem that are to some degree reductionist. Chomskyan linguistics focuses on the former of these two aspects and tries to fit grammatical items into a general view of grammar as procedures/rules/templates, dealing with them as rule-governed or as "functional" phrase-structural "heads" (e.g. Cinque 1999). Construction Grammar – as the most prominent of the functional-cognitive theories in opposition to Chomskyan ones – focuses on the item aspect to a degree where also templates for combination are dealt with as items (e.g. Croft 2001). Both positions are problematic. On the one hand, the view of grammatical items as rule-governed may be seen as nothing but a stipulation (albeit a theoretically motivated one). On the other hand, the treatment of the combination aspect of grammar on a par with lexical items is at odds with neurolinguistic evidence (Pulvermüller et al. 2013).

Table 1: Grammar vs. lexicon.

	Lexicon	**Grammar**
Items	**Lexical items**, e.g. • nouns like *food, car* • verbs like *eat, stop* • adjectives like *small, red*	**Grammatical items**, e.g. • affixes like *-s* in *cars* • articles like *the* • auxiliaries like *have* in *the car has stopped*
Procedures/rules/templates for combination/sequencing of items		**Procedures/rules/templates** for the formation of e.g. • noun phrases like *the small red car* (DET AP AP N) • clauses like *did the car stop?* (AUX NP V)

This paper advocates a recent theory of the grammar-lexicon contrast (Boye & Harder 2012) which represents an alternative to these polarized positions. The argument is based on the assumption that there are two keys to understanding the grammar-lexicon contrast. One key is aphasiology – in particular, the contrast between agrammatic and fluent aphasic speech, which represents the clearest empirical counterpart of the theoretical distinction (see below). The other key is word contrasts, i.e. contrasts between grammatical and lexical words. There are aspects of grammar that have no obvious counterpart in the lexicon. Procedures/rules/templates are one such aspect, affixes another one. However, both grammar and the lexicon comprise words. Words, then, constitute the area where grammar and the lexicon differ least and can be most directly compared.

Based on these assumptions, we first point out problems in existing studies of contrasts between grammatical and lexical words. Subsequently, we outline the theory in Boye & Harder (2012) of the grammar-lexicon contrast, and point out that it entails a distinction between grammatical and lexical words even within the same word class. Based on this theory, we classify distributional variants of Dutch modal verbs and the Dutch verb form *hebben* 'have' into grammatical and lexical instances, and we test the prediction that grammatical instances are more severely affected in agrammatic speech, whereas lexical instances are more severely affected in fluent aphasic speech – when compared to non-brain-damaged speech. We discuss possible explanations of the results and show that a distinction between grammatical and lexical is well in line with earlier aphasiological and psycholinguistic studies.

2 Grammatical vs. lexical words

Contrasts between grammatical and lexical words are found in a theoretical vacuum. They are largely ignored both by Construction Grammar and by Chomskyan theories; in the former case because construction grammar downplays the distinction between grammar and the lexicon (see e.g. Trousdale 2014: 559 for an example), in the latter case because, as mentioned, Chomskyan theories focus on the combination aspect of grammar.

In absence of a coherent theoretical anchor, the contrast between grammatical and lexical words has often been dealt with in terms of distinctions between "function" (or "form") and "content words" and between "closed-" and "open-class words". The intuition behind the former of these distinctions is that words differ in terms of degree of semantic richness (e.g. Harley 2006: 118). While this may be so, a distinction between less and more semantically rich words cannot, arguably, be co-extensive with a distinction between grammatical and lexical words, as virtually the same content (or function) may in some cases be expressed both grammatically and lexically. As illustrated in (1)–(3), for instance, possession, plurality and directivity may be expressed both grammatically, as in the a-examples, and lexically, as in the b-examples.

(1)   a.   Bob's car   Grammatically expressed possession

         b.   Bob has/owns a car.   Lexically expressed possession

(2)   a.   thieves   Grammatically expressed plurality

         b.   more than one thief   Lexically expressed plurality

(3)   a.   Go away!   Grammatically expressed directivity

         b.   I order you to go away.   Lexically expressed directivity

More importantly, the distinction between function and content words is too vague to license precise criteria for determining whether a word belongs to one class or the other. For this reason, the distinction is often defined in terms of the second one mentioned above, i.e. the distinction between closed- and open-class words (e.g. Segalowitz & Lane 2000; Harley 2006: 118).

This second distinction is based on a clear empirical difference between word classes that are limited and reluctant to accept new members and word classes that are unlimited – or at least very large – and readily accept new members. Theoretically, however, it is no less problematic than the former of the two distinctions. Firstly, what belongs to closed classes varies a lot crosslinguistically. For instance, first names are usually considered as belonging to an open class in standard average European languages, but Latin first names (praenomina) constituted a closed class (counting less than 50 members) in the early days of the Roman republic. Similarly, verbs are standardly taken as examples of open-class words, but in some languages they make up closed classes (e.g. Pawley 2006). Secondly, there is no straightforward link between belonging to grammar and belonging to a closed class. Tellingly, English prepositions are often considered lexical or content words, despite the fact that they make up a closed class (see Mardale 2011 for discussion). Thirdly, as will be discussed below, words that belong to the same closed class are not always affected to a similar degree in agrammatism.

