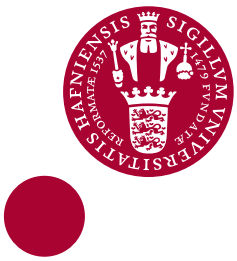

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Grammar is background in sentence processing

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ABSTRACT

Boye and Harder (2012) claim that the grammatical-lexical distinction has to do with discourse prominence: lexical elements can convey discursively primary (or foreground) information, whereas grammatical elements cannot (outside corrective contexts). This paper reports two experiments that test this claim. Experiment 1 was a letter detection study, in which readers were instructed to mark specific letters in the text. Experiment 2 was a text-change study, in which participants were asked to register omitted words. Experiment 2 showed a main effect of word category: readers attend more to words in lexical elements (e.g. full verbs) than to those in grammatical elements (e.g. auxiliaries). Experiment 1 showed an interaction: attention to letters in focused constituents increased more for grammatical words than for lexical words. The results suggest that the lexical-grammatical contrast does indeed guide readers' attention to words.

KEYWORDS: attention, grammar, lexicon, focus, letter detection, change blindness, sentence processing

1. Introduction

What makes readers attend to words? One relevant factor is whether the word is FOCUSED or NON-FOCUSED. For instance, when presented with the same sentence twice, readers are more likely to notice change in focused words than in non-focused words (Sturt, Sanford, Stewart & Dawydiak, 2004). Thus, readers are more likely to notice a change from *cider* to *beer* in (2) than in (1).

(1) It was Jamie who really liked the cider, apparently.

(2) What Jamie really liked was the cider, apparently.

Another relevant factor is what we will call WORD CATEGORY: lexical words attract more attention than grammatical words. For instance, Rosenberg, Zurif, Brownnell, Garrett and Bradley (1985) asked participants to detect all instances of the letters *t* or *a* in a written text and found a higher detection rate for lexical words compared to grammatical words. In this article, we bring together research on focus and research on word category and argue for a unified understanding. In two behavioral experiments, we explore relations and commonalities between the two effects: the effect of linguistic focus (vs. non-focus) and the effect of word category (lexical vs. grammatical). Exp. 1, a LETTER DETECTION STUDY, measures attention to individual letters in grammatical and lexical elements. Exp. 2, a CHANGE BLINDNESS STUDY, measures attention to grammatical and lexical words. For both studies, we expect that readers attend more to lexical words than grammatical words and more to focused than to non-focused constituents. In addition, we expect an interaction between these two factors. These expectations are based on Boye and Harder (2012) and on earlier studies.

1.2. Previous studies of attention guided by focus

At the core of our studies lies the assumption that different parts of a sentence may not be processed at the same depth (cf. Ferreira & Patson, 2007). Rather, the depth of processing is guided by selective attention (cf. Sandford, 2002). Such variations in sentence processing have been established by various online and offline methods. Eyetracking studies with their relatively direct measures of visual attention have given valuable insights into *processing load* (cf. Engbart, Longtin & Kliegl, 2002; Engbert, Nuthmann, Richter & Kliegl, 2005; Rayner, 1998; Rayner, Ashby, Pollatsek & Reichle, 2004; Rayner, 2009; Reichle, Pollatsek, Fisher & Rayner, 1998; Reichle, Pollatsek & Rayner, 2006; Reichle, Warren & McConnell, 2009). For instance, studies of eye saccades indicate that processing load increases for words that are low in frequency or unpredictable.

When it comes to examining *processing depth*, other methods have been used to examine the depth of attention and depth of comprehension. A number of change blindness studies have demonstrated that informants are better at detecting changes in focused words than in non-focused words. Cases in point are the reading studies by Sturt et al. (2004) and by Price (2008) which showed higher detection rates for clefted constituents, and a listening study by Price (2008) which showed higher detection rates for stressed constituents. In the same vein, McKoon, Ratchliff, Ward and Sproat (1993) found that informants are better at recalling words placed in focus position (e.g. nouns in object position) than words outside focus position.

Semantic processing also seems deeper for focused than for non-focused words. Work on discourse processing suggests that comprehenders economize their processing resources: They do not process all parts of the discourse maximally and to the same degree (cf. Ferreira & Patson, 2007, on good enough processing). Incongruent words

are more easily noticed when focused e.g. by means of clefting (Bredart & Modolo, 1988) or pitch accent (Kristensen, Wang, Petersson, & Hagoort, 2013).

The empirically supported link between linguistic focus (as created by clefting, stress patterns etc.) and attention is in line with standard linguistic theories of focus (e.g. Lambrecht, 1994: 212-213). Yet, the link has mainly been found for clefts, pseudo-clefts and pitch accent and is understudied for other types of linguistic focus, e.g. focus by means of focus particles like *precisely* and *only*.

1.3. Previous studies of attention to lexical vs. grammatical words

As mentioned, there is also evidence for a link between attention and the distinction between lexical and grammatical words. Letter detection studies suggest that readers attend more to letters appearing in lexical words than to letters in grammatical words or affixes (Healy, 1976; Drewnowski & Healy, 1977; Smith & Groat, 1979; Rosenberg et al., 1985; Koriat et al., 1991; Koriat & Greenberg, 1994; Foucambert & Zuniga, 2012) – at least when grammatical words are frequent (Roy-Charland & Saint-Aubin, 2006). In letter detection studies, readers of a text are instructed to mark all occurrences of a specific letter, e.g. the letter *t*. A disproportionate number of target letters are missed when the letter occurs in grammatical words like *the*. Letter detection is not as direct a measure of visual attention as eyetracking, but comparisons of eye movement measures for reading tasks with and without letter detection show that detection tasks are informative about word class processing in normal reading (Greenberg, Inhoff & Weger 2006).

It is heavily debated why more letters are missed in grammatical words than in lexical word. The *unitization account* by Drewnowski and Healy (1977) proposes that letters are missed because readers tend to process stimuli at the highest level available

to them. Once a reader has identified a unit (e.g. a phrase), the reader may move on to the next available high-level unit (e.g. the next available phrase) – without necessarily completing the identification of lower-level units (such as words and letters within the phrase). When a unit is highly frequent or highly familiar, it may therefore be quickly identified, and its lower levels are left uncompleted. Based on these processing assumptions, the unitization account posits that high-frequency grammatical words like *the* tend to be missed because they are read as part of larger units, e.g. short syntactic phrases. As a refinement of the original unitization account, Hadley and Healy (1991) suggest that grammatical words tend to be processed in the parafovea of the eye during reading because they are part of such larger units. However, studies by Saint-Aubin and Klein (2001) have demonstrated that there are more omissions for letters in grammatical words than in lexical words even when parafoveal processing is not available, e.g. when words are displayed in column format or one word at a time.

Some models have put special emphasis on the high frequency and high familiarity of function words. Following the unitization account, Moravczik and Healy (1995) argue that familiarity of word meaning plays a crucial role in letter detection: If word meaning is quickly accessed, readers skip the later-stage, lower-level process of identifying letters. By manipulating the linguistic context in the letter detection task, they demonstrated fewer detection errors when *the* had an unusual meaning, was contrastive or had an ambiguous referent. Yet, Saint-Aubin and Poirier (1997) find that the frequency of word meaning is not as important as word function (cf. also the structural account by Greenberg & Koriat, 1991), and a subsequent study by Moravcsik and Healy (1998) shows that even when meaning is controlled for, slight variations in word function have a modulating effect on letter detection. For instance, more letters are

detected when *the* is used as an adverb (*Third, get lots of sleep and you will feel* ***the*** *better for it*) than when it is a definite article.

In the guidance-organization (GO) model by Greenberg, Healy, Koriat and Kreiner (2004), the unitization account and the structural account are combined. The GO model assumes that letter processing occurs at a later stage than word processing, but it also specifies that structural processing of text guides eye movement to the semantically informative parts (for a critique of the GO model, see Roy-Charland, Saint-Aubin, Klein & Lawrence, 2007). The difference between attention to grammatical and lexical words is therefore seen as building on structural differences between these two word categories.

