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Grammar, gender and demonstratives in lateralized imagery for sentences

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Abstract

We investigated biases in the organization of imagery by asking participants to make stick-figure drawings of sentences containing a man, a woman and a transitive action (e.g. *She kisses that guy*). Previous findings show that prominent features of meaning and sentence structure are placed to the left in drawings, according to reading direction (e.g. Stroustrup & Wallentin, 2018). Five hundred thirty participants listened to sentences in Danish and made 8 drawings each. We replicated three findings: 1) that the first mentioned element is placed to the left more often, 2) that the agent in the sentence is placed to the left, and 3) that the grammatical subject is placed to the left of the object. We further tested hypotheses related to deixis and gender stereotypes. By adding demonstratives (e.g. Danish equivalents of *this* and *that*), that have been found to indicate attentional prominence, we tested the hypothesis that this is also translated into a left-ward bias in the produced drawings. We were unable to find support for this hypothesis. Analyses of gender biases tested the presence of a gender identification and a gender stereotype effect. According to the identification hypothesis, participants should attribute prominence to their own gender and draw it to the left, and according to the stereotype effect participants should be more prone to draw the male character to the left, regardless of own gender. We were not able to find significant support for either of the two gender effects. The combination of replications and null-findings suggest that the left-ward bias in the drawing experiment might be narrowly tied to left-to-right distribution in written language and less to overall prominence. No effect of handedness was observed.

Keywords: Imagery, reading direction, grammar, gender, demonstratives

1. Introduction

1.1. Left-right bias in imagery caused by reading

Exposure to language and linguistic structure, both written and spoken, modulates cognitive functions that have hitherto been considered non-linguistic (Athanasopoulos et al., 2015; Boiteau & Almor, 2017; Chatterjee, Southwood, & Basilico, 1999; Coventry, Griffiths, & Hamilton, 2014; Dobel, Diesendruck, & Bölte, 2007; Fuhrman & Boroditsky, 2010; Gudde, Coventry, & Engelhardt, 2016; Hendricks & Boroditsky, 2017; Kranjec, Lehet, Bromberger, & Chatterjee, 2010; Levinson, 2003; A Maass & Russo, 2003; Román, El Fathi, & Santiago, 2013; Stroustrup & Wallentin, 2018; Tylén, Weed, Wallentin, Roepstorff, & Frith, 2010; Winawer et al., 2007).

One of the strongest demonstrations of this modulation is the left-to-right bias observed in many different tasks. An early demonstration of this bias was provided by Chatterjee and co-workers (1999) who found that English speakers have a tendency to imagine the content of simple active sentences as evolving from left to right. Participants were faster at picture-sentence matching if images have left-to-right implied motion and if the agent was depicted on the left. This bias has since been interpreted to be related to reading direction (Boiteau & Almor, 2017; Dobel et al., 2007; Fuhrman & Boroditsky, 2010; A Maass & Russo, 2003; Anne Maass, Suitner, & Nadhmi, 2014; Román et al., 2013). A simple way to study this influence on imagery is to ask participants to make drawings of linguistic content (Dobel et al., 2007; A Maass & Russo, 2003; Stroustrup & Wallentin, 2018). With this method, it has been found that people from cultures with left-to-right reading direction consistently depict the first named item and the agent of the sentence to the left in the drawing (Dobel et al., 2007; A Maass & Russo, 2003; Anne Maass et al., 2014; Stroustrup & Wallentin, 2018). Recently, Stroustrup and Wallentin (2018) also found that grammatical category plays a role when Danish speakers make drawings of verbally depicted scenes. The grammatical

subject is more often placed to the left, regardless of whether it is the first mentioned grammatical element, which might be suggestive of a general left-ward bias for prominent features.

1.2. Linguistic allocation of attention

Stroustrup and Wallentin (2018) interpreted these findings within an attentional framework. Word order and grammatical categories are known to play a role in the construction of discourse, and in turn in distributing attention over different parts of linguistic expressions crucial to discourse comprehension. The first mentioned element in a sentence has a prominent role in meaning construction (Gernsbacher & Hargreaves, 1988) and instantiates the *current* “topic” or “theme” (e.g. Halliday & Matthiessen, 2004, p. 59). The grammatical subject, on the other hand, may be said to point to the *recurrent* discourse topic (Givón, 1984, p. 138). The grammatical subject thus often indicates what is important over a longer time frame (see also Frazier, 1999 for a discussion of sentence and discourse topic).