This means that also this second distinction between closed- and open-class words cannot be co-extensive with the distinction between grammatical and lexical words (nobody would consider Latin praenomina grammatical). Although it is a clear empirical difference, then, it cannot be anchored in a theoretical distinction between grammar and lexicon. Accordingly, it is incompatible with theoretically anchored hypothesis formation.

3 A functional theory of the grammar-lexicon contrast
3.1 The grammar-lexicon contrast

A recent functional theory of grammatical status (Boye & Harder 2012) aims at filling the abovementioned theoretical vacuum by simultaneously accounting for the item and the combination aspect of grammar, the contrast between grammar and lexicon, and the diachronic development of grammar through grammaticalization. This theory provides a theoretical anchor for the distinction between grammatical and lexical words. It takes its point of departure in the well-established fact that complex mental input requires prioritization. The central idea is that the grammar-lexicon contrast is a mechanism for prioritizing parts of complex linguistic messages. Based on this idea, grammar and lexicon are distinguished in terms of two properties. One property is discourse prominence: the lexicon is defined as consisting of items – including lexical words – that by convention have the potential for conveying foreground or *discursively primary* information. Grammar is defined as comprising items – including grammatical words as well as constructions (i.e. templates) that are by convention carriers of background or *discursively secondary* information. Consider the sentence in (4).

(4)   King has always hated chasing a stick.

Among the lexical items in this sentence are the verbs *hate* and *chase*. In some contexts, *chase* is primary (i.e. expresses the main point), for instance in a discussion of things King has always hated. In other contexts, *hate* is primary, for instance in a conversation about dog attitudes towards chasing sticks. In contrast, grammatical items such as the auxiliary *have*, the article *a* and the affixes *-s*, *-ed* and *-ing* cannot express primary information (outside metalinguistic and contrastive contexts, where conventions are arguably not adhered to, and where linguistic items are considered in relation to paradigmatic alternatives rather than syntagmatically related items). After a superficial scanning of (4), we know that the main point has to do with the lexical element *King, always, hate, chase* or/and *stick* and not with any of the grammatical items – if we know the conventions of English. According to the functional theory, this is the functional rationale behind grammar and its contrast with the lexicon. The prioritization of parts of complex utterances enables us to concentrate our processing efforts on the most important parts. In this respect, grammar may be considered as interacting with focus: focus points out what is most important; grammar what is not most important.

The second property, dependence, follows from the first one: lexical items can, as potentially primary elements, be the only element in a linguistic message, as in: *Fire!* In contrast, grammatical items are, as secondary elements, dependent on syntagmatically related host elements (with respect to which they are secondary). Thus, just as grammatical items cannot (outside metalinguistic contexts in which conventions are overridden) be used to convey the primary point of a message, they cannot stand alone. For instance, auxiliaries cannot be used detached from full verbs, affixes cannot be used detached from their bases, and schematic constructions such as interrogative word order cannot be produced in isolation of filler material.

3.2 Psycholinguistic support for the functional theory

There is psycholinguistic support for both of the central claims made by the functional theory. The claim that grammatical items are discursively secondary, whereas lexical items are discursively primary, is supported by perception studies which show that grammatical items are paid less attention than lexical ones. Based on diagnostic criteria in the functional theory (see below), Christensen et al. (in prep.) classify a number of Danish words as either grammatical or lexical, and then contrast them in identical contexts. In a letter detection experiment including 83 test persons, they show that letters (which occur both in the grammatical and lexical words) are detected significantly less in grammatical words than in lexical ones (see also Rosenberg et al. 1985). In a change blindness experiment including 32 test persons, they show that people are less aware of changes consisting in the omission of a grammatical word than of changes consisting in the omission of a lexical one. The distinction between processing of grammatical and lexical words can also be made within word classes. Foucambert & Zuniga (2012) used a letter detection task and found that prepositions cluster midway between grammatical words (complementizers and determiners) on the one hand, and lexical words (nouns, verbs, adjectives and adverbs) on the other. A natural interpretation of this finding is that the class of prepositions comprises both grammatical and lexical members. Accordingly, Boye & Harder (2012: 21) suggest that, for instance, the English preposition *of* is grammatical, whereas *off* is lexical.

The experiments discussed above suggest that people pay less attention to grammatical items than to lexical ones. In light of the functional theory this makes perfect sense if it is assumed with Ferreira (2003) that natural language perception relies on

"good-enough-processing" – i.e. that language users economize their resources and only process linguistic input to a degree where they think they get it right: since grammatical items are less important for communicative purposes than lexical ones, language users concentrate on the latter.

More generally, the claim that grammatical items are discursively secondary provides a motivation for the tendency for grammatical items to be phonetically and phonologically reduced: since grammatical items are less crucial for communicative purposes, they are allocated less articulatory resources in language production with the effect that they receive less stress and less articulatory accuracy.