1.4. Critique of the distinction between content and function words

A considerable portion of the research on the lexical-grammatical distinction has been carried out based on a distinction between content words (representing lexical words) and function words (representing grammatical words). The distinction between content and function items is, however, problematic in several respects. Most importantly, it is based on an assumption that two classes of linguistic items can be distinguished according to their semantics: content word have content, while function words do not (cf. e.g. Harley, 2006: 118 on *meaningfulness*). Yet, some conceptual contents (or functions) may be expressed by both content and function items. An example from English is 'possession' which may be expressed both by means of content words, i.e. the full verbs *have* and *own* in (3), and by means of a function item, i.e. the clitic *'s* in (4).

(3) Bob has/owns a car.

(4) Bob's car

Other examples of lexical and grammatical elements expressing similar content are:

- Number expression: In English, the meaning 'plurality' can both be expressed by the grammatical suffix *-s* (as in *cars*) and by the lexical expression *more than one* (as in *more than one car*).

- Illocutionary value: In English, the meaning 'directive' or 'command' can both be expressed grammatically, e.g. by means of word order (*Go away!*), and lexically (*I order you to go away*).

1.5. Critique of the distinction between open- and closed class words

The content vs. function distinction may be seen, then, as a theoretically flavored name for pre-theoretical classifications. Linguists and psycholinguists therefore frequently define this distinction in terms of the distinction between *open-* and *closed class words* (e.g. Segalowitz & Lane, 2000; Harley, 2006: 118). This second distinction is empirically well-founded (deciding between open vs. closed classes is a matter of counting class members), but entirely theoretically unanchored: like the distinction between content and function items, it is supposed to relate to the distinction between lexicon and grammar, but it is not theoretically motivated that the lexicon should solely consist of open-class items, and it is possible to find lexical items that belong to closed classes. For instance, some languages have closed classes of adjectives (e.g. Schachter & Shopen 2007). Consider also adpositions (including English prepositions like *of, by, in* and *on*). They form closed classes, but there is a strong tradition for considering them content words (see Mardale, 2011, for discussion), and there is empirical evidence that at least some of them are lexical (e.g. Bennis, Prins & Vermeulen, 1983; cf. Section 1.6).

The lack of a theoretical anchor for the two distinctions means that they are inadequate for theoretically-based hypothesis formation, and that it is difficult to account for the empirical differences with which they correlate. In particular, it is difficult to link either of the two distinctions to attention. Rosenberg et al. (1985) assume the following link between closed-class items and attention:

> "In some sense, properties of closed-class items less readily intrude themselves into conscious attention – they tend toward 'invisibility'. Without arguing the point in detail here, we assume that one plausible account of this pattern is that it arises because of differences in the way that the products of the word retrieval systems discussed above relate to processes of sentence analysis and interpretation, and hence to processes of conscious report" (Rosenberg et al., 1985: 291).

But this is a (rather vague) ad hoc assumption, rather than a theoretically motivated account. Still, as discussed above, studies based on these distinctions often led to clear results: content or open-class items attract more attention than function or closed-class items. This indicates that while the distinctions are pre-theoretical and inaccurate, there is empirical backup for the intuitions they were created to capture.

1.6. The ProGram theory: A new classification of lexical vs. grammatical words

A recent usage-based theory of the lexical-grammatical distinction by Boye and Harder (2012) – henceforth, the ProGram theory – captures the same intuitions, while at the same time providing a theoretical link between this distinction and attention. In fact, it takes attention properties to lie at the core of the distinction. According to the ProGram theory, the lexical-grammatical distinction is a means for prioritizing information.

Lexical items (including roots, lexical words, phrases) are defined as items that are *by convention potentially discursively primary*. That is, they can be used to convey the main point of an utterance – equivalent to the focus of the sentence. In contrast, grammatical items (including affixes, grammatical words and schematic morphosyntactic constructions) are defined as items that are *by convention discursively secondary*. They cannot be used to convey the main point of an utterance (as long as conventions are adhered to – i.e. outside contrastive and metalinguistic contexts[1]), but serve an ancillary role in relation to lexical hosts. Consider the sentence in (5).

(5) The child has always hated swimming.

In some contexts, *hate* would be discursively primary (e.g. when discussing attitudes towards swimming), in others, *swim* would be primary (e.g. when discussing things the child hates to do), in still others, *child* or *always* would be primary. According to the ProGram theory, however, only the lexical morphemes *child*, *always*, *hate* and *swim* have the potential to be discursively primary. The grammatical morphemes *the*, *have*, *-s*, *-ed* and *-ing* are secondary by convention. This does not mean that they cannot carry *important* information, only that they cannot carry *the main* information in a complex message (the primary/foreground information). This is evident from the fact that if the grammatical morphemes are omitted from (5), the sentence can still be understood, although this requires extra contextual support: *child always hate swim*. In contrast, omitting the lexical morphemes, or replacing them with *smurf* has fatal communicative consequences: *the smurf has smurf smurfed smurfing*.

[1] Examples of such contrastive and metalinguistic contexts would be: *I said emergED, not emergENT*, and *I WILL not clean my room, I HAVE cleaned it*. In these contexts, grammatical elements are focalized in contrast to paradigmatically related elements (*-ed* with *-ent*; *will* with *have…-ed*; see Boye & Harder, 2012:17, for details).

In other words, lexical items are by convention potential attention getters or foreground elements, whereas grammatical items are background elements. This idea is also compatible with the intuition that "structure-supporting units recede to the background as the meaning of the sentence evolves" (Koriat & Greenberg, 1994: 345**)**.

Knowing the conventions of a given language includes knowing which items are lexical and which are grammatical. This amounts to knowing which items to direct the attention towards. The ProGram theory assumes that when reading (5) any proficient language user familiar with the conventions of the English language will during a superficial scan know that *child*, *always*, *hate* or *swim* constitute the most important part of the message, and will concentrate her or his attention on these morphemes.

According to the ProGram theory, then, the functional rationale behind the lexicon-grammar distinction is that it enables us to economize resources by prioritizing the parts of complex linguistic messages to be processed. For psycholinguistic studies like the present one, the ProGram theory provides a set of criteria for distinguishing between grammatical and lexical items.

2. Criteria for categorizing words as grammatical vs. lexical

Here we will concentrate on the ProGram criteria that are concerned with focusability (Boye & Harder, 2012). Focus points out what is discursively primary. It thus follows from the definition of lexical items as potentially discursively primary and the definition of grammatical items as discursively secondary that (outside metalinguistic or contrastive contexts where conventions are overridden) only the former can be focused. Thus, *dogs* is a lexical word, because it can be focused in for example *what I like is dogs*. Grammatical items can be in the scope of a focus marker, as is the case with plural *-s* in

what I like is dogs, and with the article *a* in *what I like is a dog*, but in that case they are still not selectively focused. Compare (6) and (7), for instance.

(6) *I have exactly one apple*.

(7) *I have exactly an apple*.

In both (6) and (7), the focus particle *exactly* scopes over and focuses a noun phrase (*one apple* and *an apple*, respectively), and in both sentences it can be read as focusing the noun phrase as a unified whole. Only in (6), however, can it be read as selectively focusing the determiner. In other words, it can be read as highlighting the number meaning of *one* in (6), but not the indefiniteness meaning of *an* in (7). This is because the determiner *one* in (6) is a lexical word, whereas the determiner *an* in (7) is a grammatical word. Accordingly, some lexical items can be focused independently of other items, as in *I have exactly one*, whereas this is never the case with grammatical items.

Based on this, diagnostic tests can be used to determine whether a word is lexical or grammatical. In Danish and English, a word is lexical if it fulfills one or more of the following three criteria, all of which are instantiations of the focusability criterion (from Kristensen & Boye, 2016). If it does not fulfill any of the criteria, it is grammatical. The lexical word *family* happens to fulfill all three criteria:[2]

1. The word can be selectively focused in a focus construction. Example: *It is <u>family</u> that matters.*

[2] As discussed in Boye and Harder (2012: 16), there are limitations to some of these criteria. For instance, focusing by means of cleft constructions is limited to constituents. As mentioned, however, not all criteria have to be met for a given item to be classified as lexical.