Sentence topic, agency and grammatical subject are often collapsed in subject-initial utterances in languages such as English and Danish, and the focus of attention is therefore prototypically anchored at the beginning of the sentence. Word-order variation, however, allows speakers to separate grammatical subject and first-mentioned element and thus distribute attention across multiple elements of the sentence. The graded distribution of attention across different linguistic attractors (Talmy, 2007) has been termed “nested” attention (Talmy, 2011). In certain situations, this may be beneficial in order to make a temporary detour from the obvious or recurrent topic. Language thus allows for different forms of divided or nested attention, and these processes are also likely to take place at the sentence level, where different sentence elements attract attention to a different degree. Grammar is a contributor to this process. Knowledge of prototypical linguistic

structures is stored in long-term memory and forms the basis for predictive processing (Kuperberg & Jaeger, 2015). It is a general finding across research on attention, that unexpected and prominent events attract attention (Fritz, Elhilali, David, & Shamma, 2007; Parmentier, Turner, & Perez, 2014). The same is arguably the case for non-prototypical linguistic utterances (DeLong, Troyer, & Kutas, 2014; Kristensen & Wallentin, 2015; Kuperberg & Jaeger, 2015). In the absence of a discourse context, the listener is forced to come up with an interpretation based on episodic memory or world-knowledge for why structure deviates from the default. This taxes attentional resources.

Stroustrup and Wallentin's study (2018) provided empirical evidence supporting that grammatical categories serve a role in distributing attention across a sentence, and that the grammatical subject is given prominence in imagery, as displayed in drawings of sentence content, where the grammatical subject tends to be drawn left of the object. In the current experiment, our first aim was to replicate this effect in a larger sample.

Danish is well-suited as a language to study the effect of grammatical categories on imagery, as it allows both subject-verb-object (SVO) and object-verb-subject (OVS) word-order and thus makes it possible to disentangle word-order-based topic and grammar-based topic (see Table I for examples). In order to further investigate the degree to which attentional prominence in general could be linked to left-ward positioning in imagery, we tested the effects of two additional discourse elements: 1) Deictic linguistic markers, such as demonstratives, which are known to function as attentional pointers (Diessel, 1999, 2006) and 2) Different effects of gender identification, which could also be hypothesised to work as an attractor of attention. Below we introduce each of these two research questions separately.

1.3. Demonstratives and prominence

Demonstratives are function words (e.g. in English: *this/that* and *here/there* are demonstratives) that are used to indicate location in a contextual space during discourse (e.g. Rocca, Wallentin, Vesper, & Tylén, 2018). According to Diessel (1999, 2006), demonstratives are linguistic universals that serve to coordinate the interlocutors' joint focus of attention on objects or locations in the speech situation (*exophoric* use), but may also function to organize the information flow in the ongoing discourse (*endophoric* use).

All languages have at least two types of demonstrative terms: a proximal term (e.g. *this/these* in English) roughly expressing that the intended referent is close to the speaker (or rather, the deictic center), and a distal term (*that/those* in English) expressing that the intended referent is at some distance from the deictic center (Diessel, 1999, p. 2; Kemmerer, 1999).

While the spatial dimension is prominent in exophoric use, the contrast between proximal and distal demonstrative forms is likely to reflect more than just a *near* vs. *far* contrast. The attentional status of the referent, and its saliency relative to the physical or linguistic context of utterance are also encoded in the distinction between proximal and distal demonstrative forms. For instance, Coventry and colleagues (2014) have shown that visible objects, i.e. objects available to the speaker's attention, are more likely to be indicated via a proximal demonstrative than hidden objects.

Based on corpus data, Kirsner (1979, p. 361-364) suggested that Dutch proximal demonstratives are more often associated with referents that are perceived to be important by the speaker than distal demonstratives, e.g. proximal demonstratives are more frequently used for human referents than distals, and they are used more to refer to singular referents than distal demonstratives. They are

used more to refer to named individuals and more often occur in the grammatical subject position than distal demonstratives. A proximal demonstrative reference (e.g. *this house*) may thus imply prominence and therefore function as a stronger attentional attractor than a distal demonstrative (*that house*).

Additionally, Gundel et al. (1993) studied referring expressions, including demonstratives, according to a “givenness” hierarchy (Chafe, 1976, 1994). According to this view, the degree to which an element of discourse is known or “activated” (i.e. salient and attention demanding) by the interlocutors affects the referring expressions used. The use of a definite article (e.g. *the house*) signals that the intended referent is “uniquely identifiable”, while the indefinite article (e.g. *a house*) signals that it is new and requires attention. A similar asymmetry is observed for demonstratives. The use of a distal demonstrative can both signal that the referent is familiar (i.e. known and thus less attention demanding) or “activated” (i.e. salient and attention demanding), while the use of a proximal demonstrative always signals that the referent has the attention demanding status of being “activated”.