The claim that grammatical items are dependent on host items provides a motivation for empirically-based speech-production models such as those of Garrett (1975) and Levelt (1989). According to these models grammatical items are retrieved and encoded later than lexical items. The dependency of grammatical items provides a motivation for this later retrieval and encoding: since grammatical items depend on a host and only make sense when combined with a host, it is natural to expect that lexical hosts are planned earlier than the grammatical items.

In addition, the dependence claim implies an expectation that grammatical items come with extra production costs: the extra dependency relation of grammatical items relative to lexical ones means that everything else being equal (including phonology, which is rarely equal; cf. above), the grammatical items are a little harder to plan, or that at least they are planned later. Michel Lange et al. (2017) hypothesized that these extra costs or delayed planning is reflected in longer reaction times for the production of grammatical items than for the production of lexical ones. In a production experiment contrasting Danish auxiliaries (grammatical) with homonymous lexical full verbs (lexical) in exactly identical contexts, they find longer reaction times for the grammatical condition, thus confirming the hypothesis (see also Michel Lange, Messerschmidt & Boye 2017 on indefinite articles and numerals).

3.3 Diagnostic criteria for distinguishing between grammatical and lexical words

The theory entails diagnostic criteria for distinguishing between grammatical and lexical items (Boye 2010; Boye & Harder 2012: 13–18). One criterion, following from the dependence property is that grammatical items cannot stand alone, whereas lexical items can. By this criterion, for instance, one Danish determiner, the indefinite article *en/et* comes out as grammatical (cf. (5)), whereas the (prosodically more prominent, but otherwise homophonous) numeral determiner *én/ét* 'one' comes out as lexical (cf. (6)).

(5)   *Du   har   en   rød bil, og   jeg har   også en.
       2SG have.PRS   INDF red car CONJ 1SG have.PRS   also INDF
       Intended reading: 'You have a red car, and I also have a.'

(6)   Du   har   én   rød bil, og   jeg har   også én.
       2SG have.PRS   one red car CONJ 1SG have.PRS   also one
       'You have one red car, and I also have one.'

Another criterion follows from the prominence property. As mentioned, the functional theory considers grammar as interacting with focus: focus points out what is most important, grammar what is not most important. This entails that grammatical items, unlike lexical ones, cannot be focalized. In contrast to *King, a stick* and *hated* (the latter of which are lexical due to, respectively, the lexical constituents *stick* and *hate*), the article *a* and the auxiliary *have* cannot be focalized by means of cleft constructions or focus particles such as *indeed*.

(7)   It was King that has always hated chasing a stick.

(8)   It was the stick that King has always hated chasing.

(9)   King has always indeed hated chasing a stick.

(10)   *It was a, that King has always hated chasing stick.

(11)   King indeed has always hated chasing a stick.
        *Intended reading: 'indeed has'

The article *a* and the auxiliary *have* are both phonologically concrete items, but the criterion holds also for more schematic grammatical items. For instance, the meaning of the perfect construction *have* + V-*ed* 'anterior with relevance to reference point' cannot be the main, discursively primary point of (7), and thus cannot be focalized. The functional theory goes naturally with Construction Grammar's conception of schematic constructions as signs (e.g. Goldberg 1996; Croft 2001) on an equal footing with phonologically concrete items, and it defines all such schematic signs as grammatical. In line with generative approaches, however, it maintains a distinction between grammar and lexicon.

   In the vast majority of cases, word classifications based on the diagnostic criteria outlined above are in line with established ideas of what counts as grammatical words and what counts as lexical ones. Otherwise, the theory would not be a theory of the grammar-lexicon contrast (Boye & Harder 2012). In some cases, however, the theory – through the diagnostic criteria – suggests a classification, which runs counter to established views. As mentioned, Boye & Harder (2012: 21) suggest that the English preposition *of* is grammatical, whereas *off* is lexical (see Friederici 1982 and Bennis et al. 1983 for distinct but related ideas). Similarly, as discussed in Ishkhanyan et al. (2017), French pronouns like *me* ('me') are grammatical, while pronouns like *moi* ('me') are lexical. It goes for both prepositions and pronouns that they are traditionally considered as homogenous word classes, and as mentioned earlier members of the same word class are traditionally considered grammatical or lexical *en bloc*. The theory, then, challenges established views by suggesting that word classes are not homogeneous with respect to the grammar-lexicon contrast.

4 Testing the theory

As mentioned in the introduction, we assume that there are two keys to understanding the grammar-lexicon contrast: 1) contrasts between grammatical and lexical words, which constitute the area where grammar and the lexicon differ least and can be most directly compared; 2) the contrast between agrammatic and fluent aphasic speech, which represent the clearest empirical counterpart of the theoretical distinction. In order to test the theory, then, we first make a distinction between grammatical and lexical words and then confront it with aphasic speech data.