2. The word can be selectively focused by means of a focus particle such as *only*, *exactly* or *not*. Example: *not <u>family</u>*.
3. The word can be selectively addressed in later discourse using, for instance, a wh-question or an anaphor (in other words, the word can be referred to anaphorically in isolation from syntagmatically related words). Example: *<u>Family</u> is everything. - It is what?* (where *it* addresses *family*, and *what* addresses *everything*).

In our two experiments, we used the set of diagnostic tests to distinguish between lexical and grammatical words. A Danish article like *en* is diagnosed as grammatical: Like its English counterpart *a(n)* (cf. above), this word cannot be focused or be addressed in later discourse. Articles thereby differ from Danish pronouns like *denne* (corresponding to English *this*) which can be focused and can be referred to in later discourse. The diagnostic tests also allow us to distinguish between the Danish verb form *have* ('have') as a lexical full verb (8) and as a grammatical auxiliary (9). The full verb form can be focused by means of a negation, while the auxiliary cannot: In parallel to what holds for (6) and (7), in both (8) and (9) the focus particle *ikke* ('not') scopes over a verb phrase, and in both sentences it can be read as focusing the verb phrase as a unified whole, but in (9) it cannot be read as focusing the auxiliary *har* selectively.

(8) Jeg har ikke en bil.[3]
1SG have.PRS NEG INDEF car
'I don't have a car'.

[3] Abbreviations used in the glossing of examples (8)-(10): 1 = first person; 3 = third person; DEF = definite; DEM = demonstrative; INDEF = indefinite; NEG = negation; NOM = nominative; PL = plural; PRS = present tense; PST = past tense; PTCP = participle; SG = singular.

(9) Jeg har ikke løbet.
1SG have.PRS NEG run.PTCP
'I haven't been running'.

These classifications are in full harmony with traditional classifications. More controversially, however, the theoretically-based criteria suggest that a distinction between lexical and grammatical words should be made even within closed word classes. For instance, the English preposition *off* and pronoun *that* are lexical by the focusability criterion, whereas the preposition *of* and the pronoun *it* are grammatical (Boye & Harder, 2012: 21; cf. also Koriat & Greenberg, 1994).

Recent studies show that classifications based on the ProGram theory and its criteria are significant for the description of aphasic speech. For instance, Ishkhanyan et al. (2017) demonstrated that French pronouns classified as lexical based on focusability are less severely affected in agrammatic aphasia than pronouns classified as grammatical, and Martínez-Ferreiro et al. (2018) found that Spanish prepositions classified as grammatical are more severely affected than prepositions classified as lexical in aphasias with motor predominance, while the opposite pattern was found in aphasias with sensory predominance (e.g. Bennis, Prins & Vermeulen, 1983; cp. Boye & Bastiaanse, 2018, on Dutch verbs).

3. Hypotheses of the current studies

We conducted two studies in order to examine how attention during reading is affected by word category and focus. Parts of the results of the two experiments have been published in Danish for a Danish audience (Christensen, 2015a; Christensen, 2015b; Vinther, Boye & Kristensen, 2014). Exp. 1 examined attention to specific letters during

a letter detection task. Exp. 2 examined attention to omitted words in a change detection paradigm.

Both experiments used a 2x2 factorial design with the factors focus (focused vs. non-focused) and word category (grammatical vs. lexical). The word category manipulation occurs at the word level, while the focus manipulation concerns constituents rather than single words. The reason for focusing at the constituent level is that, by definition, grammatical words in isolation cannot be focused: grammatical items are defined as discursively secondary, and non-focusability is a criterion of grammatical status. By Lambrecht's definition (see Section 1.2 above), focus is a property of constituents, and focus markers such as clefting and focus particles scope over whole constituents. We therefore constructed target items where target words were part of larger focused or unfocused constituents.

For the focus conditions of the two experiments, we constructed example sentences in which the grammatical or lexical target word was part of a focused constituent (e.g. a noun phrase), as in (10) where the target word *den* (definite article, grammatical) or *denne* (demonstrative pronoun, lexical) is part of a clefted noun phrase constituent.

(10) Det var den/denne grønne plæne, de lå på.
It be.PST DEF/DEM green lawn 3PL.NOM lie.PST on
'It was the/this green lawn they lay upon'.

It is natural – and compatible with the ProGram theory of Boye and Harder (2012) – to expect that words do not attract the same share of attention when they are only part of

the focused constituent as when they constitute the entire focused constituent. Nevertheless, the overall hypotheses were as follows:

1) Letters and words in the lexical condition are more attended to than letters and words in the grammatical one (*grammar-as-background hypothesis*).

2) Letters and words in focused constituents are more attended to than letters and words in non-focused constituents (*focus hypothesis*).

3) There is an interaction between the lexical vs. grammatical contrast and the focus vs. non-focus contrast (*interaction hypothesis*).

The first hypothesis is based on the ProGram theory in Boye and Harder (2012). Earlier studies have confirmed similar hypotheses (see Section 1.3), but those hypotheses were not based on a direct theoretical link between attention and the lexical-grammatical distinction, and as already discussed, the distinctions between lexical and grammatical target items were not based on theoretically anchored criteria.

The second hypothesis is based on results from psycholinguistic studies using the change blindness paradigm (Price, 2008; Sanford, Molle & Emmott, 2006; Sturt et al., 2004) and other types of attentional paradigms with focus manipulations (e.g. Bredart & Modolo, 1988). To our knowledge, the focus hypothesis has, however, not yet been systematically tested with the letter detection paradigm.

As for the third hypothesis, the ProGram theory defines the grammatical-lexical distinction in terms of discourse prominence and thus links it to attention and to focus. This implies that focus and the grammatical-lexical distinction draw on the same cognitive resources: both are means for prioritizing and directing attention.

4. Exp. 1: Letter detection

The letter detection paradigm was originally developed to study the micro-structure of reading processes and the effects of phonetic manipulations (Corcoran, 1966; Healy, 1994). In Exp. 1 we used the paradigm to test the three hypotheses mentioned above. We focused on the letters *n* and *t*, which occur frequently in both lexical and grammatical words, and translated the hypotheses above into the following specific predictions:

1) Participants notice target letters more frequently in lexical words than in grammatical words.

2) Participants notice target letters more frequently in focused words than in non-focused words.

3) Focus and word category interact such that the effect of focus is different for grammatical words compared to lexical words.

4.1. Methods

4.1.1. Stimuli

We constructed a 480 word long text about an old lady who describes trivial facts in a very detailed way, and created four different versions of the text (one for each condition of the 2x2 factorial design, see Table 1). The text had two parts with experimental sentences embedded in the running text. For the first part of the story, the participants were asked to detect the letter *n*. For the second part, they had to detect the letter *t*. Each part was followed by four comprehension questions to ensure that participants read the text thoroughly. These questions were heterogeneous and were not designed to enter an analysis. The text contained a total of 16 sentences with target items. To avoid

repetition effects and overt attention to target words, the items varied and included different kinds of material.

Manipulation of word category: There were two types of target words: determiners and verbs (cf. Appendix A Table A.1). The 11 determiner items were presented as part of an NP constituent, and the difference between the grammatical and the lexical conditions involved a change in the target word (e.g. from grammatical *den* to lexical *denne*). We aimed at contrasting lexical and grammatical words that were similar or identical with respect to length (syllables), semantic domain, degree of semantic vagueness, orthography, position of the word in the sentence, position of the target letter in the word, position on the text line and whether the word was (part of) new or previously introduced information. The additional 5 items were verbs that could both function as grammatical verbs (auxiliaries) and as lexical verbs (full verbs). For verb items, the orthography of the target word was identical, but sentences in the grammatical condition contained an additional non-finite verb. It was not possible to balance the word contrasts with respect to frequency. For 10 of the 16 contrasts, the grammatical word was much more frequent than the lexical one, for 5 contrasts (*nogle-mange, nogle-mange, haft-haft, været-været, fået-fået*) the lexical word was considerably more frequent than the grammatical word, and for 1 contrast (*blevet-blevet*), there was only a small frequency difference (see Table A.1 in Appendix A).