Piwek and co-workers’ (2008) notion of accessibility is roughly equivalent to givenness, but adds to it a temporal dimension. The further away in time a discourse element was mentioned, the lower its accessibility. When a speaker uses a referring expression, she is signalling to the hearer how accessible she believes the mental representation of the intended referent is for this specific hearer in this particular context. Along a similar line, Strauss (2002) suggests that the *this/that* contrast in English reflects the degree of attention that the hearer is asked to pay to the referent. *This* is argued to be a high focus demonstrative signaling important, new information, whereas *that* is argued to represent medium focus and the unmarked *it* represents low focus.

Together, these findings suggest that the proximal/distal distinction might map onto a hierarchical

distinction in the attentional status of the referent: elements referred to by a proximal expression are bound to gain higher prominence in imagery than an element referred to by a distal expression.

Given the well-established left-ward bias in imagery for prominent sentence elements, the attentional hierarchy between proximal and distal demonstratives might transfer to an asymmetrical distribution of sentence elements singled out by proximal and distal demonstratives across the left-right axis in drawings.

In our experiment, we tested this hypothesis on Danish speakers, using Danish sentences as stimuli. In spoken Danish, the most common demonstratives used both as determiners and as nominals, are a combination of non-anthropomorphic personal pronouns “den” or “det” (in English: “it”) and a spatial adverb, either “her” or “der” (English: here/there). This system roughly corresponds to the English “this” or “that”. However, spatial adverbs can also be coupled to gendered third person pronouns, e.g. “ham/hende her/der” (English: him/her here/there) (Hansen & Heltoft, 2011, pp. 556-564). The gendered pronouns in Danish are case marked, and the demonstrative construction is almost always in the oblique case (e.g. “hende her” [her here]). Demonstratives therefore usually appear in the object position in sentences (see Table I for examples). This was also the case in the present experiment, where the demonstrative was thus always coupled with the sentence item appearing in the object position.

1.4. Gender and prominence

1.4.1 Two types of gender biases

Gender identification may, as mentioned above, also be hypothesized to influence the allocation of linguistic attention. Gendered pronouns (like “he” and “she”) are the only case marked linguistic elements in Danish (as is also the case for English). In their previous experiment on grammatical roles and left-ward bias, Stroustrup and Wallentin (2018) used gendered personal pronouns in

stimulus sentences in order to generate distinguishable entities (males and female characters) with unambiguous grammatical roles in the participants' drawings. This, however, also raises the question of whether gender itself modulates the prominence of linguistic items. If the left-to-right bias seen in drawings is due to attentional attractors, then the presence of a potential asymmetry in the way that the two genders attract attention may also influence how imagery is constructed. Gender biases can be hypothesized to influence the allocation of attention in two ways. On the one hand, a subject-independent bias towards a specific gender might exist. On the other hand, an own-gender bias could be hypothesized, sentence elements reflecting the same gender as the comprehender's might be perceived as more salient than other-gender elements.

1.4.2 A subject-independent prominent gender bias?

Gender biases exist among both adults (Koenig, Eagly, Mitchell, & Ristikari, 2011) and adolescents, such as high school students (Chalabaev, Sarrazin, Fontayne, Boiché, & Clément-Guillotin, 2013; Steffens, Jelenec, & Noack, 2010; Ter Bogt, Engels, Bogers, & Kloosterman, 2010), who were the participants in the previous and present study. In the Danish high school system, more than 60% of the students are female, according to Danmarks Statistik (www.statistikbanken.dk), while in a large corpus of written Danish texts (korpusDK, see www.ordnet.dk), the pronoun *han* (*he*) is twice as frequent as the pronoun *hun* (*she*). The scientific literature on gender biases displays a variety of effects in educational contexts, e.g. in studies of classroom talk it has been found that boys tend to monopolize both physical and verbal space, and that teachers tend to give more time and attention to boys (Coates, 2013, p. 210). Could such experiential asymmetries cause participants to have an asymmetric ordering of gender roles in imagery as well?