4.1 Grammatical and lexical instances of Dutch verb forms

Our test case is Dutch verbs. Based on the diagnostic criteria entailed by the functional theory, we propose that not only must grammatical verbs (auxiliaries) and full verbs be distinguished, the distinction applies even to distributionally distinct instances of the same word forms. The distinction between grammatical and full verbs is less controversial than similar distinctions within prepositions and pronouns. But established views of the distinction are no less clear theoretically. For instance, auxiliaries are often distinguished

from full verbs by their lack of capacity for assigning theta-roles. However, on some analyses at least, this is also a property of raising verbs, although these are in other respects qualified for being considered full verbs. Accordingly, some scholars have analyzed grammatical auxiliaries as raising full verbs (e.g. Postal 1974: 292; Langacker 1995: 49; Borsley 1996: 140–144; Davies & Dubinsky 2004: 11), while others view raising verbs as grammatical auxiliaries (e.g. Traugott 1997: 191). The confusion is complete (see Boye 2010 for discussion). Also in the case of verbs a theoretically based distinction between grammatical and lexical words is therefore needed.

The Dutch verb forms under scrutiny are *hebben:* 'have' and the modal verb forms *kunnen:* 'can', *zullen:* 'should', *mogen;* 'may'/'be allowed', *willen;* 'want', *moeten:* 'must'/'ought to' and *hoeven* 'need'.[1] For each of these verb forms we distinguished two instances on distributional grounds: one instance which does not combine with another verb (cf. (12a), (13a)), and one instance which does combine with another verb (cf. (12b), (13b)).

(12)　a.　De vrouw　heeft　　twee boeken.
　　　　　DEF woman　have.PRS two　book.PL
　　　　　'The woman owns two books.'

　　　b.　De vrouw　heeft　　twee boeken　geschreven.
　　　　　DEF woman　have.PRS two　book.PL　write.PTCP
　　　　　'The woman wrote two books.'

(13)　a.　De man wil　een　nieuwe broek.
　　　　　DEF man want INDF new　　trouser
　　　　　'The man wants new trousers.'

　　　b.　De man wil　een　nieuwe broek　kopen.
　　　　　DEF man want INDF new　　trouser buy.INF
　　　　　'The man wants to buy new trousers.'

For each verb form in the speech samples we analyzed, we classified these two instances with respect to the grammar-lexicon distinction based on the two diagnostic criteria mentioned above: the stand-alone criterion and the focus criterion. By both criteria, the instances that do not combine with another verb (as in (12a) and (13a)) are lexical items. Firstly, these instances are stand-alone items in the sense that they do not require the co-occurrence of another verb with respect to which they are discursively secondary. Secondly, they can easily be focalized. For instance, they can occur in the scope of a focalizing negation; thus, in (14a) below, the negation clearly affects *hebben*.

By both criteria, likewise, the instance of *hebben* that combines with another verb (12b) is grammatical. It cannot stand alone, but requires a co-occurring participle with respect to which it is discursively secondary, and it cannot be focalized (outside metalinguistic and contrastive contexts; cf. above). For instance, it cannot occur in the scope of a focalizing negation: in (14b), the negation affects the full verb (participle) rather than *hebben*. In English the distinction is even clearer. When *have* is lexically used, it is negated by the dummy verb *do* (*I don't have such an expensive painting*), but when it is grammatical, such a dummy verb is not needed (*I haven't bought such an expensive painting*).

(14)　a.　Zo'n　duur　　schilderij heb　　ik　niet.
　　　　　such.an expensive painting　have.PRS 1SG NEG
　　　　　'I don't have such an expensive painting.'

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[1] *Hoeven* 'need' is a negative polarity verb.

b. Zo'n   duur   schilderij heb   ik   niet gekocht.
   such.an expensive painting have.PRS 1SG NEG buy.PTCP
   'I did not buy such an expensive painting.'

By the first criterion, also the modal verbs which combine with another verb (as in (13b)) are clearly grammatical: they do not stand alone, but require a co-occurring verb with respect to which they are discursively secondary. For these items, however, the second criterion is not conclusive. Epistemic variants of modal verbs that combine with an infinitive cannot be focalized by means of a negation: in (15) the negation affects the infinitive rather than the modal verb. But non-epistemic variants can be focalized: in (16) the negation affects the modal verb.

(15)   De man zou   niet in zijn   huis   geweest zijn.
        DEF man should NEG at 3SG.REFL.POSS house be.PTCP be.INF
        '[it is said that] the man has not been in his house.'

(16)   De man mag zijn   huis   niet betreden.
        DEF man may 3SG.REFL.POSS house NEG enter.INF
        'The man is not allowed to enter his house.'

In line with Mortelmans et al. (2009: 27–29), this suggests that within the group of modals combining with another verb, a more fine-grained distinction can be made between grammatical and lexical instances (see Boye 2010 for discussion). However, the point we wish to make does not depend on the level of detail with which word instances are distinguished (see discussion below). Moreover, it is not entirely clear to us how reliable the focus criterion is in the case of modals combining with another verb (for instance, does the fact that *hoeven* always co-occurs with a negation mean that *hoeven* is always focalized?). For these reasons we ignored the second (focus) criterion for this group of verbs (modals combining with another verb) and simply classified them as grammatical *en bloc* based on the first (stand-alone) criterion.