Manipulation of focus: In the focused conditions, the target occurred in a constituent which was focused by means of either a cleft construction (4 items) or a focus particle (12 items). The focus particles used were *bare* (’merely’), *især* (’especially’), *kun* (’only’), *lige præcis* (’exactly’), *lige netop* (’just’), *netop* (’just’) and *udelukkende* (’solely’).

The four conditions of the experiment are shown in Table 1. The four different versions of each item occurred in separate text versions presented to different participants (i.e. differing between subjects). In this way, each item only occurred once in each text. For each text version, all four conditions were represented four times (i.e. differing within subject).

TABLE 1 *The four conditions of Exp. 1*

	Grammatical target	*Lexical target*
Target is part of focus	*Det var <u>den</u> saftiggrønne, nyklippede plæne, de lå på.* It was <u>the</u> juicy-green freshly mown grass they lay upon.	*Det var <u>denne</u> saftiggrønne, nyklippede plæne, de lå på.* It was <u>this</u> juicy-green freshly mown grass they lay upon.
Target is not part of focus	*De lå på <u>den</u> saftiggrønne, nyklippede plæne.* They lay upon <u>the</u> juicy-green freshly mown grass.	*De lå på <u>denne</u> saftiggrønne, nyklippede plæne.* They lay upon <u>this</u> juicy-green freshly mown grass.

The four conditions of Exp. 1 are exemplified by an experimental item with the target *den*/*denne* (in English: *the*/*this*) which is focused using a cleft-construction. The target item is underlined in this table, but not in the experimental stimuli.

4.1.2. Procedure

A total of 84 participants took part in the experiment. All were Sociology students from the University of Copenhagen (age 20-41, mean 22.6, 26 male and 58 female), and all were native speakers of Danish. The participants completed the experiment at the same time seated in a lecture hall, and they were randomly assigned one of the four text versions. The participants received an oral instruction that the purpose of the experiment was to examine multitasking during reading. They were instructed to read and comprehend the text, while at the same time striking out all instances of a specific letter (*t* or *n*) using a pen or pencil. They were also told that there would be comprehension questions. The participants each received four sheets of paper for each text part with the blank side facing up. The first sheet contained part one of the text, the second contained comprehension questions for part one, the third contained part two of the text and the fourth contained comprehension questions for part two. The procedure was identical for the two text parts (cf. Figure 1).

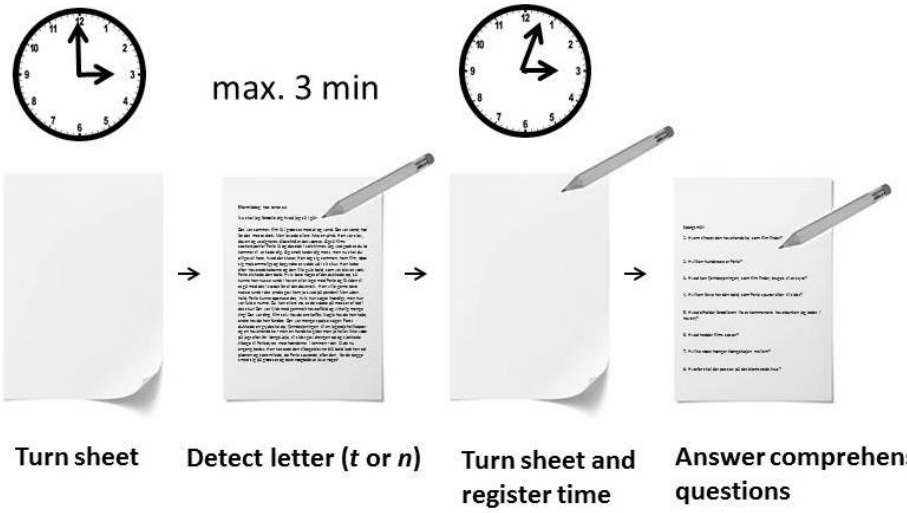

Figure 1 Procedure for the letter detection study (Exp. 1). Upon a starting signal, the participants were instructed to turn the sheet with the text. They then read the story as fast as they could while comprehending and marking the specified letter (*t* or *n*) with a pen or pencil. They were instructed to turn the blank side up once they had finishing reading. Using a large digital clock each participant individually registered how much

time they had spent (max. 3 minutes per text part). The participants then answered the 4 comprehension questions of each text part also using pen and paper.

4.3. Analysis

Vinther et al. (2014) report an ANOVA and a mixed model analysis of Exp.1. For simplicity and for an easy comparison with Exp. 2, we report a reduced mixed model here. A mixed model is a statistical model containing both random and fixed effects. A single mixed model analysis can replace traditional by-item and by-subject ANOVAs. Our generalized linear mixed model analysis was conducted in *R* version 3.1.1 (R Core Team, 2014) using the *lme4* package (Bates et al., 2014). It used a binomial link function. The dependent variable was the number of missed letters in target words. If the target letter was missed in a word that has more than one occurrence of the target letter (e.g. the word *denne* which has two occurrences of the target letter *n*), it only counted as one missed letter. The procedure for fitting the model was to start out with a model that included as random effects subject and item, and as fixed effects the main effects of the experiment: word category (lexical or grammatical target word), focus (focused vs. not focused) and the interaction between the two. To control for frequency effects, we added the log-transformed corpus frequency of all target items. We then tried to add other variables such as random slopes, the type of target letter (*t* or *n*) and stress pattern (whether the target word could be read as stressed, unstressed or both), but the model did not converge with any of these extra variables, and they were therefore not included in the final model. Reported p-values were obtained using the summary function of lme4, and reported confidence intervals (CI) were calculated using the profile method of the confint function. The log-transformed frequencies were found through corpus searches in the Danish national corpus KorpusDK (DSL, 2007), a 56-million-word sampled collection of written texts. Only exact matches (not inflected

forms) were included. Some target word forms cover more than one use, so we manually corrected the frequency measures to only include the relevant instances (for details on the procedure, cf. Appendix A). For frequency calculations of *ens*, *denne*, *dette*, *dit*, *mange*, *meget*, *nogle* and *noget*, only prenominal uses were considered relevant. For *det*, *den*, *en*, *et*, only grammatical uses were considered relevant, and for the verbs *haft*, *blevet*, *været* and *fået* we did separate calculations for auxiliaries and full verbs.

4.4. Results

Figure 2 shows the percentage of correctly detected letters. The winning mixed model (cf. Table B.1 in Appendix B) had by-subject and by-item random intercepts, and the fixed effects were word category (lexical vs. grammatical), focus (focus or no focus), the interaction between word category and focus, and finally the logtransformed corpus frequency.

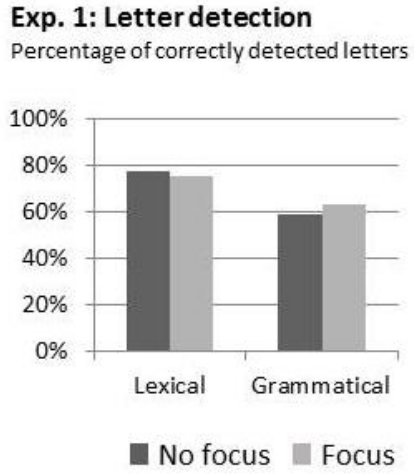

Figure 2 Results of the letter detection study (Exp. 1). The figure shows the percentage of correctly detected letters across all participants.

The mixed model showed a significant effect of corpus frequency of target words: The higher the frequency, the more letters were overlooked. There was no significant main effect of focus. There was no significant main effect of word category either, but there was a trend towards more letters being overlooked in grammatical compared to lexical items ($z = -1.931$, $p < 0.053$).

Importantly, even when taking the role of corpus frequency into account, the model also showed a significant interaction between word category and focus ($z = -2.038$, $p < 0.05$). Visual inspection of the raw data in Figure 2 does not show this clearly, but the interaction plot of the fitted model in Figure 3 shows a larger difference between the two grammatical conditions than between the two lexical ones. The interaction between focus and grammar indicates that the differences between grammatical items in focused and non-focused constituents is different from that between lexical items in focused and non-focused constituents, in accordance with our interaction hypothesis.