Gender biases have also been directly observed in the linearization in written language. Studies have found that when mentioning both men and women at the same time in texts, men tend to be named before women (as in the previous sentence). This has been found in English language textbooks (Lee, 2016; Porreca, 1984), online grammar guides (Amare, 2007) and in academic publications (Willis & Jozkowski, 2017) where graphs also usually display the male gender to the left of the female gender (Hegarty & Buechel, 2006).

Images of male-female pairs also find that males tend to be depicted to the left of females, especially, when they are perceived to exhibit greater levels of agency, in accordance with reading direction (Anne Maass, Suitner, Favaretto, & Cignacchi, 2009). In general, men are often evaluated as being more energetic and/or agentic than women (Abele, 2003; Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006).

Direct studies of this tendency (Carnaghi, Piccoli, Brambilla, & Bianchi, 2014; Hegarty, Watson, Fletcher, & McQueen, 2011; Kesebir, 2017) found that when participants were presented with a printed list of pairs of gender stereotyped occupations (e.g. “hairwasher-welder” or “welder-hairwasher”) and had to indicate whether they preferred the male-female order or the female-male mirror order, most participants preferred the male-female order, regardless of whether the occupations differed in status. Such findings have been used to argue that word order is a means of expressing and perpetuating gender stereotypes (Kesebir, 2017).

Due to such biases, listeners may therefore tend to put the male character in a sentence in the foreground, regardless of the content. This could be reflected in the drawing experiment as a general tendency to place the male character to the left. Stroustrup and Wallentin (2018) observed a

non-significant tendency for this. The lack of statistical effect could have been related to lack of experimental power. The effect could be weak when measured using the drawing method, e.g. due to the fact that the relatively slow procedure of producing drawings yield fewer trials per participant. A larger sample could potentially reveal if such an effect can be found using the drawing method.

1.4.3 Own-gender bias

As mentioned above, an own-gender bias could also be hypothesized to play a role in guiding attention in imagery for sentences with gendered content. Children are known to exhibit own-gender biases in memory (Signorella, Bigler, & Liben, 1997). Face recognition is another field where an own-gender bias has often been observed (Herlitz & Lovén, 2013; Lovén, Herlitz, & Rehnman, 2011; Rehnman & Herlitz, 2006; Wolff, Kemter, Schweinberger, & Wiese, 2013; Wright & Sladden, 2003) (but see Myers, 2015 for a different perspective). Along the lines of these findings, participants could be more prone to draw their own gender on the left, granting it more prominence than the opposite gender.

1.5. Hypotheses

In summary, we hypothesized that prominent sentence features would have a larger tendency to be displayed to the left when participants were asked to draw the contents of a sentence. Together, the following features were hypothesized to be prominent and the hypothesis that they would be drawn to the left thus formed the basis for the current experiment:

- A) First named person in a sentence (e.g. *she* is hit by that guy)
- B) Agent in a sentence (e.g. *she* is hit by *that* guy)
- C) Grammatical sentence subject (e.g. *she* is hit by that guy)

- D) Proximal object (e.g. *she is hit by **this** guy*, given that demonstratives in Danish are usually presented in the oblique case, this effect would display itself as an interaction between demonstrative adverb and grammatical subject, see table I for Danish examples)
- E) Stereotypical prominent gender (The male gender may still be dominating our minds, and the male character should thus be drawn to the left more often)
- F) Own gender: Participants may focus more on their own gender and thus draw it to the left more often than the opposite gender.

2. Materials and Methods

2.1 Participants

The project was reviewed by the Human Subjects Committee at the Cognition and Behavior Lab at Aarhus University and was found to pose no ethical concerns. The experiment conducted in two Danish secondary schools (Stenhus Gymnasium and VUC Aarhus). Five-hundred-thirty students (305/225 female/male; 47/472/8 left-handed/right-handed/ambidextrous; median age: 17 years - range: 14-52) participated. 474 participants reported having Danish as their first language, 46 reported not having Danish as their first language, 10 did not report any language info. Given that all participants were enrolled in the Danish educational system and thus should be exposed to the left-to-right reading habit, we decided to include all in our data analyses.

The experiment took place during class hours under the supervision of class teachers. No sensitive data were collected. Prior to the experiment, participants were informed about general aspects of the experiment, including that participation was voluntary and that there would be no correct or

incorrect answers. They all signed an informed consent form. After the experiment, classes were given a thorough debriefing on the project.