4.2 Aphasic speech as a testing ground for theories of the grammar-lexicon contrast

Aphasic speech represents the ideal testing ground for theories and claims about the grammar-lexicon contrast, as the contrast between agrammatic and fluent aphasic speech represents the clearest empirical counterpart of the theoretical distinction between grammatical and lexical words.

   Traditionally, aphasia types are distinguished on the basis of fluency of speech. The best-described non-fluent type is Broca's aphasia or agrammatism. Agrammatic speakers have a slow speech rate, and produce grammatically simple sentences in which mainly lexical words are used whereas grammatical words and morphemes are omitted or substituted (Goodglass & Kaplan 1972). A typical example of agrammatic speech is the following (questions of the interviewer between […]):

(17)   Amsterdam … and eh … beautiful … eh … I … nice … walk [Okay. Where?]
        Where? Eh … Amsterdam [Are you walking around the city?] No bike or no eh
        … eh … car eh … shopping … and eh … eh call and eh … first eh … eh … cup
        of coffee … eh … Mary and eh … talk a bit.

Fluent aphasic speech is characterized by word finding difficulties that may result in pauses, empty speech and/or the use of semantically related and/or phonologically related words (paraphasias) and non-words (neologisms). The speech rate is normal, there is a

more or less normal variety of grammatical variation, but some fluent aphasic speakers mix up sentence structures (paragrammatism). The most common fluent aphasia types are Wernicke's and anomic aphasia that are, theoretically, distinguished on the basis of the productions of paraphasias and neologisms and their language comprehension skills, with Wernicke's aphasia being more severe than anomic aphasia. However, in clinical practice, it is not always easy to make this distinction. A typical example of fluent aphasic speech (of the Wernicke type) is the following answer to the question *how are you doing these days?*

(18)   I've got the idea that I've been taken better. You can hear that with the talking of course. On one side but I think it's nice, my idea too. But if it does not work then it does not work. I think quite easy about that. We never say it is not possible or it does not work. And that's what I did. That's the way I am, right?

Hence, traditionally, agrammatic and fluent aphasia were defined as a grammatical and a lexical retrieval impairment, respectively.

5 Neurolinguistic support for the functional theory

In order to test the functional theory, we confronted the distinction between grammatical and lexical instances of Dutch verbs with data from agrammatic and fluent aphasic speakers.

5.1 Predictions

When confronting the theoretically-based Dutch verb distinctions with aphasic speech data, we make two predictions:

1. Verb instances classified as grammatical based on the functional theory are more severely affected in agrammatic speech than verb instances classified as lexical, when compared to the speech of non-brain-damaged speakers.
2. Verb instances classified as lexical based on the functional theory are more severely affected in fluent aphasic speech than verb instances classified as lexical, when compared to the speech of non-brain-damaged speakers. Instead, the fluent aphasic speakers are expected to overuse grammatical verbs.

5.2 Participants

In order to test our hypothesis that grammatical instances of Dutch *hebben* and modal verb forms are vulnerable in agrammatic speech but will be over-used by fluent aphasic speakers, we analyzed spontaneous speech samples from 11 non-brain-damaged (NBDs), 18 agrammatic and 10 fluent aphasic speakers.[2] All aphasic speakers had aphasia for at least 3 months. The aphasia type (Broca for the agrammatic speakers; Wernicke or anomic for the fluent aphasic speakers) was established with the Aachen Aphasia Test (Graetz et al. 1991). The demographics of the aphasic speakers and the NBDs can be found in Supplementary file 1. All participants signed an informed consent according to the Declaration of Helsinki under a procedure approved by the Medical Ethics Committees of the relevant medical centers.

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[2] The samples of the fluent aphasic speakers have been used in Bastiaanse (2011) for the analysis of finite and nonfinite verbs. Ten of the agrammatic speech samples have been used in Bastiaanse & Jonkers (1998) for the analysis of finite verbs; the other agrammatic and the NBD samples were collected for the PhD project of Bos (2015) and have not been analyzed before.

5.3 Materials and analysis

The samples were elicited by the following questions:

(19) a. Can you tell me how your speech problems started? (for the aphasic speakers)
      b. Can you tell me about the last time you were seriously ill? (for the NBDs)

(20) Can you tell me about your family?

(21) Can you tell me about your work/hobbies?

(22) Can you tell me about your last holiday?

The samples were transcribed orthographically and the whole interview was analyzed. Notice that the samples were not of equal length, but samples shorter than 250 words were excluded. In Supplementary file 2, the sample size for the individual participants are provided. Utterances containing a form of *hebben* or a modal verb were further analyzed with regard to the distribution between grammatical and lexical instances. Occurrences of *hebben* or the modal verb forms that combined with another verb were counted as grammatical words, as in *we hebben drie kinderen gekregen* 'we have got three children'; *dat kan ik me niet herinneren* 'that I cannot remember'. Occurrences of *hebben* or modal verb forms that did not combine with another verb were counted as lexical verbs, as in *ik heb een leuke familie* 'I have a nice family'; *ik doe wat ik kan* 'I do what I can'. Notice that in Dutch the full verb is at the end of the sentences when combined with an auxiliary or modal verb. It was, therefore, not always clear, specifically in cases of unfinished sentences of fluent aphasic speakers, whether *hebben* or the modal verb occurrence represented the lexical or the grammatical word. These unclear cases were not analyzed.