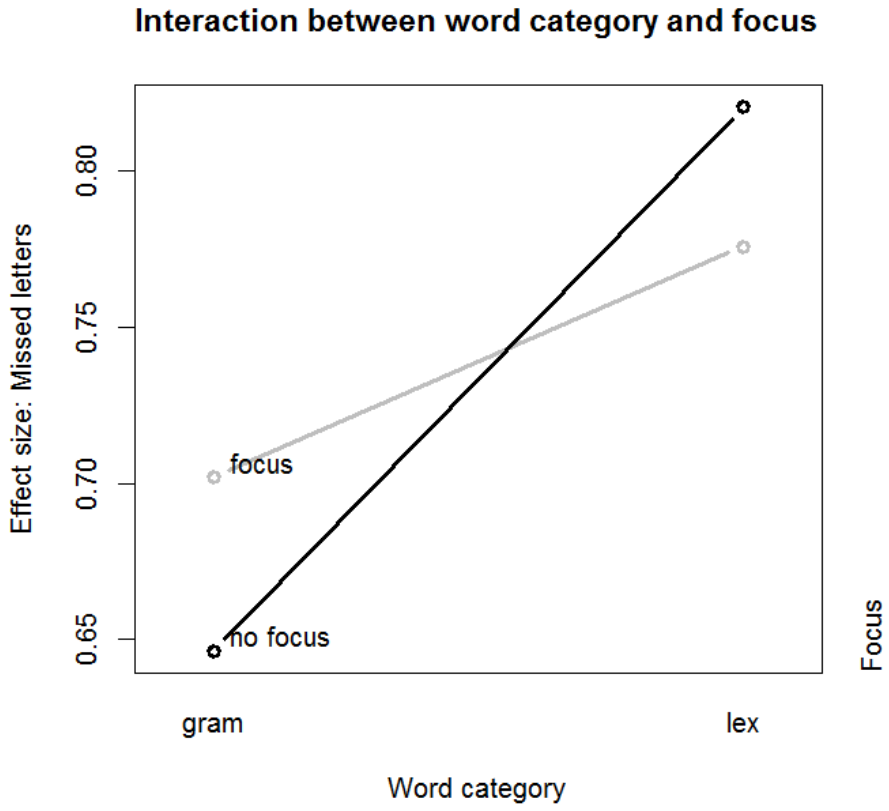

Figure 3. Illustration of the interaction between word category and focus

5. Exp. 2: Change blindness study

Psycholinguistic paradigms and measures differ with respect to sensitivity. We therefore conducted an additional experiment using a different psycholinguistic paradigm. Exp. 2 used the change blindness paradigm, which has attested sensitivity to focus manipulations. Previous change blindness studies have found reduced change blindness for focused words in clefts (Sturt et al., 2004), for stressed words (Sanford et al., 2006) and for visual highlighting provided by font differences (Sanford et al., 2006). Unlike the letter detection paradigm, which only measures attention to individual letters, the text-change design also provides a measure for depth of processing (Sanford, 2002). Readers often overlook changes in already processed information and may therefore be

blind to changes between two presentations of almost identical texts (Sturt et al., 2004). The level of change blindness is not just sensitive to whether information is old or new, but also to foreground vs. background differences. When changes occur in visually highlighted parts of a text, change blindness is reduced (cf. Sanford et al., 2006).

We designed Exp. 2 to test the three general hypotheses (cf. Section 3), which we translated into the following specific predictions:

1) Participants notice changes more frequently in lexical words than in grammatical words.
2) Participants notice changes more frequently in focused words than in non-focused words.
3) Focus and word category interact such that the effect of focus is different for grammatical words compared to lexical words.

5.1. Methods

5.1.1. Stimuli

We constructed 10 experimental sentences and 10 filler sentences in Danish (cf. Appendix Table A.2). The sentences were constructed to be long enough to elicit change blindness, but short enough to be read during the presentation time. Each experimental item occurred in four different conditions differing only with respect to focus and word category of the target word (cf. Table 2).

TABLE 2 The four conditions of Exp. 2 as they appeared during 1st presentation.

	Grammatical target	Lexical target

Target is part of focus	*Når man afleverer speciale, skal også <u>en</u> censor bedømme det.* When you submit your thesis, also an external examiner will grade it.	*Når man afleverer speciale, skal også <u>ens</u> censor bedømme det.* When you submit your thesis, also your external examiner will grade it.
Target is not part of focus	*Når man afleverer speciale, skal <u>en</u> censor bedømme det.* When you submit your thesis, an external examiner will grade it.	*Når man afleverer speciale, skal <u>ens</u> censor bedømme det.* When you submit your thesis, your external examiner will grade it.

The conditions are exemplified by an experimental item with the target *en*/*ens* (in English: *a*/*one's*) which is focused using the focus particle *også* ('also'). The target word (which is removed after the 1st presentation) is underlined in this table, but not in the experimental stimuli.

The design was within-subject – that is, all subjects read all 4 conditions of each item (i.e. there were 40 target trials per subject). In order to reduce learning effects, we changed the word material between the four presentations of an item. Each participant would read one of the versions from Table 2, but the other three conditions of that item used a different material for non-target words. For instance, one of the three alternatives to the item presented in Table 2 was *Når man afleverer synopsisopgaver, skal (også) en/ens eksaminator vurdere den* ('When you hand in synopsis assignments, (also) one's/an examiner must assess it'). Participants never read a sentence with the same word material more than once. All sentences were acceptable both with the target words included (as in the first presentation of the sentence) and with the target word omitted (as in the second presentation of the sentence).

Manipulation of word category: A list of the ten target words is shown in Appendix Table A.2. As in Exp. 1, we aimed at contrasting lexical and grammatical words that were similar or identical with respect to length (syllables), semantic domain, degree of semantic vagueness, orthography, position of the word in the sentence, position on the

text line and whether the item was (part of) new or previously introduced information.. There were two types of target words: determiners and verbs. The seven determiner items were presented as part of an NP constituent. One example is the grammatical determiner *en* ('a(n)') vs. lexical *ens* ('your') presented as part of the NP *en/ens censor* ('an/your external examinator') (cf. Table 2). The three verb items were verbs that could both function as grammatical verbs (auxiliaries) and as lexical verbs (full verbs). As in the case of Experiment 1, we judged it impossible to balance the word contrasts with respect to frequency. However, while for 5 of the 10 contrasts studied in Experiment 2, the grammatical word was much more frequent than the lexical one, for 4 contrasts (*nogle-mange, noget-meget, haft-haft, fået-fået*) the lexical word was considerably more frequent than the grammatical word, and for 1 contrast (*blevet-blevet*), there was only a small frequency difference (see Table A.2 in Appendix A).

Manipulation of focus: In the focus condition, the NP containing the determiner was focused by means of a focus particle, and verb items occurred with the negation *ikke* ('not').

5.1.2. Procedure

A total of 32 participants completed the experiment. All were university students (age 20-27, mean 22.3, 4 male and 28 female) with non-impaired vision, hearing and reading skills, and all were native speakers of Danish. All participants completed the experiment one at a time at an HP laptop. Participants were assigned one of four text versions semi-randomly, balancing the number of each text version in the experiment. The stimuli were presented visually on the screen, and responses were logged with the software PsychoPy (Peirce, 2007). The experimenter gave participants an oral introduction and also attended three practice trials. At the experiment proper, the participant was alone in

the room. The participants were told that the aim of the experiment was to test reading comprehension in a condition where they had to recollect words. All participants read 40 target sentences and 10 filler sentences. Following the procedure in Figure 4, participants were shown two presentations of a target sentence (first with the target word, then without it). Upon the second presentations, they used button presses to report if they detected any change in any of the words. If a change was reported, they were instructed to identify the change, i.e. to type the word that had been changed or omitted. Both types of responses, detection and identification of the change, were logged and further analyzed.