2.2 stimuli and materials

We adopted a mixed-effects experimental design, where some conditions were sampled repeatedly within participants and some conditions were sampled between participants. The experimental sentences were constructed using 11 Danish transitive verbs: “slår” [hits/smacks], “sparker” [kicks], “kysser” [kisses], “angriber” [attacks], “forfølger” [follows], “skubber” [pushes], “udpeger” [points out], “skyder” [shoots], “fanger” [catches], “krammer” [hugs], “rammer” [hits/strikes].

Verbs were chosen on the basis of being clearly imageable, having a simple agent-patient relationship with a default scenario unfolding in the horizontal plane. Sentences were created for each verb by combining it with case marked pronouns describing a male and a female character:

Nominative: “han” [he], “hun” [she]. *Accusative*: “ham” [him], “hende” [her]. *Adverbs (proximal/distal)*: “her” [here], “der” [there].

Danish allows both subject-verb-object (SVO) and object-verb-subject (OVS) word order (Kristensen, 2013; Kristensen & Wallentin, 2015). By including active and passive sentence forms, we constructed 2x2x2x2 sentence types for each verb as illustrated in table I.

**** TABLE 1 AROUND HERE ****

A total of 11 x 16 sentences were constructed (i.e. 11 verbs x 16 types). Based on the experiences from Stroustrup and Wallentin's previous experiment (2018), we decided that in order to prevent attentional fatigue, participants should not make more than eight drawings each. We therefore divided the sentences into 22 stimulus sets of 8 sentences. Participants were tested in 22 groups, and each group was tested on one stimulus set of 8 sentences. Within each stimulus set, the same verb and construction could only occur once, making sure that the participants were subjected to sentences with a minimum level of repetition, while also ensuring that all verbs were coupled with all constructions exactly once across the groups. The combination of sentence type and verb within each stimulus set as well as the order of presentation was determined by a randomization protocol executed in MatLab.

Sentences were recorded using a NSSpeechSynthesizer instance on macOS Sierra (Version 10.12.2) interfaced via the library *pyttsx* in Python 2.7, in order to standardize pronunciation as much as possible. Sound was recorded using SoundflowerBed (v 2.0.0) from the internal speakers, so to ensure maximum sound quality. Start and stop of each recording was automated using AppleScript commands embedded in the Python script used for speech synthesis, with the duration of each file thus being accurately time-locked to the start and end of the utterance. During the experiment, sentences were played using a standard lap-top computer with portable speakers.

Prior to the experiment, participants were each given a set of papers. The front page asked the participants to fill out information about own gender, handedness, age and whether their first language was Danish. It further contained a frame accompanied by a written pretest-sentence for illustration of the experimental procedure. The test materials consisted of 8 numbered frames (17

cm x 10,7 cm), without written sentences. The frames were supplied in order to standardize the size of the drawings. The frames were numbered in order for students to know which box to use for which sentence. Numbers were placed in the middle above the frame. The presence of the number also eliminated potential ambiguities with respect to paper orientation.

2.3 Procedure

The experiment lasted approximately 15 minutes. It was carried out in 22 different classes. Each class was tested on a different set of sentences (see above). Students were first told to fill out the front page and the consent form. Subsequently, the procedure of the test was explained and participants were instructed not to focus on the aesthetic qualities of their drawings, but simply to draw stick figures when illustrating the sentences (see Figure 1). The participants were free to use their preferred writing tool, and they were allowed to erase. A pre-test-sentence was used to give the participants a sense of the task. The pre-test sentence was both read aloud to the participants and written on the page, and after drawing this, the participants were allowed to ask questions. They were subsequently informed that during the experiment no questions would be allowed, and that the motivation for the experiment would be revealed afterwards. All test-sentences were played twice. Drawing began immediately after the 2nd sentence presentation. Participants were given 60 s. to finish each drawing. If any communication between the participants emerged during the experiment, this was immediately stopped by the experimenter.

**** FIGURE 1 AROUND HERE ****

2.4 Coding and Analysis

We used a binary coding for the dependent variable: [1] if the male character was depicted to the left of the female in the drawings; [0] if the female character was drawn to the left of the male and [NA] if left-right organization could not be determined. A total of 4240 drawings were coded. Two independent coders, blinded to the stimuli and experimental hypotheses, judged if the male character was located to the left. Initial agreement was 96.3 %. Disagreements were solved by discussion. Subsequent agreement was 99.6%. Drawings that did not contain left-right organization (as judged by both coders) or where the coders disagreed on coding were discarded, leaving 3840 drawings for analysis.

Data were submitted to a linear mixed-effects logistic regression analysis using the `glmer()` function (Bates, Mächler, Bolker, & Walker, 2015) in R incorporating a maximum likelihood model fit (Laplace Approximation). Both the data and the script for analyses are available from the Open Science Framework: osf.io/9d5pa.