5.4 Results

In Table 2, the results for the instances of *hebben* and the modal verb forms are given for the three groups. Individual data are given in Supplementary file 2.

For *hebben,* the use of the grammatical and lexical instances is different among the groups (chi^2(2) = 7.57; p = 0.0227). The pattern of the agrammatic speakers is not different from normal (Fisher's exact: p = 0.324). The fluent aphasic speakers, however, fall short on the usage of lexical instances of *hebben* (Fisher's exact: p = 0.0467). They also differ from the agrammatic speakers (Fisher's exact: p = 0.0171): the agrammatic speakers use the lexical instance of *hebben* more often than the grammatical instance, a pattern that is opposite to the one presented by the fluent aphasic speakers.

For the modal verbs, the difference between the groups is, again, significant (chi^2 = 27.15; p < 0.00001). The agrammatic speakers use the lexical instances of the modal verb forms more often than the grammatical instances, whereas the pattern for both the NBDs and the

Table 2: The number of times *hebben* 'have' and modal verbs were used grammatically and lexically, and the percentages of grammatical use per group: non-brain-damaged speakers (NBD; n = 11), agrammatic speakers (n = 18), and fluent aphasic speakers (n = 10).

	have			modal verbs		
	grammatical	**lexical**	**% grammatical**	**grammatical**	**lexical**	**% grammatical**
NBD	45	48	48,7	26	7	78,8
agrammatic	13	21	38,2	20	36	35,7
fluent aphasic	40	21	65,6	49	14	77,8

fluent aphasic speakers is the opposite (p < 0.0001 in both cases). There is no difference between the patterns for the NBDs and the fluent aphasic speakers (p = 1).

In Figure 1, the data for the lexical and grammatical words have been collapsed. This nicely illustrates the differences between the two aphasic groups.

When we add the numbers of times that the grammatical instances of *hebben* and the modal verb forms were used and compare these numbers with numbers for the lexical instances, there is a significant difference between the 3 groups (chi^2 = 26.024; p < 0.00001). Both the agrammatic and the fluent aphasic speakers use grammatical and lexical instances differently from how the NBDs use them. For agrammatic speakers the pattern is opposite of that found for NBDs and fluent aphasic speakers: they produce lexical instances of *hebben* and modal verb forms more often than grammatical instances (Fisher's exact; p = 0.0057). Both NBDs and fluent aphasic speakers use grammatical instances more often than lexical ones, but for the fluent aphasic speakers the discrepancy is larger than for the NBDs (Fisher's exact; p = 0.0125).

6 Discussion

As both our predictions were confirmed, the empirical study supports our distinction between grammatical and lexical instances of Dutch word forms, and thus the functional theory of the grammar-lexicon contrast upon which this distinction was based.

6.1 Alternative explanations in terms of frequency or semantics

Grammatical items are often more frequent than lexical ones. Accordingly, one might wonder if the dissociation we found could be accounted for in terms of frequency. In order to cover our findings, such an account would need to claim that frequent items are more problematic than non-frequent ones in agrammatic speech, and that non-frequent items are more problematic than frequent ones in fluent aphasic speech. First of all, we know that frequency of (full) verbs does not influence retrieval in aphasia, neither in isolation nor in a sentence (Jonkers & Bastiaanse 2007; Bastiaanse et al. 2016). Also, the frequency of the use of grammatical structures in normal spoken language does not influence agrammatic performance (Bastiaanse et al. 2009). In our study, a frequency account of the agrammatic performance can also be ruled out. While for the modal verb forms, the
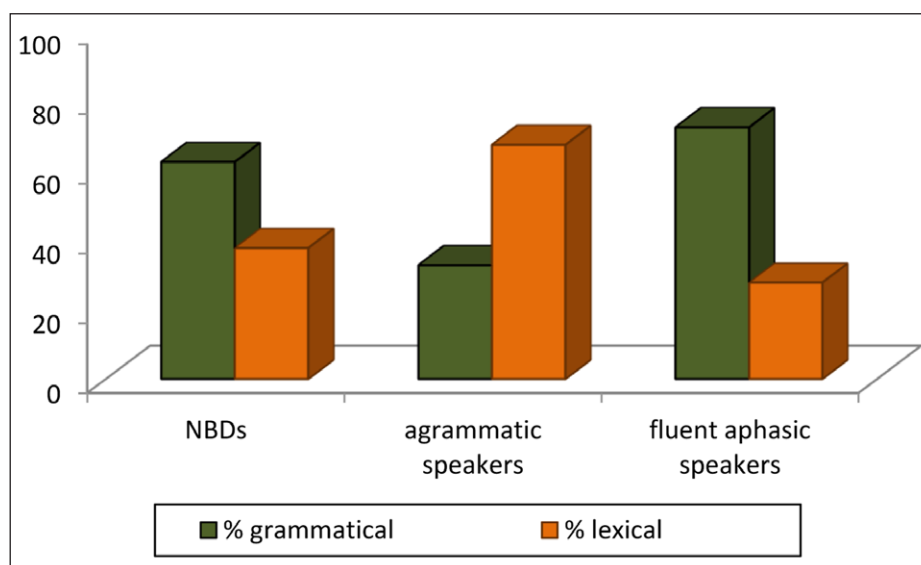