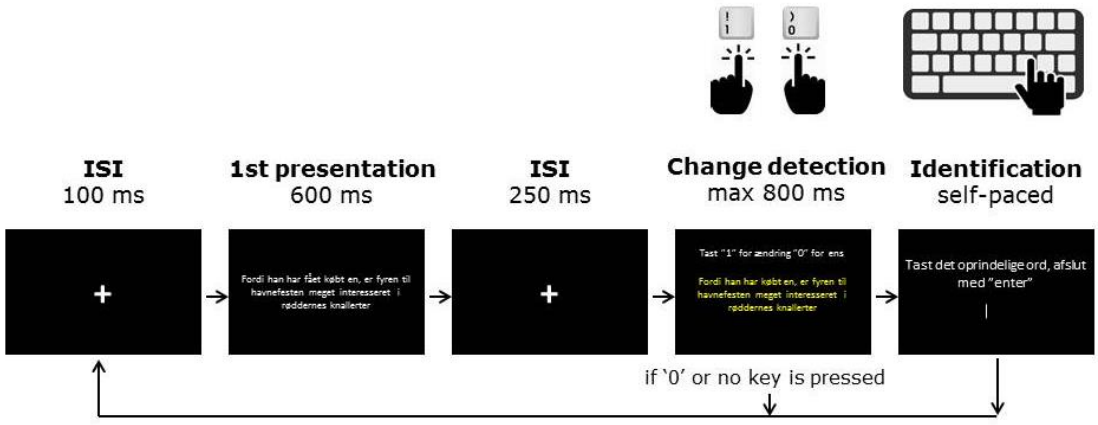

Figure 4 Procedure for change blindness study (Exp. 2). Each trial started with an ISI (Interstimulus Interval) with a white fixation cross shown for 100 ms. The first presentation of the sentence had a duration of 600 ms and was followed by an ISI of 250 ms. The second presentation of the sentence (the 'change detection' phase) had a duration of maximally 800 ms. The stimuli were the same as during the first presentation, but the font color was yellow instead of white, and one of the words was omitted. During the 'change detection' phase, the participant was instructed to press '1' to indicate a change and '0' to indicate that the two sentences were identical. Only if the participant pressed '1', the 'identification screen' was displayed, and the participant was prompted to type the word that appeared during the first presentation, but not during the second presentation.

The filler sentences consisted of different sentence types. For half of the filler trials, the second presentation contained a change to another word. Responses to fillers were logged, but not analyzed further. For 1 out of 6 trials, participants were asked to answer a comprehension question in order to ensure that they were reading for comprehension rather than memorizing. The questions were heterogenous and were not designed to enter an analysis. Therefore the answers were logged but not analyzed further.

5.3. Analysis

Two mixed model analyses were carried out following the same procedure as in Exp. 1. The dependent variables were number of detected changes (first model) and number of identified changes (second model). Both models included as random effects subject and item. The fixed effects were the log-transformed corpus frequency of target items as well as the main effects of the experiment: word category of the target word (lexical vs. grammatical), focus (focused vs. not focused) and the interaction between the two. As in Exp. 1, we tried to include other relevant variables including random slopes, but the model did not converge with any of these variables, and we therefore only included the variables mentioned above. The two winning models are reported in Appendix B (Tables B.2 and B.3).

5.4. Results

The rates for change detection and change identification are shown in Figure 5. Participants sometimes detected a missing word without being able to type it correctly, as evident from the larger rates in change detection compared to change identification.

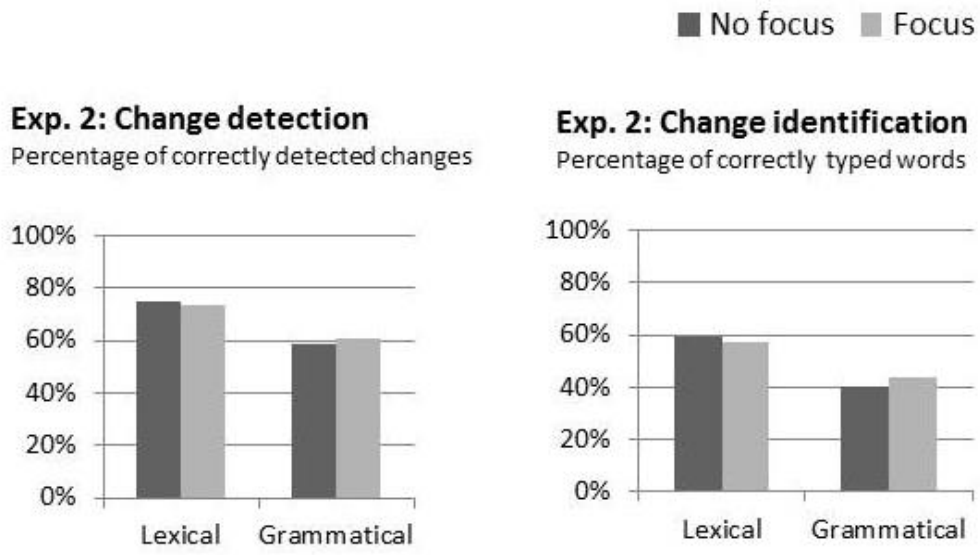

Figure 5 Results of Change blindness study (Exp. 2). The left bar chart shows the percentage of correctly detected changes during the 'change detection phase' of the experiment across all participants. The right bar chart shows the percentage of all words for which the change was not only detected by the participants, but in which the original word was also correctly identified (i.e. typed in correctly).

The effect of word category was significant for both change detection ($z = 4.320$, $p < 0.001$) and change identification ($z = -4.789$, $p < 0.001$): Participants detected and identified significantly more changes in the lexical condition than in the grammatical one. There were no significant effects of the other fixed effects, i.e. no effect of corpus frequency, no effect of focus and no interaction between focus and word category – neither for change detection, nor for change identification.

6. Discussion

Using different paradigms, Exp. 1 and Exp. 2 tested the same three general hypotheses: 1) that grammatical words are less attended to than lexical ones (*grammar-as-background hypothesis*), 2) that words in focused constituents are more attended to than those in non-focused constituents (*focus hypothesis*), and 3) that word category and focus interact (*interaction hypothesis*).

The grammar-as-background hypothesis was confirmed by exp. 2, and exp. 1 showed a trend in the same direction. Readers paid less attention to grammatical words than to lexical words, in line with Boye and Harder's (2012) assumption that grammatical elements are discursively secondary, and consequently less attended to.

The focus hypothesis was not confirmed by the experiments. Previous studies have suggested that the attention of readers is guided by focus (Bredart & Modolo, 1988; Price, 2008; Sanford et al., 2006; Sturt et al., 2004). The readers in Exp. 1 and Exp. 2, however, did not attend more to focused constituents than to non-focused ones.

The interaction hypothesis was confirmed by Exp. 1, but not Exp. 2. In Exp. 1, the focus manipulation was more pronounced for grammatical words than for lexical ones. Judging from Figure 3, letter detection rates for lexical words did not differ much across the focus conditions (focus vs. non-focus), but for grammatical words, readers more often noticed letters in focused constituents than in non-focused ones.

It is striking that the unconfirmed focus hypothesis is the least controversial of the three experimental hypotheses. In what follows we discuss possible reasons for these findings.

6.1. The grammar-as-background hypothesis

The change blindness study (Exp. 2) shows that omitted lexical words are detected more frequently than omitted grammatical words. Change detection rates have previously been interpreted as a proxy of depth of processing (Price, 2008; Sanford et al., 2006; Sturt et al., 2004). Our study is the first to find a difference in detection rates for grammatical vs. lexical elements. Building on the interpretations of previous change blindness studies, we suggest that word category guides depth of processing.

While Exp. 1 showed no significant effect of word category, it showed a trend indicating that the missed letter effect was more pronounced for grammatical than lexical words. This trend is in line with previous letter detection studies which found increased letter detection rates for "content words" compared to "function words" (Foucambert & Zuniga, 2012; Koriat, Greenberg & Goldshmid, 1991; Roy-Charland & Saint-Aubin, 2006; Rosenberg et al., 1985; Smith & Groat, 1979). Compared to these previous studies, Exp. 1 has a theoretically more well-founded basis, replacing the intuition-based distinctions between content and function words and between open- and closed-class words with a distinction between lexical and grammatical words based on criteria entailed by the ProGram theory in Boye and Harder (2012).