The statistical model was based on our hypotheses. Five categorical main effects were included as fixed effects. These were: FIRST (FF/MF): Gender of person named first in the sentence; AGENT (FA/MA): Gender of the AGENT in the sentence; SUBJECT (FS/MS): Gender of the grammatical subject of the sentence; GENDER (FP/MP): Gender of the participant; DEMONSTRATIVE (PD/DD): Use of proximal (here) or distal (there) adverb in combination with object pronoun to form a demonstrative (e.g. *Ham her [him here, i.e. this guy]*). Given that the demonstrative is bound to the grammatical object of the sentence, our hypothesis also specifically targeted the interaction term: SUBJECTxDEMONSTRATIVE as a model of this relationship. However, to allow for the observation of unexpected events, we employed an additional model with all possible

interactions. A model comparison found that the complex model represented no significant improvement in explaining the data ($\chi^2(25)=32.1$, $p=0.15$). We therefore report the results of the hypothesis-based model, where PARTICIPANTS and VERBS were included as random effects in order to counter any biases in sampling. An initial regression analysis (see osf.io/9d5pa for the analysis script) found no effect of handedness ($\chi^2(2)=4.3$, $p=0.11$), and handedness was dropped as a variable in order to avoid model inflation.

Inferences were made using type II Wald chi-square tests. The Benjamini & Hochberg (1995) false discovery rate correction for multiple comparisons was applied to p-values.

3. Results

Overall 51.7% of the drawings had the male character on the left. Using a null-model in `glmer()` with participants and verbs as random effects, we did not find a significant overall gender asymmetry ($z=1.44$, $p<0.15$). Hypothesis E was thus not supported. Distribution across dependent variables can be seen from table II and figure 2.

****TABLE II AROUND HERE****

Placement of the characters in the drawing was significantly affected by who (male/female) was named FIRST ($\chi^2(1)=109.58$, $p(fdr)<0.0001$). This yields support to hypothesis A. An effect was found for whether the female/male character was the AGENT ($\chi^2(1)=115.98$, $p(fdr)<0.0001$), adding support to hypothesis B, and for whether the female/male character was the grammatical SUBJECT ($\chi^2(1)=20.75$, $p(fdr)<0.0001$), adding support for hypothesis C. We found no main effects of distal/proximal DEMONSTRATIVE use ($\chi^2(1)=1.25$, $p(uncorrected)=0.27$) and did not see a significant grammatical SUBJECT x DEMONSTRATIVE interaction ($\chi^2(1)=1.45$,

$p(\text{uncorrected})=0.23$) and thus could not support hypothesis D. Contrary to hypothesis F, we found no main effect of participant GENDER ($\chi^2(1)=1.98$, $p(\text{uncorrected})=0.16$), i.e. participants were not prone to draw their own gender more to the left.

****FIGURE 2 AROUND HERE****

4. Discussion

We replicate previous findings showing how the first mentioned item in a sentence, the agent and the grammatical subject of the sentence tends to be depicted to the left in a drawing (Stroustrup & Wallentin, 2018). These findings add to the increasing number of studies that find effects of reading habits on non-linguistic cognition, such as the processing of near/far space (Braine, Schauble, Kugelmass, & Winter, 1993; Vaid, Rhodes, Tosun, & Eslami, 2011), on aesthetic preference (Chokron & De Agostini, 2000; Anne Maass, Pagani, & Berta, 2007), and in the perception of violence (Anne Maass et al., 2007), also when it applies to calling a foul in a soccer game (Kranjec et al., 2010).

The position of the first named, the agent and the grammatical subject in a sentence are statistically correlated in Danish: SVO sentences are 1.5-4 times as frequent as OVS sentences (Thomsen & Kristensen, 2015) and verbs in the passive form only make up 5-7% of the total number of finite verbs in both written and spoken Danish (Laanemets, 2013). This distribution of sentence types fits with the idea that the language has different means by which to allocate attention to different parts of the sentence, but that the norm is to use different attention markers in unison (see introduction). This interpretation is also supported by the observation that although both subject and object can occur in the first position in Danish, in discourse, object-first sentences are only licensed in special

situations, i.e. if it is somehow singled out in the preceding discourse and made “topic-worthy” (Kristensen, 2013).