Figure 1: The percentages of which *hebben* 'have' and modal verbs were produced as grammatical and lexical words by non-brain-damaged (NBDs), agrammatic, and fluent aphasic speakers.

grammatical instances are more frequent than the lexical ones in the NBD sample (79% vs. 21%; see Table 2), the grammatical and lexical instances of *hebben* have approximately the same frequency (48,7% vs. 51,3%); the latter implies that frequency cannot account for the performance of either of the aphasic groups.

One might wonder if the dissociation we found could be accounted for semantically. In the case of *hebben,* the distinction between a grammatical instance and a lexical one is co-extensive with a semantic distinction: grammatical *hebben* is part of a perfect construction with a meaning that can be roughly paraphrased as: anterior with relevance to reference time (cf. English *have* in *we have lived here for 20 years*); lexical *hebben* expresses possession (cf. English *have* in *if I had a hammer*). One might argue then that agrammatic speakers have problems expressing anterior with relevance to reference time (see Bastiaanse 2013), while fluent aphasic speakers have problems expressing possession. However, fluent aphasic speakers have the same problems with reference to the past as agrammatic speakers (Bos & Bastiaanse 2014) and they use *hebben* twice as often as an auxiliary than as a lexical word, ruling out a semantic explanation. The modal verbs also present an argument against any semantic account. We found a dissociation between grammatical and lexical instances of modal verbs, in spite of the fact that there are only subtle if any semantic differences between the two kinds of modal verb instances. For instance, both the lexical instance of *willen* 'want' in (13a) and the grammatical instance in (13b) express non-epistemic modality: volition. To be sure, only the group of grammatical modal verb instances includes epistemic instances, and semantically epistemic instances differ considerably from non-epistemic instances. However, epistemic instances were largely absent from our aphasic speech sample.

6.2 The problem of distinguishing between items

Our distinction between grammatical and lexical Dutch verb instances rests on a distributional distinction between verb instances combining and verb instances not combining with other verbs. This distributional distinction presents several potential problems. A general objection could be that distributional differences are not enough to distinguish between items. A more specific objection could be that at least in the case of Dutch modal verbs, the distributional distinction we make is nonsensical as there is no neat semantic reflection of it: only when the modal verbs combine with another verb, can they have epistemic modal meaning, but non-epistemic meanings are found both in modal verbs that combine and modal verbs that do not combine with another verb.

Whether such objections are valid or not, they are irrelevant to the argument made in the present paper. We tested an implication of Boye & Harder's (2012) theory of the grammar-lexicon contrast. This theory does not depend on any specific claim about when and how to distinguish items. It only presupposes that items can be distinguished. As soon as one item has been isolated, this can be classified as grammatical or lexical based on the theoretically anchored diagnostic criteria.

Different ways of distinguishing and identifying items will lead to different contrasts between grammatical and lexical items. Consider the Dutch modal verb forms. One might distinguish different items based on their semantics rather than on distributional grounds. For instance, one might claim that epistemic modal verbs were a set of items distinct from non-epistemic modal verbs. Such a semantic distinction would cut across the distributional distinction we made: epistemic modal verbs are only a subset of modal verbs combining with another verb, and non-epistemic modal verbs comprise both modal verbs that combine with another verb, and modal verbs that do not combine with another verb. As mentioned earlier, epistemic modal verbs seem to be grammatical by the focus criterion, whereas at least some non-epistemic modal verbs seem to be lexical. When confronted

with aphasic speech data, this semantically-based distinction might be theoretically and empirically stronger than the distribution-based distinction. When confronted with aphasic speech data, it might accordingly lead to an even clearer dissociation between grammatical and lexical items. However, our results show that even when combined with an item distinction that may not be ideal, the functional theory makes the right predictions about the grammar-lexicon contrast.

6.3 Additional neurolinguistic support for the functional theory

We would like to end the discussion by briefly relating this study to other neurolinguistic studies that support or can be interpreted as supporting the functional theory. One study is similar to the present one in that it makes a distinction, based on the functional theory in Boye & Harder (2012), between grammatical and lexical items within a closed class of words, but it differs in that it confronts this distinction only with agrammatic and not with fluent aphasic speech data: in a study of pronoun production in French agrammatic speech associated with Broca's aphasia, Ishkhanyan et al. (2017) made a distinction between grammatical pronouns (e.g. *je, me*) and lexical pronouns (e.g. *moi*) based on the focus criterion discussed earlier, and found that the former are more severely affected than the latter.