The confirmation of the grammar-as-background hypothesis is a strong argument for distinguishing between lexical and grammatical items. We suggest the following account of the difference:

1. Grammatical words are conventionalized as discursively secondary, while lexical words are conventionalized with the potential to be discursively primary.
2. In order to economize with cognitive processing resources, discursively prominent words (including words with the potential to be discursively primary) are visually more attended to and processed more deeply than non-prominent (including discursively secondary) words.

The ProGram theory does not define lexical items as discursively primary, but as *potentially* discursively primary. In a given context, lexical items can also be discursively secondary. Nevertheless, the detection rates of our experiments show a difference in discourse prominence between lexical and grammatical items. The reason for this, we believe, is that lexical items, because of their primary uses, are *entrenched* with a higher inherent discourse prominence than grammatical items.

6.2. The focus hypothesis

Neither of the two studies showed significant effects of focus on attention to letters (Exp. 1) and words (Exp. 2). It was not confirmed that readers attend more to elements in focused than in non-focused constituents. To our knowledge, there are no previous accounts of focus effects on letter detection (though Moravcsik & Healy, 1998, find effects of preposing), but for the change blindness paradigm, the effect of focus is well-established. It is therefore surprising that our change blindness study did not find increased detection rates for focused compared to non-focused constituents. Previous studies used a wide variety of attention capturing devices, including clefting (Sturt et al., 2004), pitch accent (Price, 2008; Sanford et al., 2006) as well as non-linguistic visual highlighting (Sanford et al., 2006). Our text-change study used a different kind of focus marking, focus particles, although the letter detection study also used clefting. Taken together, these focus manipulations may have been more subtle than those used in previous studies, and this may explain why our experiments did not confirm the focus hypothesis.

Alternative or supplementary explanations may be found in two other aspects of our study designs. Firstly, the meanings of our target words were relatively abstract or semantically bleached. They may have been too abstract or semantically bleached to attract attention to a degree which is affected – to a measurable extend – by focus differences (cf. Sturt et al., 2004: 884). Earlier studies of focus contrasts employed target words whose meaning were relatively concrete compared to the words in our study. For example, we employed words like the verb *have* (‘have’), whereas Sturt et al. (2004) used target nouns such as *beer* and *cider*.

Secondly, our target words were not independently focused (because grammatical words cannot be focused) but were part of focused constituents (see

Section 3). We may reasonably expect that words do not attract the same share of attention when they are only part of the focus domain as when they constitute the entire focus.

Our results might be taken to suggest that the lexical vs. grammatical distinction is a stronger indicator of discourse prominence than the distinction between focus and non-focus: firstly, only the grammar vs. lexicon hypothesis was confirmed; secondly, our results show that even grammatical words in focused constituents attract less attention than lexical words in non-focused constituents. This conclusion would be highly surprising in light of the fact that the grammar-as-background hypothesis is far more controversial than the focus hypothesis. Our study was not designed with the purpose of measuring whether word category or focus is better at attracting attention, however, and we believe that the disconfirmation of the focus hypothesis is a design artifact.

6.3. The interaction hypothesis

Exp. 1 showed an interaction between focus and the lexicon-grammar distinction. This interaction suggests that, as claimed by the ProGram theory, the grammatical-lexical distinction is linked to attention, just as focus is. Both focus and the grammatical-lexical distinction are means for prioritizing and directing attention.

Compared to target letters in lexical words, the target letters in grammatical words gain more attention from being part of a focused constituent. This does not mean that the grammatical words become focused themselves: they cannot be focused (cf. Section 2); accordingly, even when they are found in focused constituents, they receive less attention than lexical words. What it means is only that when a constituent is focused, all parts of the constituent gain attention.

A plausible account of the fact that grammatical words gain more attention by occurring in a focused constituent than lexical words, is that they have a much bigger potential for gaining attention because they are inherently less prominent than lexical ones.

This interaction was only found in Exp. 1. The change detection and change identification measures in Exp. 2 did not show the same sensitivity. The difference may indicate that the interaction occurs at an early stage of processing. While letter detection is an online measure, change detection and change identification may reflect later processing steps. Further research on online and offline differences may clarify whether word category and focus interact at early stages only.

7. Conclusion

Readers are better at detecting changes made to the lexical words, and they showed a trend towards being better at detecting specific letters in lexical words than in grammatical words. This supports our hypothesis that the prioritization of processing resources mirrors that of discourse prominence in language use, with grammatical words being coded as discursively secondary.

We found no main effect of focus for either of the two experiments, which may be due to the type of focus-marking, the extensive scope of the focus or to targets that were semantically vague in both the grammatical and lexical conditions. In spite of that, Exp. 1 showed an interaction, indicating that target letters in grammatical words (compared to lexical words) gain more attention from being part of a focused constituent.

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Declarations of interest: None

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Appendices

Appendix A: Experimental stimuli

Some target word forms in Exp. 1 and Exp. 2 cover more than one use, so we manually corrected the frequency measures to only include the relevant instances. For instance, the word *ens* has a frequency of 5123 in KorpusDK (DSL, 2007). In our study, *ens* carried a pronominal meaning (‘one’s’), but *ens* can also mean ‘alike’ as in *de er ens* ‘they are alike’. To only include relevant pronominal uses in our frequency measure, we extracted 500 random occurrences of *ens* from KorpusDK, counted the number of tokens that were relevant to our study (i.e. omitting the *alike* uses) and were left with 339 relevant pronominal tokens. The fraction of relevant tokens was then multiplied by the total number of *ens* in the KorpusDK frequency count (5123). Similarly, the target word *dit* was used as a prenominal pronoun in our study meaning ‘your’, but the total count of *dit* in KorpusDK also includes irrelevant non-prenominal uses, such as *valget er dit* (‘the choice is yours’) and *dit og dat* (‘this and that’). Using the same procedure as for *ens*, we therefore manually corrected the frequency measures to only include only relevant uses. For frequency calculations of *ens, denne, dette, dit, mange, meget, nogle* and *noget*, only prenominal uses were considered relevant. For *det, den, en, et*, only grammatical uses were considered relevant, and for the verbs *haft, blevet, været* and *fået* we did separate calculations for auxiliaries and full verbs.

Table A.1: List of matched item pairs used in Exp. 1 (letter detection task)

Target letter	*Grammatical*	*Lexical*	*Context*	*Frequency (relevant use)*
n	*en* indefinite article singular common gender	*ens* 3rd person singular possessive pronoun	*men (lige netop) en/ens handske* but (exactly) a/one's glove	968292/3487
n	*en* indefinite article singular common gender	*Sten* male proper name	*en mand/Sten,* a man/Sten (Focus manipulation: cleft)	968292/697
t	*et* indefinite article singular neuter gender	*Ediths* female proper name	*(kun) et/Ediths skrantede helbred* (only) a/Edith's ailing health	335146/16
n	*den* definite article singular common gender	*denne* demonstrative adjective common gender	*den/denne saftiggrønne, nyklippede plæne* the/this juicy-green freshly mown grass (Focus manipulation: cleft)	510375/64682
n	*den* definite article singular common gender	*denne* demonstrative adjective common gender	*(netop) den/denne nærmest underudviklede højrearm* (exactly) the/this almost underdeveloped right arm	510375/64682

n	*den* definite article singular common gender	*denne* demonstrative adjective common gender	*(især) al den/denne gamle snak* (espeically) all the/this old talk	510375/64682
t	*det* definite article singular neuter gender	*dette* demonstrative adjective neuter gender	*(netop) det/dette legemlige besvær* (exactly) the/this bodily discomfort	315315/34580
t	*det* definite article singular neuter gender	*dit* 2nd person singular possessive pronoun neuter gender	*(lige præcis) det/dit blomstrede krus* (exactly) the/your floral mug	315315/6537
t	*noget* indefinite adjective singular neuter gender	*meget* 'much' neuter gender	*noget/meget skammeligt stads* some/much gross stuff (Focus manipulation: cleft)	75004/113204
n	*nogle* indefinite adjective plural	*mange* 'many'	*nogle/mange timer* some/many hours (Focus manipulation: cleft)	59771/96469
n	*nogle* indefinite adjective plural	*mange* 'many'	*nogle/mange spøjse ting* some/many weird things (Focus manipulation: cleft)	59771/96469
t	*haft* 'had' as auxiliary	*haft* 'had' as full verb	*Jeg har engang (netop) haft plantet/haft en*	365/16067

			hasselbusk som den. I have once (exactly) had planted/had a hazel bush like that.	
t	*blevet* 'been'/'become' as auxiliary	*blevet* 'been'/'stayed' as full verb	*Det er (udelukkende) blevet omtalt/blevet mellem vejens kvinder.* Is has (solely) been discussed/stayed among the women in the street.	22316/16329
t	*blevet* 'been'/'become' as auxiliary	*blevet* 'been'/'stayed' as full verb	*Anne er (bare) blevet boende/blevet hos sin mor.* Anne has (just) been living/been with her mum.	22316/16329
t	*været* 'been' as auxiliary	*været* 'been' as full verb	*Den har vist (kun) været parkeret/været i deres indkørsel* It seems it has (only) been parked/been in their driveway	12127/67499
t	*fået* 'got' as auxiliary	*fået* 'got' as full verb	*Jeg har (kun) fået købt/fået et par nye krus.* I have (only) got bought/got a pair of	4238/21192

		new mugs.	