Other studies have also shown how linguistic structure is linked to attention in sentence production experiments (Gleitman, January, Nappa, & Trueswell, 2007; Andriy Myachykov, Ellis, Cangelosi, & Fischer, 2013; A. Myachykov & Garrod, 2008; Andriy Myachykov, Garrod, & Scheepers, 2012; Andriy Myachykov & Tomlin, 2008; Andriy Myachykov, Tomlin, & Posner, 2005; Tomlin, 1995), e.g. Tomlin (1995) found that participants often mention a given element in a description of a scene first, if their attention is directed towards it. If an arrow is pointed towards a dark fish as it is being eaten by a lighter fish, English speakers will tend to describe the scene with a passive construction (“the dark fish is being eaten by the light fish”) whereas they will use an active construction if an arrow points their attention to the light fish (“the light fish eats the dark fish”). Similar studies have been conducted with Russian and Finnish speakers (A. Myachykov & Garrod, 2008; Andriy Myachykov & Tomlin, 2008).

We find, however, that there are limitations to how much influence markers of prominence have in their ability to influence the left-ward bias in drawings. We did not observe any effects of demonstratives, although they have attested functions as attention allocators in language (Diessel, 1999). The reason for this may be that demonstratives primarily are used in a spoken context. They may, thus, not be associated with as strong a left-ward bias as other attentional markers, if this bias primarily stems from experiences with written language.

We did not find support for the two gender hypotheses. Gender stereotypes (hypothesis E) do not seem to be so manifest in the minds of young Danish high school students to make them pay more

attention to the male character in the sentences. Neither did we find any support for the own gender bias hypothesis (hypothesis F). Three main interpretations may be presented for these null-findings: 1) either the biases are not there, 2) they are too weak to be pick picked up by the experiment, or 3) the experiment is not geared to observing these kinds of effects.

The observed gender bias effects in other types of research (see introduction) speaks against the first option, although gender effects also have a tendency to be inflated in research (Wallentin, 2009). We note that in both this experiment and Stroustrup and Wallentin's previous (Stroustrup & Wallentin, 2018), a non-significant (and thus weak) nominal effect has been found, pointing in the direction of males being depicted to the left more often. If this reflects anything else than noise, it has to be noted, that the effect thus must be weak compared with the other effects investigated in our experiments, given that we cannot find a significant effect with more than 500 participants.

In favor of the latter explanation and the lack of an effect of demonstratives, one might speculate that it is not prominence per se that causes sentence elements to be left lateralized in imagery, but a closer connection between prominence and leftward positioning in written language. Although gender stereotypes have linearization correlates as mentioned in the introduction, these may not be strong enough to override actual word order as it is played out in the experimental sentences.

For each drawing, the participant can only choose between two options in her drawing (male left/female left). If the participant chooses to draw the male or own gender on the left, this has to happen in a manner which is statistically independent of the other independent variables. Due to the counterbalancing procedures of the experiment, any effect observed in the present data thus arises from the situations where the participants choose to draw a particular character on the left despite

the fact that other variables suggest a different order. A hypothetical gender effect would therefore reflect trials where participants choose to override the other factors and place the prominent gender to the left. This may require a stronger gender bias than what is present among Danish high-school students.

Further studies with fewer dependent variables or using other methods may come closer to disentangling these possibilities. The fact that we find lateralization effects for other variables consistent with those observed in previous experiments, points towards the experiment having the power for detecting effects if they are strong enough. The competition from the other variables, however, may overshadow weaker effects. Conversely, we may conclude that the effects of being mentioned first, being the agent and grammatical subject are strong enough to survive in an experiment with added complexity, underlining the replicability of these effects.

We found no evidence that biomechanical constraints, such as handedness, play a role in the distribution of figures in the drawings. This is to some extent contrary to previous research that has found that hand use in right-handers interacts with drawing and sentence comprehension (Boiteau & Almor, 2017; Braswell & Rosengren, 2002), e.g. righthanders have been observed to draw from left to right when asked to draw with their right hand, but from right to left when drawing with their left hand (Braswell & Rosengren, 2002) and it has also been observed that the left hand is more sensitive to agent/patient biases during a sentence comprehension task (Boiteau & Almor, 2017). It seems, however, that left-handers do not have a similar reversed pattern of drawing. This supports the notion that the effects are not simply a matter of handedness, but reflect reading and writing habits along with what is brought to the forefront of attention.

In summary, our experiment replicates previous experiments showing that the first mentioned element in a spoken sentence in Danish is imagined as placed to the left of the second named element; that the agent in a sentence is displayed to the left, and that the grammatical subject is placed to the left of the grammatical object. No effects were found for gender and demonstratives.