Other studies align with the present one in supporting a distinction between grammatical and lexical words that cuts across traditional distinctions between closed- and open-class words or between function and content words. Friederici (1982) used a sentence completion task to test production of prepositions with what she called "semantic" and "syntactic" functions[3] in agrammatic and fluent aphasic speakers. The agrammatic speakers were better in producing the prepositions with a "semantic" function and the fluent aphasic speakers the ones with a "syntactic" function. Similar results were reported by Bennis et al. (1983) on a production test. For agrammatic speakers prepositions with a "syntactic" function were hardest to produce and there was no difference between prepositions with a "lexical" or "subcategorized" function. For the fluent aphasic speakers, prepositions with a "syntactic" function were easiest, with again no difference for the two other preposition types. Bennis & Bastiaanse (in press) analysed spontaneous speech of agrammatic, fluent aphasic speakers and non-brain-damaged speakers and reported that the agrammatic speakers produce relatively many prepositions with a semantic functions, whereas they hardly use prepositions with a grammatical function.

Still other studies align with the present one in emphasizing the need for the grammar-lexicon distinction within open word classes. Neurolinguistic studies of open-class items have focused on contrasting different classes of words. In particular, the difference between nouns and verbs has frequently been stressed in aphasiological studies. In general, verbs are more impaired than nouns in agrammatic production; the results are less clear for fluent aphasia. Some authors find the same discrepancy between verbs and nouns as in agrammatic aphasia (e.g. Williams & Canter 1987; Jonkers & Bastiaanse 2007), whereas others find nouns relatively impaired (Luzzatti et al. 2002) or no difference (Zingeser & Berndt 1990). In agrammatic spontaneous speech, verbs are very vulnerable, which has been shown for a variety of languages (English: Saffran et al. 1989; Thompson et al. 2010; Italian: Miceli et al. 1983). Notice that these authors blame verb inflection or arguments structure, typical properties of verbs, for causing these problems. However, Bastiaanse & Jonkers (1998), for Dutch, and Abuom & Bastiaanse (2012), for English and Swahili, took individual variability into account, and showed that there is

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[3] Notice that it is not entirely clear what Friederici (1982) means by "syntactic function": the scarce examples she gives are what we call "subcategorized". The point we would like to make here is that closed class word classes cannot be treated as being homogeneous.

a kind of competition between verb inflection (grammatical) and the diversity of full verbs (lexical). Agrammatic speakers who inflect their verbs to a normal extent have little variation in the full verbs they produce, whereas agrammatic speakers who use verbs with a normal variation show a reduced proportion of finite verbs. The authors call this a "trade-off" effect in agrammatic speech: when the focus is on discursively secondary (or "background") information (in this case grammatical morphemes), the variability of lexical words (in this case full verbs) diminishes; when the focus is on lexical words (full verbs), grammatical background information is neglected. This interaction between grammar and lexicon can also be observed in fluent aphasia. Fluent aphasic speakers use a normal proportion of finite verbs, but for these finite verbs, the variability is lower and the frequency is higher than normal and, interestingly, also than for their nonfinite verbs (Bastiaanse 2013). This means that lexical retrieval diminishes when more grammatical information needs to be encoded: again a trade-off between grammatical information and lexical information and a discrepancy within the class of full verbs, emphasizing the need for the grammar-lexicon distinction even within word classes.

7 Conclusions

This paper rests on the assumption that 1) the grammar-lexicon contrast is best understood by examining word contrasts, as words are the area where grammar and lexicon differ least, and 2) that aphasic speech data present the ideal testing ground for theories and claims about this contrast, as agrammatic and fluent aphasia display the clearest empirical manifestation of the contrast.

In accordance with this assumption, the study tested a recent functional theory of the grammar-lexicon contrast by confronting a Dutch word distinction based on the theory with a Dutch aphasic speech sample consisting of both agrammatic and fluent aphasic speech.

The word distinction is a distinction between grammatical and lexical instances of Dutch modal verb forms and the verb form *hebben*. We predicted that the grammatical items would be more severely affected than the lexical items in agrammatic speech, when compared to non-brain-damaged speech, and that that the lexical items would be more severely affected than the grammatical items in fluent aphasic speech, when compared to non-brain-damaged speech. Both predictions were confirmed by our study.

Our results support the functional theory tested. More importantly, since the grammatical and lexical items we contrasted do not only belong to the same open class (verbs) – they are in fact distributionally distinct instances of the same word forms – the results present a strong argument for abandoning theoretically unanchored distinctions between closed- and open-word classes and between function and content words when investigating the grammar-lexicon contrast.

Abbreviations

1 = first person, 2 = second person, 3 = third person, CONJ = conjunction, DEF = definite, INDF = indefinite, INF = infinite, NBD = non-brain-damaged, NEG = negation, PL = plural, PTCP = participle, POSS = possessive, REFL = reflexive, SG = singular

Additional Files

The additional files for this article can be found as follows:

- **Supplementary file 1.** Demographic data of the Agrammatic and fluent aphasic speakers and the non-brain-damaged (NBD) control speakers. (m = male, f = female; MPO = months post onset; CVA = cerebro Vascular Accident, TBI = traumatic brain injury). DOI: https://doi.org/10.5334/gjgl.436.s1

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Competing Interests

The authors have no competing interests to declare.

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