Table A.2. List of matched item pairs used in Exp 2. (text-change study). To avoid learning effects, each participant saw each item pair with four different kinds of context (cf. Christensen 2015a for a detailed description of the stimuli). Only the context used in version A is shown here, but there was also a version B, C and D which featured the same target word and the same focus particle, but with different words in the context surrounding the target word (cf. the materials section for Exp. 2). These versions were distributed between participants. For instance, one group of participants would read item 1 in version A with *også en* ('also a'), the second group of participants would read item 1 in version A with *også ens* ('also one's), the third group would read version A with *en* ('a' without a focus particle) and the forth group of participants would read version A with *ens* ('one's' without a focus particle).

Target	*Lexical*	*Version A*	*Frequency (relevant use)*
en indefinite article, singular, common gender	*ens* one's	*Hvis man som studerende afleverer skriftlige opgaver, skal (også) en/ens censor inddrages i bedømmelsen.* If as a student you submit written assignments, (also) an/one's external examiner must be involved in the assessment.	968292/3487
et (a/an) indefinite article, singular, neuter gender	*Eas* Ea's	*Peter har brugt frøken Jensens kogebog og (også) et/Eas spækbræt under tilberedningen af spaghetti med kødsovs.* Peter has used miss Jensens' cookbook and (also) a/Ea's chopping board during the	335146/2

		preparation of spaghetti & meatballs.	
nogle Some	*mange* many	*Drengene fra byen gav landmandens høns (netop) nogle/mange grønne æbler på deres årlige æblerov.* The town boys gave the farmer's hens (just) some/many green apples while scrumping.	59771/96469
noget some	*meget* much	*Der er blevet konfiskeret (især) noget/meget udeklareret vin på gårsdagens razzia som skattevæsnet har foretaget.* (Epecially) some/much wine was confiscated during yesterday's raid undertaken by the tax authorities.	75004/113204
det definite article, singular, neuter gender	*dette* demonstrative pronoun, singular, neuter gender	*Enkelte af hans bekendte var vidner til (netop) det/dette blændende vid hos komponisten i hans store jugendinspirerede hjem.* Some of his acquaintances witnessed (exactly) the/that brilliant wit of the composer in	315315/34580

		his Art Nouveau-inspired home.	
den definite article, singular, common gender	*din* possessive pronoun, singular, common gender	*Men (lige præcis) den/din lille mor på plejehjemmet har du glemt at invitere og så på juleaften, råbte Petras far rasende.* But you have forgotten to invite (exactly) the/your little mother at the nursery home even though it is Christimas eve, Petra's dad yelled furiously.	510375/15906
de definite article, plural	*disse* demonstrative pronoun, plural	*Når deres kristne elever ytrer (præcis) de/disse radikale ideer, slår flere skolelærere alarm for at undgå ballade.* When their Christian students utter (precisely) the/these radical ideas, the teachers sound the alarm to avoid trouble.	552474/34836
fået got (past participle auxiliary verb)	*fået* got (past participle full verb)	*Fordi hun (ikke) har fået (købt) en, er pigen der er med sin far i Tivoli meget interesseret i sælgerens fine balloner.* Because she has (not) accomplished	4238/21192

		buying/received one, the girl who is with her dad in Tivoli, is very much interested in the salesman's fine ballons.	
haft had (past participle auxiliary verb)	*haft* had (past participle full verb)	*Bogen om hjernens anatomi har professoren (ikke) haft (læst), men han synes også der er mange andre bøger der er lige så interessante.* The professor has (not) accomplished reading/owned the book about brain anatomy, but he also thinks many other books are just as interesting.	365/16067
blevet auxiliary in passive construction	*blevet* stayed (past participle)	*Ifølge Ib der bor ved havnen, burde lystjollerne fra kapsejladsen (ikke) være blevet (søsat) der, og fiskerne burde kunne fiske i den.* According to Ib, who lives by the harbor, the dinghies from the sailing race should (not) have been (launched) there, and the fishers should be allowed to fish there.	22316/16329

Table B.1. Mixed model analysis for missed letters in the letter detection task of Exp. 1. A positive estimate indicates that more letters were missed. Significant effects are marked in the right-most column with 1 asterix (*) for $p < .05$, 2 asterices (**) for $p < .01$ and 3 asterices (***) for $p < .001$.

Random effects			
Groups	Name	Variance	Standard deviation
Subject	(*intercept)*	0.8026	0.8959
Item	(*intercept)*	0.7248	0.8513
Total observations: 1344, 84 subjects and 16 items			

Fixed effects					
	Estimate	Standard error	*z*-value	Pr(>|z|)	CI
(Intercept)	-2.326	0.5419	-4.294	1.76e-05 ***	-3.44, -1.28
Word category (lexical)	-0.3853	0.1995	-1.931	0.05348	-.78, .01
Focus (no focus)	0.2542	0.1777	1.431	0.15255	-.1, .6
Log. frequency	0.1439	0.0414	3.475	0.00051***	.06, .23
Interaction: Focus and Word category	-0.5334	0.2685	-1.987	0.04696 *	-1.07, -.002

Table B.2. mixed model for change detection in Exp. 2, i.e. whether the change was detected. Significant effects are marked in the right-most column with 3 asterices (***) for $p < .001$.

Random effects			
Groups	Name	Variance	Standard deviation
Subject	(*intercept)*	0.2540	0.5040
Item	(*intercept)*	0.5609	0.7489

Total observations: 1280, 32 subjects and 10 items

Fixed effects					
	Estimate	Standard error	*z*-value	Pr(>|z|)	CI
(Intercept)	0.5671	0.4760	1.191	0.234	-.38, 1.53
Word category (lexical)	0.5671	0.4760	4.320	1.56e-05 ***	.45, 1.2
Focus (+ focus)	0.1064	0.4760	0.612	0.541	-.24, .45
Log. frequency	-0.0140	0.0347	-0.404	0.686	-.08, .05
Interaction: Focus and Word category	-0.1629	0.2598	-0.627	0.531	-.68, .35

Table B.3 Mixed model for Change identification in Exp. 2, i.e. whether the correct word was typed. Significant effects are marked in the right-most column with 3 asterices (***) for $p < .001$.

Random effects			
Groups	Name	Variance	Standard deviation
Subject	(*intercept)*	0.6577	0.8110
Item	(*intercept)*	0.6454	0.8034
Total observations: 1280, 32 subjects and 10 items			

Fixed effects					
	Estimate	Standard error	*z*-value	Pr(>|z|)	CI
(Intercept)	0.1605	0.4618	0.348	0.728	-.76, 1.08
Word category (lexical)	-0.9094	0.1900	-4.789	1.67e-06 ***	-1.29, .54
Focus (+ focus)	-0.1741	0.1779	-0.979	0.328	-.52, .18
Log. frequency	0.0323	0.0298	1.084	0.278	-.03, .09
Interaction: Focus and Word category	0.2725	0.2534	1.075	0.282	-.23, .77