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Table I. Example sentences.

Sentence	Danish examples	English translation	First	Agent	Subject	Demonstrative
1	<i>Hun kysser ham der.</i>	<i>She kisses that guy.</i>	FF	FA	FS	DISTAL
2	<i>Hun kysser ham her.</i>	<i>She kisses this guy.</i>	FF	FA	FS	PROXIMAL
3	<i>Hende der kysses han af.</i>	<i>That girl, he is kissed by.</i>	FF	FA	MS	DISTAL
4	<i>Hende her kysses han af.</i>	<i>This girl, he is kissed by.</i>	FF	FA	MS	PROXIMAL
5	<i>Hun kysses af ham der.</i>	<i>She is kissed by that guy.</i>	FF	MA	FS	DISTAL
6	<i>Hun kysses af ham her.</i>	<i>She is kissed by this guy.</i>	FF	MA	FS	PROXIMAL
7	<i>Hende der kysser han.</i>	<i>That girl, he kisses.</i>	FF	MA	MS	DISTAL
8	<i>Hende her kysser han.</i>	<i>This girl, he kisses.</i>	FF	MA	MS	PROXIMAL
9	<i>Ham der kysser hun.</i>	<i>That guy, she kisses.</i>	MF	FA	FS	DISTAL
10	<i>Ham her kysser hun.</i>	<i>This guy, she kisses.</i>	MF	FA	FS	PROXIMAL
11	<i>Han kysses af hende der.</i>	<i>He is kissed by that girl.</i>	MF	FA	MS	DISTAL
12	<i>Han kysses af hende her.</i>	<i>He is kissed by this girl.</i>	MF	FA	MS	PROXIMAL
13	<i>Ham der kysses hun af.</i>	<i>That guy, she is kissed by.</i>	MF	MA	FS	DISTAL
14	<i>Ham her kysses hun af.</i>	<i>This guy, she is kissed by.</i>	MF	MA	FS	PROXIMAL
15	<i>Han kysser hende der.</i>	<i>He kisses that girl.</i>	MF	MA	MS	DISTAL
16	<i>Han kysser hende her.</i>	<i>He kisses this girl.</i>	MF	MA	MS	PROXIMAL

Table II. Percent Male/Female drawn on left

First	Agent	Subject	Demonstrative	% Male left	% Female left
FF	FA	FS	DISTAL	31.3	68.7
FF	FA	FS	PROXIMAL	33.0	67.0
FF	FA	MS	DISTAL	39.3	60.7
FF	FA	MS	PROXIMAL	38.8	61.2
FF	MA	FS	DISTAL	56.4	43.6
FF	MA	FS	PROXIMAL	46.6	53.4
FF	MA	MS	DISTAL	51.2	48.7
FF	MA	MS	PROXIMAL	52.9	47.1
MF	FA	FS	DISTAL	46.0	54.0
MF	FA	FS	PROXIMAL	50.2	49.8
MF	FA	MS	DISTAL	50.9	49.1
MF	FA	MS	PROXIMAL	61.3	38.7
MF	MA	FS	DISTAL	62.3	37.7
MF	MA	FS	PROXIMAL	64.6	35.4
MF	MA	MS	DISTAL	73.0	27.0
MF	MA	MS	PROXIMAL	73.8	26.2

Figure captions

Figure 1. Participants were asked to draw stick figures illustrating the content of sentences read aloud to them, e.g. using English glossing: A: “This girl, he is kissed by” [FF, FA, MS, PD]; B: “That girl, he hugs” [FF, MA, MS, DD]; C: “He is being pointed out by that girl” [MF, FA, MS, DD]; D: “She shoots this guy” [SF, SA, SS, PD]; E: “She is being followed by that guy” [FF, MA, FS, DD]; F: “He kicks this girl” [MF,MA,MS,PD]. Drawings were coded for whether the male or female character was to the left of the other character in the drawing. Independent variables were FF/MF: The female/male character was named before the other; FA/MA: The female/male character was the agent performing the action; FS/MS: The female/male character was the grammatical subject of the sentence; PD/DD: the grammatical object was coupled with an adverb to form a proximal (here) or distal (there) demonstrative.

Figure 2. Percentage drawings with the female/male character on the left for each sentence type. Chance level=50%. FF/MF: Female/Male named First, FA/MA: Female/Male Agent; FS/MS: Female/Male sentence Subject; DD/PD: Distal (there)/Proximal (here) Demonstrative.